Our Ice Age: The Geohistorical Imagination in the Northern Hemisphere

by

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Graduate Program in Literature
Duke University

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Dissertation submitted in partial fulfillment of
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ABSTRACT

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Abstract

"Our Ice Age: The Geohistorical Imagination in the Northern Hemisphere" contributes to discussions in the environmental humanities about the historical and narrative significance of climate change by examining representations of the ice age, a relatively recent geological moment that began 2.5 million years ago and continues, according to climatologists, into our own "interglacial" time. Linking scientific and literary narratives of our warming interglacial world with those of the last glacial epoch, this dissertation analyzes the imagination of climate change when planetary forces, rather than humans, serve as the primary drivers, and theorizes this discourse's continuing relevance for understanding anthropogenic global warming. Across a variety of texts, this dissertation traces the persistence of two forms of storytelling—"gradualist" narratives of slow change and "catastrophist" plots of rapid transformation—that define representations of both the last glacial period and contemporary global warming. Observing this continuity, this project argues that current responses to global warming are not composed solely of modern reactions to a genuinely new situation; they are sedimented stories formed from climate change's past as a long-standing social, political, scientific, and environmental problem.

The four chapters of "Our Ice Age" traverse the Northern Hemisphere and range from the nineteenth century to the present. Chapter one analyzes two major works of ice

age geology, Louis Agassiz's *Studies on Glaciers* (1840) and James Croll's *Climate and Time* (1875). Concentrating on the narrative form of these books, this chapter observes how Croll's gradualist story of the ice age, in which climate change occurred slowly over time, came to supplant Agassiz's initial catastrophic vision. Chapter two explores two novels, Johannes Jensen's *The Long Journey* (1922) and Kim Stanley Robinson's *Shaman* (2013), in order to demonstrate how our fascination with human survival during the glacial epoch prompted both catastrophist and gradualist forms of climate fiction. Moving to the interglacial present, chapter three discusses the scientific, political, and cultural significance of the melting Arctic for researchers and indigenous communities; this chapter draws from a range of nonfiction about the "New Arctic," including William Glassley's *A Wilder Time* (2018) and Sheila Watt-Cloutier's *The Right to Be Cold* (2015). Chapter four explores the politics of Pleistocene Park, a wildlife reserve in Siberia created to mitigate catastrophic global warming by reviving its ice-age ecosystem. Embracing both of the philosophically-opposed practices of "rewilding" and geoengineering, the park represents an ambiguous response to the conditions of the Anthropocene. Theorizing the "geohistorical imagination" that threads through these texts, this research shows how representations of the ice age perpetually shape our collective understanding of climate change.

In sum, this dissertation encourages the environmental humanities to serve as a more spacious venue for interdisciplinary conversations about the environment. This work draws inspiration from across disciplinary boundaries, not only using the tools of literary criticism to reflect on geology, ecology, environmental history, but also wielding insights from those fields in narrative analysis. Just as Hayden White read nineteenth-century historians for how they "emplot" history, this research reads geological and ecological treatises as a form of storytelling. At the same time, this research widens literary interpretation: where most humanist studies of the relationship between culture and environment focus exclusively on ecological transformations that have occurred since the industrial revolution or the post-WWII "great acceleration," this work digs into evolutionary and geological history. This project interprets cultural products against the backdrop of geological time and human evolution. "Our Ice Age" thereby establishes a conceptual framework in which literary and scientific discourses meet productively to shed light on the consequences of climate change.

Dedication

For my parents, who raised me on Long Island, where the ice of the last glacial epoch ended, and whose love, patience, and support has been the bedrock of everything I have ever done.

Contents

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This project began with the encouragement of my committee, Michael Hardt, Priscilla Wald, Fredric Jameson, and Robyn Wiegman. I am immensely grateful for the support I have received from them throughout the process of composing this dissertation. I also wish to thank Brent Ryan Bellamy, Veronica Hollinger, and the anonymous reviewers at *Science Fiction Studies* who helped me work on many of this dissertation's ideas in an essay.

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Introduction: Our Ice Age

My approach to the environmental humanities through geological history emerged, I like to think, from my experiences on Long Island, where I grew up among the remains of the last ice age. My most prominent memory is of a five-million-pound boulder that sat near my elementary school, a glacial erratic scraped from the bedrock and deposited toward the end of the Pleistocene epoch. I vividly recall when a teacher of mine, gesturing toward the school's window, invited my class to imagine a two-mile-high ice sheet on the horizon, slowly bearing the granite rock to that precise location 20,000 years ago. Asked for the first time to consider the impermanence of the environment, the agency of nonhumans, the unimaginable temporality of the past, I felt at the time a sense of wonder and disquiet that such a temperate place had once been engulfed by ice. Today, as I look back on that memory, the historical irony is hard to miss. Long Island is one of the many coastal areas threatened by the rising oceans and superstorms of global warming, a space that in the deep future may no longer be able to sustain the forms of life, including the humans, that made their home there. Seen over the temporality of the planet, Long Island weaves together the glacial past and the warming future, a landscape composed by one and fated to dissolution by the other. Prompted by my encounters with the island's geological features and its endangered future, this dissertation focuses on the kinds of storytelling—in literature, film, science, or nonfiction—that capture the continuity between geohistory and the present, and that seek to understand the importance of the Earth's deep history for us today.

"Our Ice Age: The Geohistorical Imagination in the Northern Hemisphere," examines scientific and literary narratives of the ice age in order to understand these subjects. In a moment of global warming, ice ages may seem to be of little importance. The most recognizable figures of climate change point our minds in precisely the opposite direction: we confront scenes of a "drowned world," as J.G. Ballard puts it, with melting glaciers and a rising sea level, rather than continents layered under ominously advancing ice sheets, or wooly mammoths roaming the steppe. The greatest indication of the climatological transformations we face can be seen precisely in the disappearance of glaciers and sea ice in the Arctic polar region, where warming happens at a significantly higher rate than the global norm. With the waning of the ice, what could be less crucial than the period in Earth history when glaciers flowed across the Northern Hemisphere? In the Anthropocene, when the power of the cryosphere has been replaced by human power, what is the relevance of the ice age? The fundamentally counterintuitive claim of this dissertation is that although we are in a period of global warming, ice ages are relevant as a way of interpreting the present.

Some of this claim rests on a rather remarkable description that some paleo-climatologists give to our current planetary state: that we are living in an ice age. When we speak of "the ice age," we typically refer to a period of glaciation that began around

116,000 years ago; the Last Glacial Maximum, which names the greatest extent of these glacial advances, occurred roughly 21,000 years ago.[1] The end of this particular period of cold 11,700 years ago marks the start of the Holocene epoch, and all of what we refer to as human "civilization." But this is a limited conception of what ice ages are. More broadly, ice ages are defined as "a period of the Earth's history in which at least one of the poles was glaciated," and in that sense ice ages mark much longer periods of time.[2] For most scientists, our current geological period—the Quaternary, which began roughly 2.5 million years ago —is itself one long ice age. Ice ages in this conception have glacial and interglacial periods of relative warmth and cold: what we usually call "the ice age" is merely a period of glaciation within a larger ice age. Perhaps more bewildering, our current geological epoch, the Holocene, is merely an interglacial within one long ice age. As David Archer explains, "a time period such as today, with permanent ice sheets somewhere on Earth, will be referred to as a 'great ice age.' Within our current great ice age, the ice sheets periodically grow and melt back, and global temperature rises and falls, in what are called 'glacial cycles.' The Earth is currently in an interglacial interval of a great ice age."[3] We all, in that sense, live in an ice age, whether we know it or not.

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[1] Marshall 208
[2] Ehlers, Hughes, and Gibbard 43
[3] Archer 78

Linking representations of our warming interglacial world with those of the last glacial epoch, "Our Ice Age" analyzes the imagination of climate change when planetary forces, rather than humans, serve as the primary drivers, and theorizes this discourse's continuing relevance for understanding anthropogenic global warming. I suggest, over the course of this project, that ice ages remain relevant in a number of different ways: they underpin scientific research and understandings of climate systems; they shape how literary artists conceive of climate change; they provide the historical context for the melting Arctic today; and they influence how some scientists think we ought to respond to our current ecological predicament. They are relevant, most broadly, for sharpening our understanding of the present situation; as a different form of climate change, the ice age allows us to imagine a moment that is both substantially alien and eerily similar, and in turn enables us to reflect on the present as if from the outside. In this sense, we may see the significance of Jamie Woodward's statement: "Paradoxically, in an era of warming climate, the study of the ice age past is now more important than ever."[4]

Generally speaking, ice ages only appear as an object of study for the sciences. While this dissertation frequently makes reference to scientific work, it pursues a number of different formal and generic avenues for understanding the ice age, including science fiction, literature, poetry, films, graphic novels, and nonfiction essays. As with the study of contemporary climate change, cultural objects help us to piece together the

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[4] 142

significance of the ice age beyond the bare bones of empiricism. They are usefully read together with scientific accounts because they form a more comprehensive picture, helping us to understand both the environmental and societal consequences of a geohistorical event that far exceeds what we are typically called upon to grasp and make meaningful. The aim of "Our Ice Age," then, is as much to rethink how we approach climate change through a scientific perspective as it is to understand how literature helps us imagine deep history, and how it may be interpreted from that perspective.

This project contributes to the environmental humanities, a field that joins the study of literature, culture, and history with the study of the environment. Writing in the environmental humanities typically demonstrates how an ecological lens sheds light on literary texts, historical moments, and philosophical questions; at the same time, it considers what we can learn about the environment from literature, history, and philosophy. Although "Our Ice Age" draws on insights from all three of the branches of the environmental humanities, as a literary project it is most aligned with the project of "ecocriticism." In its initial formulations, as in Lawrence Buell's pathbreaking *The Environmental Imagination* (1995) and Cheryll Glotfelty and Harold Fromm's *The Ecocriticism Reader* (1996), this sub-field concentrated on Anglo-American texts, and was concerned with nature writing, pastoral aesthetics, dwelling and the georgic, the wilderness, the idea of place, and representations of waste, environmental degradation, and pollution. Such concerns transformed quickly into international and politically-oriented commentary around the problems of environmental justice, as in Joni Adamson, Mei Mei Evans, and Rachel Stein's *The Environmental Justice Reader* (2002) or Rob Nixon's *Slow Violence and the Environmentalism of the Poor* (2013).[5] More recently, literary scholars have also begun discussions around large-scale environmental transformations like climate change and the Anthropocene, as in Jesse Oak Taylor's analysis of climate and the London fog in British literature in *The Sky of Our Manufacture* (2016).[6]

"Our Ice Age" participates in this field, to begin with, by continuing "second wave" ecocriticism's efforts to move beyond the Anglo-American context. Nixon's *Slow Violence and the Environmentalism of the Poor* stands as one of the most significant achievements in this regard: it moves seamlessly between different historical and environmental contexts to discuss a staggering range of situations: Union Carbide's Bhopal factory leak, oil extraction in the Middle East and Nigeria, dam building in India and Arundhati Roy's response, South Africa and ecotourism, climate change in the Maldives, and so on.[7] My archive, too, extends beyond national boundaries, although I do not reproduce the breadth of Nixon's study. My primary concern will be with texts

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[5] For field overviews, see Heise's and Buell's articles.
[6] These two terms, despite how frequently they are discussed together, do not designate the same thing. Where global warming designates an observed rise in the global mean temperature since the mid-twentieth century caused by greenhouse gases, the Anthropocene conceptualizes a larger series of geologically recognizable human interventions into planetary ecosystems. The Anthropocene includes the problem of anthropogenic global warming, in the sense that human carbon output will be recognizable in the geological record, but it is not defined by it.
[7] See Nixon, *Slow Violence and the Environmentalism of the Poor*

from the Northern Hemisphere—Europe, Russia, North America, and the Arctic circles to be precise; texts have their origins in a range of national situations, including Switzerland, Scotland, Denmark, the United States, Inuit communities in Canada, and Russia. Such a transnational commitment speaks not only to the way in which the idea of the ice age travels across international borders, but also to the important fact that the issue of climate change stands as a global, rather than national, problem.

"Our Ice Age" also continues the practice, exhibited in some recent examples of environmental humanities work, of placing different kinds of texts—scientific, literary, nonfiction, public policy—in conversation. Ursula Heise's *Imagining Extinction* (2016), for example, addresses the problems of extinction and endangered species by reading the narrative form of different representational situations; in one memorable reading, for example, Heise reads an endangered species databases as a kind of "epic" and places it in conversation with Margaret Atwood's extinction novel *Oryx and Crake*.[8] This dissertation similarly encourages the environmental humanities to serve as a more capacious tent for interdisciplinary conversations about climate change. This work cuts across disciplinary boundaries, not only using the tools of literary criticism to speak about geology, ecology, and environmental history, but also enabling insights from those fields to impact narrative analysis. My research reads geological and ecological treatises as a form of storytelling; at the same time, it widens literary interpretation to

[8] See Heise, *Imagining Extinction*, chapter 2, "From Arks to ARKive.org: Database, Epic, and Biodiversity."

include geological history: I see science fiction and literary nonfiction as genres with an imagination of the nonhuman time of the planet.

But in addressing climate change from a significantly different perspective, this dissertation also attempts to break with certain habits and limitations within the environmental humanities. For Dipesh Chakrabarty, both climate change and the Anthropocene require us to formulate a substantially new concept of history, in which the history of modernity must now be seen in conjunction with the deep histories of the human species and the planet.[9] While humanist contributions on the Anthropocene often cite from Chakrabarty's work, they have largely been uninterested in embracing the implications of such a new view of history. Chakrabarty remarks that what tends to happen in discussions of climate change is the containment or "folding" of geological time back into human time.[10] A typical humanist engagement with the Anthropocene inevitably performs the same action by folding the Anthropocene within an all-too-narrow disciplinary perspective: for scholars of the post45 period, the Anthropocene begins with the "great acceleration," for the Victorian scholar, it begins in the industrial era, for the Romanticist, it starts even earlier, and so on. Despite the generally historicist impulse behind so many of these engagements, they are inevitably "presentist," insofar as they focus on relatively recent events; they fail to address, in other words, the

[9] See Chakrabarty, "The Climate of History: Four Theses."
[10] See "Anthropocene Time."

Anthropocene in the context of geological history. The field is still stuck in the present, despite the call of the Anthropocene into deep history. My work's contribution is to move the field into that direction. I am embracing the problem of the Anthropocene—its nonhuman temporality—to its fullest extent. We have thus far been skating on the surface of history; the point is to fall through the ice and embrace geohistory's cold waters. This dissertation thinks through the ice age in both geohistorical and human scales; my aim is to think human time and geological time all at once.

I understand my effort to challenge this ingrained form of anthropocentric thinking as part of an effort to provide a theoretical contribution to the environmental humanities. It has often been remarked that this field lacks a theoretical inclination. This is certainly true of "ecocriticism" from the 1990s, which grew spontaneously apart from theoretically oriented forms of literary criticism like psychoanalysis, Marxism, deconstruction, postcolonial criticism, feminist criticism, and queer theory. What makes ecocriticism untheoretical, or at least beside theory, is hard to say, and depends entirely on how we define "theory."[11] This dissertation aims to be theoretical because it is interested in historicizing thought, for example the way we conceptualize climate change and the Anthropocene. It is also theoretical in that one of its primary concerns is literature's relationship to history; in particular, I ask what happens to the text/context

[11] Andrew Cole presents a number of different ways of defining theory, one of which is that theory "historicizes thought" (810).

binary when history becomes more than what we are accustomed to. Fredric Jameson's *The Political Unconscious* remains one of the most significant engagements with the problem of reading literature historically, and serves as an anchor for this project. For Jameson, textual interpretation must proceed through a series of horizons: it first involves encountering a text within a local political horizon; it then moves to considering it within a broader social framework of class struggle; finally, the analysis opens up to include the mode of production.[12] The importance of this hermeneutic method may not be immediately clear in this context, given how the nonhuman environment finds itself excluded entirely.[13] But, in an effort to grasp the problems generated by climate change and the Anthropocene, my work expands Jameson's layers of interpretation into deep history: moving not only through economic and political frameworks, but also into environmental, evolutionary, and geological ones.[14]

Central to the intellectual trajectory of "Our Ice Age" is the concept of the "geohistorical imagination," a phrase I borrow from the historian of geology Martin J.S. Rudwick.[15] The geohistorical imagination, in my understanding, refers to our capacity for imagining the planet historically. It involves seeing a place, or the entire planet,

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[12] Fredric Jameson, *The Political Unconscious*, 75.
[13] This is an interesting omission on Jameson's part, particularly because his framework for the layers of history owes a debt, as he acknowledges, to Fernand Braudel. But it is also not surprising, in the sense that deep history (both geological and species) is still generally excluded from most historical accounts.
[14] Chakrabarty articulates the precise way in which climate change forces us to bridge a number of different scales of history—the geological, the human, and political. "Climate and Capital," (1)
[15] In *World's Before Adam*, Rudwick briefly uses the term to describe a particular essay by Charles Lyell (256). It seems to me that Rudwick's magisterial project, in this book as well as its companion volume, is to trace the birth and development of the geohistorical imagination.

undergoing enormous environmental changes over time, like when you picture the landscape before you morph from one environment to another in a sequence, from tundra to grassland, or from forest to city, as if the geological history of a single place could be seen all at once, vertically broken up into layers. The geohistorical imagination is a recognition of the historicity of nature, and is therefore not merely an acknowledgement of the existence and importance of the nonhuman world, as in the environmental imagination of nature writing.[16] The geohistorical imagination aims, as Chalres Darwin writes, "to regard every production of nature as one which has had a history."[17]

For this project, it is crucial to note that the geohistorical imagination is not merely a static form of picturing, like placing two different images together to conjure up something new. I argue that this form of imagination is fundamentally narrative, by which I mean that to imagine geohistory is to place events into a connected sequence. Just as Hayden White envisioned the ways in which nineteenth-century historians "emplot" human history, I suggest that the geohistorical imagination—whether it appears in works of geology, where it first emerged, or in literary texts or nonfiction—contains a fundamental element of storytelling. As the geologist Marcia Bjornerud remarks, "[t]he dramatic narratives of the geologic past are perfectly suited to the

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[16] I borrow this term from Lawrence Buell's *The Environmental Imagination*.

[17] Darwin, *On The Origin of Species*

human appetite for storytelling."[18] What this dissertation tracks through its four chapters, then, is not merely the presence of this way of imagining the world, but how the planet comes to be brought into narrative terms. The invention of the ice age in particular, I claim, was a profoundly imaginative act, in the sense that it required the observation of contemporary circumstances, and an extrapolation and reconnection of those circumstances. Thus my title references the fact that the ice age is both a real event in the past of the planet—a period of Earth history we have lived through and which has formed us—as well as a narrative construct, a scientific fact produced through human efforts, subsequently narrated in a variety of textual circumstances.

My effort to unfold how the ice age is produced through imagining geohistory proceeds both chronologically and thematically. This dissertation's four chapters traverse the Northern Hemisphere and range from the nineteenth century to the present. Understanding the ice age as a moment still present, my dissertation considers representations of glacial periods but also approaches the present interglacial as part of an ice age. In the first two chapters, I analyze scientific and cultural representations of past and futures ice ages, from the earliest theorizations of that form of climate change to relatively recent novels and films. In the second two chapters, I explore the significance of considering our own time as an ice age. In this sense, the first half of the dissertation concerns itself with the "glacial," while the second half is occupied with the

[18] Bjornerud 174

current “interglacial.” The shift from glacial to interglacial also moves chronologically: we begin in the 19th century, when the term the term “ice age” was first coined in a poem by the German scientist Karl Friedrich Schimper in 1837; moving into the 20th and 21st century, I explore climate fiction written about the humans of the last glacial period. Remaining in the contemporary moment, the second half of the dissertation explores writing about the “New Arctic” and a scientific projecting responding to that new situation.

Conceptually, the first section concerns itself with awakening our sense of geohistory, our ability to imagine geohistory through science and literature. I understand geohistory to be a particularly difficult representational subject: not merely because of the sublime temporality of deep history, which defies our cognitive capabilities, but also because of many different forms of agency that populate that history. Geohistory, in this sense, seems to have many of the same characteristics that scholars assign to contemporary climate change. In his important book *The Great Derangement*, Amitav Ghosh suggests several reasons why literary novels might struggle to represent climate change, but it seems to me that these categories might be more broadly used to understand why climate change is difficult to represent in any medium: For Ghosh, the improbable events of climate change, its nonhuman entities, and its geological time scales are reasons for it to be difficult to humans to hold on to with our modern ways of knowing the world: we have come to see the temporality of daily life as the only one that remains relevant to us, and we have come to assume, as Bruno Latour first reminded us, that the nonhuman agents of the world do not matter very much. Both these challenges are as true of climate change as they are of the Earth's deep history more broadly, and it is for this reason that the first half of the dissertation attempts to work through the texts that succeed in finding narrative strategies to represent geohistory. The second half of the dissertation, meanwhile, begins to think more about how this new perspective may be applied to contemporary writing and politics. The first section teaches us how to imagine deep history; the second section attempts to understand how we might begin to interpret the contemporary moment through deep history, and develop political positions from it. Political claims and actions are easy to think of as separate from the nonhuman agents and long temporality of deep history: politics is confined to human activity, and to the time in which those activities can take place. And yet what the second half of this dissertation project shows is that the imagination of geohistory—the historicity of the planet—can have direct implications for political claims and ecological activities surrounding global warming. In that sense, this dissertation tells the story of how deep history can come to inform our understanding of the present.

Chapter one explores the long "birth" of the concept of the ice age in nineteenth-century Europe. I begin the story of how ice age science emerged in the history of the geohistorical imagination. Following the work of Rudwick, I suggest that the basis for the geohistorical imagination emerged as early naturalists began to reconstruct the planet's past outside of traditional mythologies, a process that involved greater attention to the immense age of the planet as well as the diversity of nonhuman agents important for shaping the Earth. But even as more empirical efforts were made to understand the planet's past, the narrative element continued. I demonstrate that geological texts are best read for the ways in which they narrate or "emplot," to use White's term, geological history, and I assert in particular that the narrative forms of catastrophism and gradualism retain the greatest importance. Having explored this history of the geohistorical imagination, I then analyze two major works of ice age geology, Louis Agassiz's *Studies on Glaciers* (1840) and James Croll's *Climate and Time* (1875). First, I recount how Agassiz arrived at a "catastrophic" narrative about the ice age, in which all life suddenly perished on Earth. Next, I examine Croll's *Climate and Time*, which emphasized the multiplicity of nonhuman "physical agencies" that were responsible for climatic cycles. Unlike Agassiz, Croll relied on a uniformitarian or "gradualist" narrative of Earth history in which geological processes move slowly and life adapts. Concentrating on the narrative form of these books, I demonstrate how Croll's gradualist story of the ice age, in which climate change occurred slowly over time, came to supplant Agassiz's initial catastrophic vision. Taken together, Agassiz's and Croll's texts not only exemplified the geohistorical imagination but also inaugurated climate science by theorizing the complexity of global climate, which had previously been conceived in simplistic and mechanistic terms.

Shifting into the realm of fiction, chapter two explores two novels, Johannes Jensen's *The Long Journey* (1922) and Kim Stanley Robinson's *Shaman* (2013), in order to demonstrate how our fascination with human survival during the glacial epoch prompted a strain of "climate fiction" that significantly predates contemporary writing about global warming. Typically, climate fiction is associated with contemporary global warming and its potential futures. But I redefine climate fiction as the literature of the geohistorical imagination, in which human history and geological history are imagined together, as a way of including works about the ice age past. I begin by exploring the first book of Jensen's *The Long Journey*, a novel which mythologizes human evolution and technological advancement while also presenting a catastrophic vision for the ice age. In Jensen's novel, the oncoming ice age forces humans living in a tropical Europe to either adapt to the cold or to migrate south. Such a scenario forms the basis of Jensen's essentially racist myth of human evolution, in which European dominance is originally a product of the adaptive struggle of surviving the ice age. Kim Stanley Robinson's *Shaman* (2013), I show next, has a radically different agenda in turning to human life during the ice age. At the most fundamental level, Robinson's novel is about identifying with prehistoric humans, and creating lines of continuity between now and then. The "gradualist" representation of climate change in the novel—shown through the foregrounding of survival and daily life in the ice age—thereby serves as a way of suggesting that humans today might also finds ways of adapting to the changing climate.

Moving to the interglacial present, chapter three discusses the scientific, political, and cultural significance of the "New Arctic"—a term given to describe the major environmental and geohistorical changes happening to the Arctic with the advent of global warming—in recent nature writing and nonfiction. Describing the end of the ice age in the Arctic, I make a twofold argument in this chapter. To begin with, I suggest that the passage from "old" Arctic writing to new Arctic writing is marked by a shift from a primarily environmental imagination—occupied with ecological interconnections and place—toward a geohistorical imagination, marked as I show in previous chapters by sense of the planet's radical historicity. In examining Barry Lopez's *Arctic Dreams*, a text written just before the effects of global warming, I show how the environmental imagination remains of primary importance in understanding the Far North. Moving on to two different works of what I am calling New Arctic nonfiction, William Glassley's *A Wilder Time* (2018) and Sheila Watt-Cloutier's memoir, *The Right To Be Cold* (2015), I show how the geohistorical imagination becomes substantially more crucial for grasping the Arctic's present situation. Just as in my first two chapters, I suggest that in the process of imagining the present of geohistory, both Glassley and Watt-Cloutier gravitate toward a particular narrative form. For Glassley, a geologist, transformations in the Arctic are represented as gradual and slow, with few urgent consequences. For Watt-Cloutier, an Inuit activist, meanwhile, the Arctic's thawing could not be more catastrophic: the disappearance of ice signals the destruction of the many Inuit cultural practices tied to that particular geohistorical feature. Watt-Cloutier's catastrophism, unlike Agassiz's, therefore serves a direct political purpose: to establish the seriousness of the end of the Arctic, and the need for recognition of the Inuit's fundamental "right to be cold." Catastrophism, rather than gradualism, leads to the possibility for political change.

Remaining in the Arctic, chapter four considers Pleistocene Park, a wildlife reserve in Siberia designed to revive the steppe ecosystem. By reproducing this ice-age environment—including its inhabitants like bison, horses, and even the woolly mammoth, pending its successful de-extinction—the Russian geophysicist Sergey Zimov aims to prevent permafrost from melting, thereby reducing the release of carbon into the atmosphere and mitigating global warming. In approaching Pleistocene Park through several different kinds of media, like documentaries, several popular write ups, and scientific essays by Zimov, I track the kind of geohistorical imagination required to understand this project. I begin with Zimov's underlying vision of recent geohistory, which includes the rapid demise of the woolly mammoth at the hands of nomadic humans. Zimov's story of the mammoth's demise, along with the destruction of the generally stable pasture ecosystem that accompanied it, is fundamentally catastrophic, and therefore akin to the stories told Agassiz, Jensen, and Watt-Cloutier in previous chapters. Moreover, Zimov's sense of what will occur to the planet if Siberia's permafrost is allowed to melt and release an unthinkable amount of methane into the atmosphere, remains wholly within the realm of catastrophism. Yet I suggest that the strange complexity of Pleistocene Park is that it may also be seen, in terms of its practices and vision for the long term future, as a fundamentally "gradualist" response to global warming, because it intends to solve issues of planetary significance over relatively long periods of time. The three practices most important practices in Pleistocene Park—its long term plans for "rewilding," "de-extinction," and "geoengineering"—all represent gradualist responses to the global warming catastrophe. Digging deeper, I claim throughout this chapter that although these practices remain tied together by their gradualist sense of time, they are also profoundly at odds with one another as reactions to the Anthropocene. Zimov's park muddies the distinctions between what I think of as modernist and anti-modern responses to the Anthropocene. In advocating for rewilding, a process by which ecosystems are allowed to reestablish themselves without significant human intervention, Pleistocene Park seems to questions the importance of humans in nature. And yet Pleistocene Park is also interested in bringing back the woolly mammoth through geoengineering, and allowing it to gradually reshape the steppe environment. In a similar sense. The park's entire purpose is in effect to geoengineer the atmosphere, a practice that similarly reasserts human agency over nature. My goal in raising this contradiction is not to disparage the park; it is rather to show the difficulties and challenges of bringing a geohistorical perspective into a contemporary political project that is trying to benefit both the human world and the planet more broadly.

Taken together, these chapters on our ice age and the geohistorical imagination make two interrelated points about narrative and history. As a project fundamentally grounded in the study of literature, the most fundamental of these arguments centers on narrative form. Across the four chapters, I trace the persistence of two forms of storytelling—"gradualist" narratives of slow change and "catastrophist" plots of rapid transformation—that define representations of both the last glacial period and contemporary global warming. The catastrophism and gradualism of climate that are present in early ice age science emerge in different forms in literary works, which come to include human life in those catastrophes and slow transformations of glaciation. What is remarkable, too, is that this way of narrating climate change persists into the present when describing the transformations of the New Arctic. This continuity suggests that current responses to global warming are not composed solely of modern reactions to a genuinely new situation; they are sedimented stories formed from climate change's past as a long-standing social, political, scientific, and environmental problem. The Earth's ice age perpetually shapes how we speak about and act in response to global warming today.

The kinds of storytelling I am interested in speak to several historical points that this dissertation attempts to make, specifically about our conception of human history and geological history. Chakrabarty, among others, asserts that the Anthropocene is a moment of conjuncture between human history and Earth history: as humans intervene in the environment at such enormous scales, we "become geological agents."[19] But the work I present here on the ice age pushes us to consider something different: that we have always been tied to geological history, and that we have always been operating with and in reaction to climatic transformations, even when we have not caused them.[20] A vision of history that sees humans and climate, or humans and geological history, as constantly interacting, implies that the significance of the Anthropocene lies not in the fact that humans need to, only today, see themselves as a part of geohistory, nor in that we must only now survive climate change. What is new in the Anthropocene is our transformation from an environmental factor to a geological one.[21] This is not to underplay the significance of these developments—indeed, our geohistorical situation is most staggering when understood in light of the deeper perspective that the perspective of ice age affords us, from which we can see that the enormity of our impact on the

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[19] "The Climate of History" 207

[20] For a comprehensive review of the link between human and climate history, see John L. Brooke's *Climate Change and the Course of Global History*.

[21] As Will Steffen, Paul Crutzen, and John R. McNeill explain, humans have always had an impact on their environments. The concept of the Anthropocene emphasizes the scale of this impact: "the human imprint on environment may have been discernable at local, regional, and even continental scales, but preindustrial humans did not have the technological or organizational capability to match or dominate the great forces of nature" (614).

planet is unprecedented in the entirety of human evolution—but rather to specify it: we are witnessing a shift in the scale of our relationship to Earth's deep history, not our first contact with it.

"Our Ice Age," in sum, thus attempts to say something rather simple: neither climate change nor our reactions to it are wholly new. Climate change's deep past remains relevant not merely in the sense that geological forces—like orbital cycles and expanding ice sheets—persist, but also because stories about the Earth's ice age continue to inform the narratives of anthropogenic global warming today. The narratives we use remain grounded in those of the ice age past; and the current moment, however new, hardly exceeds the bounds of geological history that have contained humans for their entire earthly existence. Human history has always occurred within the container of geological history: we are not constantly aware of this history, but it informs our habits, what we eat and wear, how we construct our spaces, and how our bodies have evolved over millions of years. Ultimately, to recognize this is to better equip ourselves for understanding warming today, driven by a small segment of the human population, alongside climate change as a nonhuman geophysical force.

1. The Birth of the Ice Age: Narrative and Climate History

On February 15, 1837, the naturalist Louis Agassiz distributed a poem to the audience of one of his *Cours de Geologie* lectures, held in the Swiss town of Neuchâtel. The 21 stanza "scientific document," composed in German by the poet-naturalist Karl Friedrich Schimper, was printed on a leaflet with the help of a local newspaper.[1] Despite the familiarity of the poem's form—an ode in unrhymed, four-line stanzas—the content of the poem was no doubt bewildering to its first audience. The ode begins with an address to the polar bear, a creature more "captivating" than all others in the kingdom of life. The polar bear's allure, more than its appearance, derives from its habitat: although the bear lives "crowded" in the Arctic today, it once lived in the "heart of Europe, still blanketed in winter." Schimper's ode unexpectedly directs us back in time: we learn of Europe's formerly cold climate, in which "Nature" had "buried" itself under ceaseless snow storms and brought to extinction the mammoths and oxen that had previously roamed the "ancient forest." The "bleak and dreary" scene dominated by the "frost's violence" was only disrupted when, from the "bowels" of the planet, the Alps burst through the ice sheet, scattering enormous boulders and causing a "terrible" flood. This deluge marked the moment when life returned to Europe: in a moment of "renewed creation," the polar bear was the first to come into existence, perfectly suited for the chilly environment, but fated to recede pole-ward as the climate became too

[1] Krüger 172

warm, and other creatures, including humans, came into being. Although it might have simply been titled "Ode to the Polar Bear," in a burst of poetic and geohistorical insight, Schimper fittingly titled this poem about Europe's wintry past with a synecdoche: in calling this imagined moment "*Die Eiszeit*" ("The Ice Age"), Schimper defined an entire moment by its most distinctive part: ice.[2]

Although Schimper's poem was meant to be lighthearted, it paved the way for Agassiz's more serious, but no less speculative, attempt to describe the *époque glacée* (glacial epoch) a few months later in July 1837. Gathered in Neuchâtel, members of the Swiss Society of Natural Sciences (*Société Helvétique des Science Naturelles*) expected Agassiz, their president, to deliver an address examining fossilized sea creatures. To their surprise, he announced that his talk would explore the details of "glaciers, moraines, and erratic boulders," a topic entirely apart from his research, but appropriate enough for the lecture's venue, which was not far from the ice-covered Alps.[3] Agassiz began his talk by arguing, following the recent work of fellow academy members Ignatz Venetz and Jean de Charpentier, that the glaciers of the Alps had once been larger than they currently were. But toward the end of his lecture, he moved his talk in a more speculative direction, drawing on ideas he and Schimper had discussed over the past months. He attempted to account for the presence of erratic boulders (giant rocks

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[2] The original German text of this poem, as well as a translation, are available in Krüger 172-176. Unfortunately it appears that a stanza was left out of this transcription. For the full poem in the German original, see Schimper 301-304.

[3] Agassiz, Studies, xlv

scattered across the landscape that differed from the underlying bedrock), rounded pebbles, and polished surfaces in the Jura, a sub-alpine mountain range distant from the glaciers in the Alps. To Agassiz, these features were inexplicable without the agency of glaciers. He therefore surmised that before the dawn of humans, Europe had entered into an "epoch of intense cold," and a substantial ice sheet had formed over the entire continent.[4] Like Schimper, Agassiz proposed that such an enormous ice sheet, lasting for an undefined amount of time, wiped out all life on Earth and only retreated when an even greater geological event, the uplifting of the Alps, broke through the glaciers and generated enough heat to warm the climate.

Agassiz's *époque glacée* and Schimper's *Eiszeit* were immediately debated and rejected by the members of the scientific community, even though similar ideas had recently been proposed. Venetz, who was present in the audience, demonstrated that there had been substantial changes in the size of glaciers in the Swiss Alps that likely corresponded with shifts in the climate.[5] Elsewhere, the Danish-Norwegian mineralogist Jens Esmark explained the presence of erratic boulders in Europe by arguing that they had been transported down to the sea by ice from the Norwegian mountains; this glacial growth, he guessed, resulted from changes in the Earth's orbit that placed the planet farther from the sun.[6] But even these early ice-age theories failed to lessen the surprise

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[4] Agassiz liii
[5] Kruger 99-109
[6] Krüger, 92-96

and shock of the audience at Agassiz's suggestion that all of Europe had been covered by an immense shield of ice. The very notion of an extensive period of intense cold in the recent past would have been foreign to most of the audience members, who would have likely accepted the popular theory that the Earth's climate had been warmer in the past and was progressively cooling. Given this tenet of "normal science," contemporary naturalists would have been unlikely to imagine that Schimper's "The Ice Age" and Agassiz's "Discourse at Neuchâtel," as it is called today, would mark the lasting entrance of ice age theory into the field of geological sciences.

Such an inaugural moment for the theory of the ice age—first in a poem, then in a highly speculative talk—demonstrates that, as I will insist throughout this chapter, the discovery of the glacial epoch was as much a great feat of empirical observation as it was a profoundly imaginative and narrative act. Where most accounts of the discovery of the ice age emphasize the empirical progression from earlier theories to the present day, my purpose in this chapter is to show how the ice age's emergence involved an extended narrative contestation, in which competing ways of storytelling came up against one another.[7] By considering two of the most important works of nineteenth-century ice age theory—Agassiz's *Studies on Glaciers* (1840) and James Croll's *Climate and Time* (1875)—

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[7] The most direct and in-depth account of the concept of the ice age is Tobias Krüger's *Discovering the Ice Age*. Important overviews of the emergence of this concept also appear in Martin J.S. Rudwick's *Earth's Deep History*, John McPhee's *Annals of the Former World*, Jamie Woodward's *The Ice Age*, John Imbrie and Karen Palmer Imbrie's *Ice Ages*, Doug Macdougall's *Frozen Earth*, and in David R. Oldroyd's *Thinking about the Earth*.

my aim is to demonstrate that the writing of Agassiz and Croll are best read for the ways in which they "emplot" the ice age. Reading *Studies on Glaciers* closely, I explore how Agassiz described glaciers and how, from a formal analysis of their structure, he eventually arrived at a "catastrophic" narrative about the ice age. Next, I examine Croll's *Climate and Time*, which emphasized the nonhuman "physical agencies" that were responsible for climatic cycles in deep time. He argued that a series of interwoven processes determined the course of Earth's climatic history: changes in the planet's orbit around the sun were primarily responsible for driving climate change, but only in combination with transformations in wind patterns, ocean currents, and ice sheets. Unlike Agassiz, I show, Croll relied on a "gradualist" or "uniformitarian" narrative of Earth history and produced a substantially different story about the planet's past.

Both works, although technically about climate change, were produced in the intellectual setting established by the early geological sciences. I therefore I begin this chapter by arguing that geology itself, both today and in its earliest formation, stands as a narrative science.[8] Borrowing from the historian of geology Martin J.S. Rudwick, I propose that this branch of science is best understood in terms of its "geohistorical imagination."[9] I define this imagination simply as our ability to approach the Earth as a product of history. For geologists, this involves taking into account the agency of the

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[8] This is a point made forcefully by Stephen Jay Gould in *Time's Arrow, Time's Cycles*, as well as by Martin J.S. Rudwick in *Earth's Deep History*.
[9] Rudwick, *Worlds Before Adam*, 256.

nonhuman material world (today, primarily the movement of plate tectonics) and reconstructing the deep history of the planet. It also involves the creation of a narrative about this incomprehensibly old material world. To imagine geohistory is, as Hayden White claimed of nineteenth-century history writing generally, to "emplot" particular facts about the planet's deep history in narrative structures. These structures take many forms, but here I focus in particular on the two most important generic categories (akin to White's tragedies, comedies, satires, and romances) in the geohistorical imagination: catastrophism and gradualism. In reading Agassiz and Croll's works for how they emplot the ice age within these narrative forms, I address these books not merely as founding documents in ice age science but also as contributions to the geohistorical imagination.

Taken together, Agassiz's and Croll's works, unlike preceding works in the history of geology, transformed the geohistorical imagination by turning its attention to the climate itself, which had previously been conceived in simplistic mechanistic terms. In other words, Agassiz's and Croll's texts not only exemplify the geohistorical imagination—which is to say it represents a continuation of early 19th century geology's capacity for imagining the planet historically, and narrating in particular generic ways—but also draw the climate's complexity into their scope. I argue in conclusion that their joining together of the geohistorical imagination with climate change, seeing the changing climate as an element in the planet's geological unfolding, is significant because of how it opened up new possibilities in geology and grounded contemporary climate science. This was, I argue, not only their most distinctive contribution to the imagination of geohistory, but also their contribution to contemporary science. The discovery of the ice age, and the sense of climatic complexity required to understand it, continues to play an important role in the narrative life of global warming.

1.1 The Geohistorical Imagination

The science of geology introduced a way of understanding the planet historically. Geologists did not merely seek to classify the planet's minerals and biosphere or to understand how its systems operate; they also attempted to understand, through looking at rock outcrops and the fossils buried within them, the history of the planet's unfolding. Geology's way of comprehending the planet may be called the geohistorical imagination. Simply put, the geohistorical imagination refers to our ability to consider the Earth as a historical entity, with moments of the past that were radically different from the present.

Such a way of imagining the Earth is hardly new. The history of this imagination reaches back to geology's emergence, which coincided with the broader scientific revolution of the sixteenth and seventeenth century (beginning roughly in 1543 with Copernicus, continuing with Galileo in 1632, then completed with Newton's *Principa* in 1687), when the practice of collecting fossils found in rock layers and studying minerals for the purposes of mining became common.[10] The geohistorical imagination emerged when naturalists began to tell stories about the Earth that substituted science for myth. Mythologizing the planet tends to involve a human-centered moral narrative as its central element: although Noah's flood imagines a radically different environment in the Earth's past, it does so not in an effort to explain the nonhuman world, but rather to clarify the moral relations of humans to God. But where myths tell stories about humans to humans, the geohistorical imagination tells stories about the nonhuman world to humans. The geohistorical imagination consequently emerges only after scientific narratives begin to challenge and—at the same time—productively grow out of myths.[11]

The challenge to Biblical myths posed by the newly developed empirical methods of the scientific revolution occurred slowly over many years, beginning with natural theology, which attempted to justify Biblical accounts through science. James Ussher, for example, famously attempted in *Annals of the Old Testament* (1650) to mathematize the Bible and establish a kind of "chronology" of the planet over 6,000

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[10] See, for an overview that informs my understanding of geological history, Rudwick's *Earth's Deep History*. The term "geology" was first used in the seventeenth century: the earliest use of the word in the modern sense appears in Jean Andre De Luc's work, and was quickly and influentially used in Horace-Bénédict de Suassure's *Voyages dans les Alpes* (published in several volumes between 1779-1796). But modern geology, according to most textbooks, has its origins in the theorization of Earth's history by James Hutton (1726-1797) in *Theory of the Earth* and in the stratigraphic work of William Smith (1769-1839), who famously began to identity repeating patterns of fossils in various rock layers and drew the first geological map of England in 1815. Following the writing of Hutton and Playfair, the field's methods were famously codified in Charles Lyell's great work, *Principles of Geology* (1830-1833), and then given its first major biographical and historical reconstruction in Archibald Geikie's *Founders of Geology* (1896).

[11] Geology is often viewed in terms of its gradual break with religion, in particular biblical literalism and the desire to see the Earth's history as exactly described in the bible. As Rudwick has persuasively argued, this narrative needs to be seen more complexly. Science and religion are better seen in cooperation and tension rather than as pure opposition.

years.[12] Moving slightly later, the publication of Thomas Burnet's *Sacred Theory of the Earth* (1681) also marked a significant rupture in the power of Christian myths, for Burnet's book attempted to work through the Bible's events, but began to incorporate methods of empiricism and offered a striking level of attention to the nonhuman forces of the world.[13] Yet, in most accounts of the history of modern geology, there is little doubt that the planet's history—however inaccurately imagined—only fully eclipses the myth of the planet with James Hutton's *Theory of the Earth* (1788).[14] Hutton's work remains important in the story of geology not merely because it was the first to recognize geological time, but also because it established the Earth as a system maintained in a balanced state by the forces of erosion and uplift.[15] It is on the basis of

[12] See Rudwick 11
[13] Describing Noah's flood, for example, required Burnet to explain where all of the water originally came from; it was no longer sufficient to suggest that it had merely appeared through divine will. See accounts of Burnet in both Gould and Rudwick.
[14] The earliest written assessment of Earth's deep history emerged in George Louis Leclerc, Le Comte du Buffon's *Epochs of Nature* in 1778. Buffon took it upon himself to calculate, in mathematical terms, how the old the Earth was. Assuming it had been cooling since its inception, he conducted a series of experiments using heated iron balls to determine how long it would take to reach its present temperature. He concluded that the Earth was roughly 75,000 years old, but he privately considered ages far beyond that. It should be noted that many others at the time had already begun to take for granted that the Earth must be older than Ussher's 6000 years, and must have a history that extends before the presence of humans. See Rudwick 65 and Noah Heringman's important article "Deep Time at the Dawn of the Anthropocene." I do not date the birth of the geohistorical imagination with Buffon largely because of the impression his work gives that deep time emerged from a purely speculative mathematical project. For Hutton, by contrast, deep time emerged from the direct observation of geological history. This distinction is somewhat arbitrary, and that it would be entirely reasonable to argue that both Buffon and Hutton are responsible for the emerge of geohistorical imagination.
[15] Hutton's recognition of geological time was tied directly to his observation of these slow processes. Seeing such a balance, mountains rising, only to be slowly eroded away by wind and water, which deposited the sediments elsewhere, he deduced that there had been no discernible beginning to the world, and that there would be no catastrophic termination. The Earth, in that sense, was inconceivably old. Hutton's famous lines in the first volume of *Theory of Earth* encapsulated his sense of unending time—accompanied by Earth

Hutton's work and its influence that a theory of the geohistorical imagination may be articulated.

Synthesizing modern accounts of geological history like Robert Hazen's *The Story of the Earth*, Earth science textbooks like Stephen Marshak's *Essentials of Geology*, and popular writing on geology like John McPhee's *Annals of the Former World*, geology's imagination today includes both a sense of the way in which the material world operates, and its extensive age. In other words, geohistorical imagination is defined by its commitment to the agency of the Earth's nonhuman forces in deep history.[16]

The impulse to describe the power and animation of the nonhuman world is a feature of many—if not all—modern sciences, but in geology it manifests as a particular concern for the formation of rocks and other planetary features. For the geologist, rocks and other elements of the landscape are not necessarily agents, but they are the historical products of powerful agents. What those agents are and how they act has changed

history—quite powerfully: "For having, in the natural history of this earth, seen a succession of worlds, we may from this conclude that there is a system in nature; in like manner as, from seeing revolutions of the planets, it is concluded, that there is a system by which they are intended to continue those revolutions. But if the succession of worlds is established in the system of nature, it is in vain to look for any thing higher in the origin of the earth. The result, therefore, of this physical inquiry is, that we find no vestige of a beginning,—no prospect of an end." Earth history here, like in Burnet's text, is seen to have material causes that do not require "any thing higher" like divine providence. But Hutton departs significantly from Burnet in that he appears to expand the time of the Earth almost infinitely; in Hutton there is no genesis in the past or revelation in the future of the planet, only the continuously functioning processes of erosion and deposition.

[16] Although Burnet's work certainly had a sense of the nonhuman world as historical, composed of a succession of different environments and events, it had little sense of the depth of the planet's history or its age. This is why we would want to begin the geohistorical imagination in Hutton's work.

dramatically over the course of geology's history—where it has been long recognized that wind, rivers, oceans, volcanoes, earthquakes, and glaciers shape rock formations, more recently geologists have come to recognize the deep role that plate tectonics play in shaping all of those forces—but the fact of their importance has been stable.

Such a conception of nonhuman agency—and nonhuman objects more generally—appears to coincide with relatively recent humanist theorizations of "vibrant matter," speculative realism, and object-oriented ontology.[17] While it is true these strains of thought, widely disparate in terms of origins and institutional situations, share a common interest with geology in the nonhuman, it is worth noting a significant difference between them and the geohistorical imagination. Most importantly, the geohistorical imagination thinks about objects not merely in terms of their "vibrancy" and "agency" but also in terms of their historicity. A focus on the agency of rocks does not eclipse their existence in history, whether human or planetary; objects lead us back to history. The attention to nonhuman objects—a pegmatitic rock, for example, broken at angles with mica and quartz and garnet—is the key to the past: to imagine geohistory is not merely to understand such a rock's vibrancy, but to understand its formation underground. We are not trapped in the present, as we frequently are with other kinds

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[17] See for example Jane Bennett's *Vibrant Matter*, Timothy Morton's Hyperobjects, and Quentin Meillassoux's *After Finitude*.

of new materialism. Geologists are therefore not "new materialists," in any traditional sense, but rather very old materialists.[18]

It is in this sense that the geohistorical imagination registers an idea of agency that is tied directly to the planet's deep history, the discovery of which, according to Stephen Jay Gould, stands as one of the most important events in human thinking, a decentering akin to the Galilean and Darwinian revolutions that "shattered yet another facet of an original hope for our own transcendent importance in the universe."[19] A significant component of this decentering was the sheer impossibility of comprehending the billions of years of Earth's history; although it stands as a concrete unfolding of agencies still active today, from plate tectonics to microbes, the planet's past has long presented a challenge to representation.[20] In his inaugural account of deep history, the Scottish geologist John Playfair recounted a trip with the founder of modern geology, Hutton, to the east coast of Scotland. There they encountered a rock formation at Siccar Point that was composed of vertically oriented gray sandstone and shale covered by horizontally lying old red sandstone. For Hutton, such a formation was incontrovertible evidence of Earth's deep history; one was forced to imagine the immensely slow process

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[18] My distinction here derives in part from Andrew Cole's excellent critique of this strain of thinking in "The Call of Things."

[19] Gould, *Time's Arrow*, 1

[20] To use more Heideggerian terminology, we would want to say that deep history is essentially "withdrawn" or concealed from us, until the very moment or place—the outcrop—when its being is "unconcealed." The planet's past is withdrawn and then surfaces so that we may write geohistory; outcrops and mountains are the locations where planetary history is made visible. See Heidegger "On the Essence of Truth" in *Basic Writings*. Dipesh Chakrabarty has recently drawn Heidegger's terminology into questions about climate change in his essay "The Planet."

of the gray sandstone's deposition, its overturning and weathering, the subsequent deposition of the red stone, and then the exposure of these rocks on the surface through the ocean's immense powers of erosion. "The mind seemed to grow giddy by looking so far into the abyss of time," Playfair recounted, "and while we listened with earnestness and admiration to the philosopher who was now unfolding to us the order and series of these wonderful events, we became sensible how much farther reason may sometimes go than imagination can venture to follow."[21] A similar description appears in McPhee's important account of the discovery of deep history, when he proposes an essentially biological limitation on our capacity to envision this form of planetary temporality.[22] Gould, echoing McPhee, similarly proclaims the impossibility of understanding deep time "in the gut" even when we understand it intellectually.[23]

Deep history is therefore commonly understood in terms of the sublime, for it is too immense for the human mind to adequately comprehend. Indeed, deep history falls somewhere between Immanuel Kant's two forms of the sublime.[24] On the one hand, deep history bears striking similarities with the "mathematical" sublime: Kant's figure for the mathematical sublime is infinity, which we can conceive of, but cannot fully

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[21] Playfair 81

[22] Here is the full quote: "The human consciousness may have begun to leap and boil some sunny day in the Pleistocene, but the race by and large has retained the essence of its animal sense of time. People think in five generations—two ahead, two behind—with heavy concentration on the one in the middle. Possibly that is tragic, and possibly there is no choice. The human mind may not have evolved enough to be able to comprehend deep time. It may only be able to measure it" (90).

[23] Gould 3

[24] Kant 61–79

comprehend. Infinity is not directly encountered by the "senses," to use Kant's terminology: I cannot feel, touch, taste, see or hear infinity; I have to think it. Deep history is similarly an imagined entity: you cannot directly encounter it with the senses. The rocks at Siccar point, to reference Playfair's account of the discovery of deep history, were themselves not sublime. What was sublime was the story, the imaginative history that could be attributed to them. We experience the sublime of deep history not at the object itself, but at the history that we imagine composed it.

Yet, on the other hand, many of the objects of deep history—mountains, volcanoes, rift valleys—fall generally into Kant's category of a "dynamic" sublime, which involves powers that exceed human scope. Indeed, Kant's "bold, overhanging, and as it were threatening, rocks" used to illustrate the dynamic sublime were, more than likely, rather old formations that became "overhanging" through an extensive process of erosion lasting thousands of years.[25] To think deep history we keep objects front and center, which would seem to indicate its difference from infinity; the theorization of deep history proceeds through the senses, even if it subsequently moves beyond them into the imagination.

This distinction illustrates precisely why I refer here to deep history as a component of the geohistorical imagination, rather than to "deep time," a phrase coined by McPhee and subsequently adopted by Gould. Rudwick has argued, responding to

[25] Kant 75

these accounts, that “deep history” ought to be privileged as a concept over “deep time,” because the actual magnitude of Earth’s age—the precise, mathematically sublime number of 4.5 billion years—mattered to the history of geology substantially less than the transformations that occurred over that period of time: “[W]hat was far more significant than the stretching of the bare magnitude of the Earth’s timescale,” Rudwick writes, “was the character of the Earth's history that was reconstructed within this greatly extended span of time.” “Deep history” Rudwick states definitively, “mattered far more than deep time.”[26] Deep history is thus not only a recognition that humans are temporally recent in the Earth’s 4.5-billion-year history, but also that the Earth has constantly been changing in dramatic ways that dwarf human powers since its formation: a combination, in other words, of Kant’s two sublimes.

1.2 The Emplotment of Geohistory

By the early 19th century, the basic components of the geohistorical imagination had been worked out: there was a sense of deep history among scientists—even if, in numerical terms, it was unclear just how far back Earth’s history stretched—and a commitment to explaining the past of the planet through material rather than mythic means. This hardly meant, however, that there was a consensus about the form of Earth’s deep history. Geology by its nature is a speculative science, because the earth

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[26] Rudwick, *Earth’s Deep History*, 101

presents mysteries in rock formations that defy even the most attentive observations. Geologists offer the best possible "interpretations" of rocks, imagining the inevitably complex series of circumstances that produced any given outcrop. In this sense, the geohistorical imagination—defined by a sense of nonhuman agency and the deep history of the planet—inevitably narrates observed phenomena.

That historians similarly narrate the events compiled in their research is the lesson of Hayden White's *Metahistory*. White argues that once historical writing moved from mere chronology to genuine story writing, with causal links between different events, the writer could develop different kinds of explanations in order to import meaning into the story. For White, these included the modes of "emplotment," argument, and ideological implication, all three of which had a variety of options that could be used to account for various works of history. Recognizing the narrative basis for works of history, it becomes possible, from White's perspective, to see that nineteenth-century historians like Michelet, Ranke, Tocqueville, and Burckhardt wrote romances, comedies, tragedies, and satires respectively, even though they all made claims to "realism."[27]

Although White's schema impressively covers the historical writing of the 19th century, from Hegel to Croce, his categories becomes less useful when we turn to geological writing. White himself offers an explanation for this disjuncture: history in

[27] See White's introduction to *Metahistory*, pages 1–41.

White's conception has consistently struggled as a discipline with its identity as a mixture of both art and science. This distinction becomes particularly important for White when he distinguishes between science and history (as opposed to history and the arts). For White, the most salient difference between the study of "nature" and the study of history is that scientists broadly speaking agree over what counts as problems and explanations, where historians never reach that kind of agreement. Causality is consistently used for explanations in science. This mode of explanation was agreed upon relatively early in the scientific revolution; for example, geology standardized a "mechanistic" explanation for the world in the sense that it searches for the "laws" that govern particular phenomena. Historians, meanwhile, disagree over the "form" an explanation is supposed to take.[28] It is precisely this difference that allows for the production of multiple interpretations of history, and that allows for consensus in the sciences.

But, as Nasser Zakariya has suggested, White's distinction between science and history ignores the abundance of "scientific historiographic projects" that can be found in biology, physics, and geology.[29] These projects, ranging from evolutionary histories to stories of the birth of the universe, contain a speculative component that opens up the possibility for disagreements over "modes of explanation" in the sciences. Like history,

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[28] White 12.
[29] Zakariya 431n3

they always involve interpretation and a strong narrative component. Although I agree with White that certain elements of scientific discourse are in essence already decided—in particular the form of explanation by argument, which tends to always rely on "mechanistic" explanations—the mode of "emplotment" differs radically when scientists set their sights on providing a historical perspective making use of those principles.

The process of emplotment is prevalent in narratives of Earth history; perhaps more so than biology and physics, the discipline of geology is firmly grounded in these narratives and would be would impossible without them.[30] Gould, in his important study of the history of geology, has already suggested that geology involved two different attitudes toward the narrative shape of history: one that views history as movement and progress (an "arrow"), the other that views it as pure repetition (a "cycle"). To see history as an arrow is to see time moving forward in unrepeatable, irreversible, and distinct, events; to see it as a cycle is to see change as repetitious, governed by timeless order and law. Gould demonstrates, through a close reading of three major texts, the strength and consistent presence of these metaphors in governing the imagination of geohistory. Burnet's work of natural theology, *Sacred Theory of the Earth*, for example, imagines the world of the scripture through natural causes and laws

[30] It is worth noting that, for Rudwick, geology's impulse toward historicizing the Earth was born initially out of chronology writing, and is therefore intimately tied with that discipline (17).

that are not subject to change at the same time that he saw direction in Earth's history, from creation to destruction in fire.[31] Burnet therefore embraces both time's arrow and cycle. Hutton, later, developed an entirely different view based in the cyclical repetition of a self-sustaining system. For him, Earth is a kind of perpetual motion machine, which, once started, will never stop, an endless repetition of erosion, deposition, consolidation, and uplift.[32] Lyell, finally, believed in substantial changes in the Earth system, but only to the extent that they were repeated over and over again. Nothing was radically different; changes in the fossil record marked for Lyell moments of historical uniqueness, but not progress.[33]

While these categories are important—they will make an appearance throughout the two major ice-age texts to be discussed shortly—they fail to speak to the particular historical controversies that motivated geology during the nineteenth century and that were especially crucial in the study of ice ages. In this sense, I focus on two related categories that are more central to the story of the ice age: catastrophism and gradualism (or "uniformitarianism"), terms that the philosopher and historian of science William Whewell (1794–1866) originally coined in the 1830s.[34] For Whewell, catastrophism stood

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[31] Gould 28-38
[32] Gould 66
[33] See Gould 110-160.
[34] Whewell coined the terms in a review of Charles Lyell's *Principles of Geology*. He later developed the concepts more fully in a section of *The History of the Inductive Sciences* (1837) on "The Two Antagonist Doctrines of Geology" (606-622). I want to emphasize that these are far from the only controversies at the time. Indeed, the most immediately recognizable debate between "neptunium" and "vulcanism" concerned

as the spontaneous way of approaching Earth history. Viewing the essentially broken surface of the Earth, or seeing in the fossil record constant breaks and disappearances, it was only logical to conclude that great catastrophes had periodically modified and wrecked the planet. Although catastrophism in that sense reaches back to Steno in Whewell's history, its most important advocate and theorist was the French naturalist Georges Cuvier (1769-1832). Cuvier asserted that there were "former worlds" to be discovered in the history of the planet, moments that were substantially different in terms of living animals than the current world; Cuvier argued that nothing known could cause a mass extinction; only some unknown "revolution" or catastrophe could do so.[35] The fossil record could only be explained through disasters. Gradualism and uniformitarianism, by contrast, state that there is an unchanging set of natural processes that shape the planet; these processes are visible today, and would have been equally visible in the past, had humans been around to observe them. These processes are thought to be gradual: the events that shapes the geological record happen slowly over extensive periods of time. Such a position was first formulated by Hutton in *Theory of the Earth*, popularized by Playfair, and set in stone by the English geologist Charles Lyell in *Principles of Geology* (1830–1833). There, Lyell insisted on the "uniform order of physical

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the nature of rock formation, and whether the history of rocks primarily involved volcanic or liquid forces (See Krueger and Rudwick).

[35] See Rudwick 110-116 for an excellent overview.

events" and railed against the many "theoretical errors" that resulted in overly speculative attempts to explain the Earth's history.[36]

These two positions—still referenced by contemporary geologists—are typically discussed as competing empirical positions or explanatory models. But catastrophism and gradualism are also two ways of telling a story: forms of emplotment, narrative shapes that may be filled in with the details of how material agents transformed the Earth throughout deep history. These terms, in other words, are best understood as generic categories akin to tragedies, comedies, satires, and romances rather than empirical positions. In this sense, catastrophism and gradualism may replace White's four kinds of emplotment drawn from literary genres—romance, satire, comedy, and tragedy—which seem to break apart, as if they had been stretched too thin, when the complex agencies of nonhumans are at play, instead of the conscious decisions made by human actors. When confronted with the unknown of the Earth's past, geologists necessarily interpret the story of a given rock formation: a catastrophist will tend toward one kind of narrative, a uniformitarian another. Seeing, for example, a rock outcrop carved by a river, one geologist might suppose that a uniform rate of river erosion was responsible; another might assume that most of the erosion was the result of a series of catastrophic floods. Observing the same features, two geologists can develop radically

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[36] Lyell 26

different explanations for their presence. It is precisely this necessity of speculation and interpretation that indicates the presence of narrative, rather than pure empiricism.[37]

1.3 Louis Agassiz and Catastrophic Geohistory

Although Louis Agassiz was, by training, a zoologist, his work on the ice age is best understood in the context of the geohistorical imagination.[38] Published in 1840, three years after Agassiz and Schimper jointly developed and presented the first ice-age theory in Neuchâtel, *Studies on Glaciers* stands as an important example of and contribution to the geohistorical imagination because it is marked by a commitment to theorizing nonhuman agency, by a sense of deep history, and by a necessity to "emplot" the past of the planet. Along these lines, Agassiz's book may be approached as having two distinct but interrelated parts. The first part, composing a vast majority of the book, consists of detailed descriptions of the formation, structure, and movement of glaciers. The second part discusses the historicity of glacial formations and, as Agassiz explains at the beginning of the book, demonstrates the existence of an "Ice-age" which was an "intermediate between the present epoch and that during which lived the organisms

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[37] Where catastrophism tells a relatively dynamic story, uniformitarianism holds to a steadier plot. We might also suggest, following Stephen Jay Gould, that catastrophism largely holds to progressive and linear conceptions of historical movement, where uniformitarianism sees cycles.

[38] Agassiz makes it clear in the introduction that he sees his work contributing to this field: "Science was rapidly progressing toward new discoveries, however, and geology in particular, by extending the limits of the past far beyond the creation of man, could not fail to recognize on the surface of the ground, which is the reliable testimony of all the earth's revolutions, the traces of such powerful agents as glaciers" (lxx).

buried in the so-called *diluvial* formations."[39] Taken together, these chapters exemplify and push the boundaries of the geohistorical imagination.

Agassiz refers to the work of the early chapters in terms of "describing."[40] As Joanna Stalnaker has observed, description became a contested category in the 18th century, one as important for science as for literature. It was precisely through description that scientists of this period began disseminating their understanding of the nonhuman world.[41] While for some 18th century naturalists descriptive and empirical language mixed readily with a kind of poetry, Agassiz's descriptions are clinical, designed to show the "glaciers as they appear to any observer."[42] Agassiz systematically breaks apart the glacial object into concise chapters: he writes on the heavily compacted and stratified snow that composes glaciers, on their "wonderful" blue color, on their crevasses, pinnacles, moraines, and ice tables, on their dangerous surfaces and cavities, and on their temperature.[43] Throughout, it is clear that he wants to convey the abstract structure of glaciers in general, rather than describe any individual glacier. While Agassiz's clinical prose is occasionally disrupted in order to marvel at particular features of the glaciers— he describes a feeling of "astonishment and admiration" when he sees the ice pinnacles on glaciers, and later ice tables strike him with "astonishment" because

[39] Agassiz 9
[40] Agassiz 77
[41] See Stalnaker.
[42] Agassiz 77
[43] Agassiz 32

they are “unexpected” and “unexplainable”—he largely holds to detached observation and abstraction.[44]

This is hardly to imply, however, that Agassiz had a corpse-like conception of glaciers as inert objects. On the contrary, Agassiz, like many glacial scientists and alpine dwellers, knew that glaciers moved and that they were much more than “rigid, immoveable shields of ice,” as Johann Wolfgang von Goethe wrote.[45] Agassiz emphasizes that while they appear to be unmoving, glaciers are constantly in motion, enacting forms of “action” on the world around them. “Although the massive aspect of glaciers seems to suggest the idea of a certain stability,” Agassiz writes, “nothing is actually more mobile and changing than their surface”:

> When we visit a glacier that we have not seen for a certain number of years, we are always surprised to notice so many changes. A given place which displayed a surface grooved by rivulets of water or pits and hollows, appears now almost smooth; a large block that you had seen at a particular place has disappeared; a crevasse which you had crossed with difficulty, has been closed or has changed place; all these features express mobility and movement under the appearance of immobility.[46]

Here, Agassiz provides a (nearly-personal) anecdote of the surprise of discovering the change undergone by a glacier over time. It requires a precise kind of noticing to see the little changes in the smoothness of the surface, the position of boulders, and presence of

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[44] Agassiz 51 and 72
[45] Kruger 123. Goethe assumed that rocks slid down glaciers withouth the glacier itself moving (124). By October 1829, Goethe’s thinking changed, and he embraced the motion of glaciers (125).
[46] Agassiz 25

crevasses. Moving slowly through a process Agassiz called "dilation," in which the ice expanded due to varying temperatures, glaciers could move imperceptibly downhill, like a slow river. His theory of glacial movement ultimately proved incorrect— in reality, glaciers move plastically: the weight of the ice at the top of the glacier slowly but surely pushes the lower ice down hill—but his sense of the their almost "vibrant" capacities, to borrow a term from Bennet, proved to be accurate.[47]

Yet what makes these descriptions of glaciers unique is Agassiz's sense of the profoundly indifferent nature of glacial agency. For Agassiz, glaciers lack discrimination: "ice," Agassiz says, "does not spare either heights or depressions, and tends to level all surfaces."[48] Glaciers erode everything they come into contact with. Agassiz describes the "action of glaciers" on the valley walls and the substratum: glaciers pick up, round off, and polish rocks, fragments of which "act like so many diamonds" by scratching the bedrock.[49] Agassiz even extends this indifferent violence to glaciers' interactions with humans. He describes the dangers that glaciers pose to potential researches and residents of glacial valleys, mentioning the frequent ice-avalanches encountered by climbers and recounting the recent disaster in the valley of

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[47] See Bennett's *Vibrant Matter*, a book that has informed some of my thinking here.
[48] Agassiz 106
[49] Agassiz 105-106

Bagnes, when the Giétroz glacier caused an enormous flood in June 1818 that destroyed an entire village.[50]

Like other scientists, Agassiz devoted his thinking to the movements of the nonhuman world through description. He imagined the way the Earth appeared to shape itself outside of conscious human intervention. Glaciers here have the same agency that floods have in other texts: they move sediments and rocks all around the continent, and they erode those materials during the course of transportation. As in Hutton, the forces of erosion and deposition form the present features of the Earth, and are not motivated through mythic or divine means. The slow agency of glaciers is to be marveled at as much as it is to be feared by those in its path, humans and nonhumans alike.

Agassiz's sense of glacial agency grounds the final chapters, which represent a methodical build up to his theory of the ice age and his contribution to the deep history of the planet. Agassiz begins by suggesting, following the work of Venetz (just as he did at Neuchâtel), that glaciers in the Alps had once been substantially larger than at present, a fact that Agassiz was able to deduce from the presence, far away from the current alpine glaciers, of features that "are preserved even after the disappearance of the ice" like moraines, perched boulders, and polished and striated rocks.[51] If it is true

[50] See also: pages 44 and 98. There is yet more about the dangers of glaciers and the "shock waves" they create to destroy things. (87)
[51] Agassiz 135

that glaciers move and leave behind identifiable traces, Agassiz reasoned, then moraines, not far from where the glaciers currently were, could have also been caused by larger glaciers.[52] This deductive leap—one that would have been relatively acceptable to his readership—ultimately allows Agassiz to speculate, in the final chapter, on the mysterious erratic boulders near the Jura mountains. These boulders, Agassiz explains, were evidently moved by "powerful agents," but the precise nature of those agents was unknown at the time: some proposed that it was powerful currents of running water; Charles Lyell, meanwhile, thought that icebergs carried the erratics boulders over the flood plains; still others thought they had simply been transported along an "inclined surface" that has since become flat. But Agassiz proposes, instead, that "the overall phenomenon of erratic boulders" are in fact related to glaciers.[53]

In doing so, Agassiz felt it was necessary to advance a "hypothesis of great glaciers" that tied together the erratics of the Jura mountains with other disparate features all over Europe in a "single great phenomenon."[54] He theorized that there are "great oscillations" in the Earth's temperature that effect the entire planet; ice ages punctuate the end of "each geological epoch." An enormous ice sheet formed in the

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[52] Here is the quote in full: "The simultaneous existence, in the lower part of the Alpine valleys, of all the phenomena which constantly accompany glaciers is, in my opinion, the most convincing proof that could ever be required of their former and greater extent. This coexistence of facts produced by different factors, belonging to the general phenomenon of glaciers, obviously demonstrates that neither the streaks of blocks considered as ancient moraines, nor the perched boulders, nor the polished and striated rocks, nor the lapiaz, nor the potholes of waterfalls, could be produced by agents other than glaciers, because the latter only are able to generate all these features at the same time" (143).

[53] Agassiz 156-157

[54] Agassiz 164

polar regions and spread during the "the phase of low temperature;" the "huge mass of ice" moved continuously downhill, rushing and rounding everything it could move.[55] The ice sheet covered Europe for an extended period of time. When the Alps uplifted and fractured amid the frozen world, erratics formed and spread across the slippery ice sheet. During the uplift, the temperature of the Earth rose again, and the "climatic conditions" began to shift toward those of the present, and suddenly the seasons, which had all come to resemble winter, became cyclical again.[56] Moraines and erratics were deposited during the ice sheet's retreat, and large amounts of erosion were generated by melting ice.

For Agassiz, it was crucial that this punctuated, rapid drop in temperature was also accompanied by the "catastrophic" destruction of all life on Earth.[57] Having seen mammals—namely the wooly mammoth—completely preserved in the ice of Siberia, Agassiz concluded that they must have perished through an "abrupt temperature drop."[58] Agassiz's estimation of this extinction event is as beautiful as it is disquieting:

> The development of these huge ice sheets must have led to the destruction of all organic life at the earth's surface. The ground of Europe, previously covered with tropical vegetation and inhabited by herds of great elephants, enormous hippopotami, and gigantic carnivora became suddenly buried under a vast expanse of ice covering plains, lakes, seas and plateaus alike. The silence of death succeeded to the movement of a powerful creation. Springs dried up, streams ceased to flow, and sunrays rising over that frozen shore (if they ever reached it)

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[55] Agassiz 166
[56] Agassiz 169
[57] Agassiz 168
[58] Agassiz 166-168

> were met only by the whistling of northern winds and the rumbling of the crevasses as they opened across the surface of that huge ocean of ice.[59]

Here it becomes clear, in the very vividness of the prose, that although Agassiz's theory was one of geology—a series of explanations about how rocks appear—his primary interest is in the history of life. Agassiz provides a story of destruction: a once lush and tropical Europe becomes buried under the ice, and life, rather than learning to adapt or evolving, is faced with a sudden environmental catastrophe that only the uplifting of the Alps, and the subsequent rise in temperature, could repair. Although Agassiz was vague about the amount of time required for these transformations—he merely concludes that "the time of maximum extent of the ice lasted quite a while"—it should be clear that this narrative is fundamentally catastrophist.[60]

Yet Agassiz's catastrophism—based on the work of his mentor Cuvier—is not necessarily a negative or pessimistic view of planetary existence. For every catastrophic destruction of life, Agassiz also imagined a series of renewals, in which a divine being would recreate all life on Earth, as if the biblical creation story simply repeated itself over and over. Each of these new creations would correspond precisely to the newly formed world. There is a close relationship between Earth history and organic life; they develop in tandem in a way that eventually makes possible the existence of conscious

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[59] Agassiz 169
[60] Agassiz 170

humans. “It would be erroneous,” Agassiz writes, “to consider these changes as accidents or unfortunate events which only destroyed existing things; on the contrary, they correspond to periods of renewal in the sequence of successive and closely related metamorphoses undergone by the earth, which have eventually established the present conditions.”[61] Referring to the establishment of “present conditions,” Agassiz implies that there is not only a relationship between organic life and the Earth, but that this relationship is teleological and progressive, changing ceaselessly until the appearance of humans.[62]

What I want to suggest about Agassiz, in the context of the geohistorical imagination, is that he “emploted” his story of the deep history of glaciers and climate change in catastrophist form, but nonetheless relied on certain principles of uniformitarianism. Like most other supposed catastrophists of his time, Agassiz’s theory had a strong basis in the empirical methods that grounded gradualism.[63] Throughout, Agassiz insists on the “facts” and on building his own claims from the work of others more established in the field of glaciology and geology.[64] Most significantly, he

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[61] Agassiz 175

[62] This would be an opportunity to note the historical concept is an “arrow” in Gould’s terms.

[63] It already seemed clear to Whewell in 1837 that both positions were useful for explaining the Earth’s past (617). Moreover, as both Gould and Rudwick note, there was never anything like a debate between catastrophists and uniformitarians. The real debate was in terms of different kinds of empiricism, and whether present processes at their current rate was in fact enough explain the way the Earth looked at all times. See Gould 113 and Rudwick 171.

[64] Agassiz was well aware that he was building on the work of others. Agassiz cites Johann Jakob Scheuchzer (1672-1733) as the father of glacial research, but says that the most important work was done by Horace-Bénédict de Saussure (3). Venetz and De Charpentier have now done the most recent crucial work:

consistently emphasizes the way in which all of the forces of the ice age are currently still in operation, writing that the "slow and quiet mode of transportation" of ice-age glaciers was "similar to the one displayed today by the glaciers of the Alps."[65] The tension moving through Agassiz's text is between uniformitarian practice—here identifiable as an empiricism that takes the modern world as a model for how the prior world functioned—and catastrophist form; or in other words the contradiction that structures Agassiz's text is between empiricism reliant on description and a strong commitment to historical speculation. The detailed descriptions of glacial agency through the first three-quarters of the text ultimately allow Agassiz to theorize the ice age in the last three chapters; in the final speculative chapters, the text moves from description to a more dramatic narrative of absolute catastrophe and renewal.

1.4 Croll the Uniformitarian

The intervening years between the publication of Agassiz's book and the appearance of James Croll's *Climate and Time* (1875) saw continuous debates about the very possibility of ice ages. But it also saw an accumulation of field evidence that could only be explained by the growth of glaciers in the relatively recent past, as Tobius Krüger has

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"Through their investigations, Venetz and De Charpentier have given us the most probable explanation of one of the greatest phenomena in the earth's history, the transportation of the erratic boulders which are found perched on the sides of mountains at a great distance from their origin" (lxx).

[65] Agassiz 157

demonstrated in his important study of the ice age's discovery. Yet even if mounting evidence suggested to the international collection of scientists that an ice age had occurred in the past, it remained unclear, well into the later-half of the nineteenth century, why they had occurred in the first place.

This was the problem Croll endeavored to solve in *Climate and Time* (1875). Unlike Agassiz, who spent his life in formal training in the sciences, and with great institutional authority, Croll derived his knowledge of physics and geology from his own private reading. Croll worked as a millwright, owner of a teashop, insurance agent, and hotel owner before becoming a caretaker at the Andersonian College and Museum in Glasgow in 1859.[66] It was as a caretaker for this college—he is sometimes simply called a janitor in more popular accounts—that he gained access to the books required for learning geology and physics.[67] After years of careful study, Croll made a name for himself in 1864 with an essay in *Philosophical Magazine* on the "physical cause" of climate change, and received that same year a post at the Geological Survey at Edinburgh, which is where he remained as he researched and published *Climate and Time*.[68]

Like Agassiz's *Studies on Glaciers*, Croll's work was occupied with the movements of nonhuman agents in deep history. They both, in other words, exemplify what I have been calling the geohistorical imagination. But beyond this broad shared

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[66] Woodward 96
[67] Imbrie and Imbrie 78-80
[68] Bol'shakov, Kapitsa, Rees 201.

commitment to a way of thinking, these are two radically different texts. The aims of the work are, for one thing, entirely different: where Agassiz was primarily interested in the functioning of glaciers, and the introduction of the conceptual possibility of an ice age, Croll's book arrived when ice age theory itself was largely accepted, but what remained to be explained were the causes of these periods of glaciation. The very form of the two books illustrates the difference well. Unlike Agassiz's single-minded book devoted to the movement of glaciers and the evidence they left behind of a past ice age, Croll's book bursts out of its own form, with chapters covering a stunning variety of subjects: not merely proposing the causes of ice ages, Croll references mathematical theories of the Earth's orbital transformations, describes the causes of ocean heat distribution and circulation, insists on the possibility of glacial-interglacial cycles during ice ages, speculates on the possibility of former ice ages, underscores the difficulties of understanding geological time, hypothesizes the age and origin of the sun, investigates sea level changes due to climate change, considers the formation of coal during the interglacial periods, and finally, in a nice parallel with Agassiz, establishes the cause of glacial motion.

Yet the most significant difference lies in the form of narrative with which Croll chose to emplot his theory of the ice age. Croll's *Climate and Time* tells a story grounded in explicit uniformitarianism rather than catastrophism. Croll's description of his method makes his commitments abundantly clear. For him the "province of geology" is the "investigation of the successive changes and modifications which the earth's crust has undergone during past ages."[69] These transformations, Croll observes, are understandable only through "acquaintance with the agencies by means of which the successive change and modifications were effected."[70] It is precisely in the nature of these agencies that Croll wants to establish his uniformitarianism:

> Although volcanic and other subterranean eruptions, earthquakes, upheavals, and subsidences [*sic*.] of the land have taken place in all ages, yet no truth is now better established than that it is not by their convulsions and cataclysm of nature that those great changes were effected. It was rather by the ordinary agencies that we see every day at work around us, such as rain, rivers, heat and cold, frost and snow. The valleys were not produced by violent dislocations, nor the hills by sudden upheavals but were actually carved out of the solid rock, silently and gently, by the agencies to which we have referred.[71]

Large-scale transformations in nature, Croll explains, do not happen through sudden catastrophic events like volcanic eruptions; they happen, rather, "silently and gently" over the course of thousands of years, like river water slowly eroding a valley. In a classic gradualist gesture, Croll establishes a binary system of "ordinary" and "extraordinary" events: only ordinary events play a significant role in Earth history, and they do so over the course of thousands of years.[72]

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[69] Croll 1
[70] Croll 1
[71] Croll 1
[72] For the contemporary geologist, these views will appear to be entirely too short sighted. It is well established that both groups of forces play a role in shaping the planet; Croll's investment in climatic forces, rather than subterranean geological forces, would make little sense in today's geology. That Croll seems to only believe in the forces that were currently in operation in his own local environment—the rain, ice, and wind of Scotland—immediately indicates the limitation of such a strictly uniformitarian conception of

Croll's position was written in the wake of Lyell's enormously popular *Principles of Geology* (1830-1833), which established the importance of an approach to geology that focused its explanations only on forces currently in operation. Lyellian uniformitarianism insisted that the present is the key to the past. Presently visible forces—rain, ice, wind, and so on—were also in existence in the past, and are therefore tools for explaining it. This is precisely what Croll has in mind when he writes that "what holds true of the present holds equally true of the past," or when he emphasizes later that "climatic agents are not only now the most important and influential; they have been so during all past geological ages."[73] The reach of Lyell's thinking extends deeply into Croll's text: Lyellian uniformitarianism also emphasizes the importance of gaps in the geological record, which were interpreted as moments in which deposition did not occur. Croll takes this to be an important element of his own reading of ice ages, and how they might appear to future geologists;[74] moreover, Croll's conception of the age of the planet— "something like one hundred million years"—was also derived fundamentally from Lyell's insistence on the uniform processes of the planet, which required an extensive amount of time to make the earth in its present form: "It was,"

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history; merely because the presence of erosion from water and ice would have been more substantial in Scotland than the power of volcanoes, earthquakes, and "upheavals" hardly means those processes are inactive elsewhere on the planet.

[73] Croll 3. See also page Croll 256 for his remarks about the difference between astronomy and geology, which also emphasizes the way which the present is the key to the past.

[74] Croll 271

Croll argued, "the modern doctrine that the great changes undergone by the earth's crust were produced, not by convulsions of nature, but by slow and almost imperceptible action of rain, rivers, snow, frost, ice, &c., which impressed so strongly on the mind of the geologist the vast duration of geological periods."[75]

There is no better evidence for uniformitarianism's ascent to the status of "normal science" than Croll's insistence that uniformitarianism was not a method among others; it was the only truly scientific method available. Uniformitarianism for him is the only way by which a "rational comprehension" of geological history is possible. Indeed, a uniformitarianism in which the "physical laws" of the current world—all uniform, all discernable—are understood and projected into the past is the only way in which geology may be considered a "science" in the proper terms.[76] Indeed, uniformitarianism for him stands in opposition to speculation; everything Croll observes is derived from "physical science."[77] Such an insistence will be carried by Croll throughout the entire text, appearing in perhaps its most interesting place when he

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[75] Croll 20

[76] Croll 2. He also writes that "We may describe, arrange, and classify the effects as we may, but without a knowledge of the laws of the agency we can have no rational unity. We have not got the higher conception by which they can be *comprehended*. It is this relationship between the effects and the laws of the agency, a knowledge of which really constitutes a science" (4).

[77] Here is Croll's quote in full: "There is one point to which I wish particularly to direct attention—viz., that I have studiously avoided introducing into the theories propounded anything of a hypothetical nature. There is not, so far as I am aware, from beginning to end of this volume, a single hypothetical element: nowhere have I attempted to give a hypothetical explanation. The conclusions are in every case derived either from facts or from what I to be admitted principles. In short, I have aimed to prove that the theory of secular changes of climate follows, as a necessary consequence, from the admitted principles of physical science" (22).

assures his readers that his theory is "no mere picture of the imagination, no mere hypothesis," but rather a "necessary consequence from physical principles."[78] Croll's uniformitarianism was able to attach itself to the claims for being the only rational science available, the only way to do science as such.

But as I have argued earlier about Agassiz's catastrophism, uniformitarianism is best understood not as an empirical position but rather as a narrative form or strategy adopted in order to contain the complexity of geological history. Contrary to Croll's position, I am insisting precisely that Croll's work is a "picture of the imagination" just as much as it is a theory derived from his understanding of physical principles.

Croll's uniformitarianism is most visible in the central chapter of *Climate and Time* on "the Physical Agencies which lead to Secular Changes of Climate." Here Croll attempts to articulate in a single location his theory of secular climate change; his theory is an excellent example of uniformitarianism at work as a form of emplotment. Croll's theory suggests that there were multiple ice ages—Agassiz's ice age was not unique, but it had been relatively recent, geologically speaking ("quite a modern affair," as he says—and that these moments all consisted of cyclical glacial and interglacial epochs, or a "long *succession of alternate cold and warm periods*."[79] Unlike contemporary theories of the

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[78] Croll 69

[79] Croll 285 and 252. Croll was convinced that ice ages had occurred before this one, but that the evidence was sparse (287). Indeed, Croll's sense of the modern landscape only reinforced such thinking: for him, "we have the surface of the land in almost identically the same state in which it was when the ice left it, with the boulder clay and all the wreck of the ice lying upon it" (286). It is worth noting that such a conception

ice age, which see glacial moments as fully global, Croll thought of them as isolated in hemispheres: during an ice age, one hemisphere would enter a glacial epoch while the other would become warm; interglacial moments then designated times of relative warmth throughout the planet.[80]

But the essence of Croll's story is about causality, and an essentially mechanistic conception of the way various agents interact with one another in order to produce not only ice ages but also cyclical glacial and interglacial moments. Croll's theory of causality begins in outer space. For him, two changes in the earth's position around the sun are important for transformations in climate: the precession of the equinoxes and the eccentricity of the Earth's orbit. The precession of equinoxes refers to a shift in the directions that Earth's rotational axis points: just as a spinning top's axis will rotate as it spins, Earth's axis of rotation also shifts over time, pointing in different directions in the night sky. Eccentricity, meanwhile, is the simpler of the two, but also the more important for Croll's theory: it refers to the extent to which the Earth's orbit is more or less circular. High eccentricity means it is more like an oval, low eccentricity means it is more like a circle. In Croll's conception, transformations in the eccentricity of the orbit

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indeed caused Croll to question whether the metonymical notion of an "ice age" was even appropriate: by Croll's time it was clear that ice ages had been a semi-global phenomenon. Croll's theory states explicitly that ice ages happened in cycles of glacial and interglacial periods, in which the northern and southern hemispheres traded off the cold as if they were sharing the burden. Indeed, it in this sense that the name "ice age" is called into question by Croll, although no alternative is proposed (238).

[80] The best explanation of this theory may be found in Imbrie and Imbrie.

subsequently set in motion a series of "physical agents" that can lead to an ice age. An ice age will begin only when the Earth's eccentricity is high; in such a time period, glaciers will begin to grow in the hemisphere that has its winter when it is furthest away from the sun. Earth's orbital eccentricity dramatically reduces that hemisphere's heat; when the Earth's orbit is most like an oval, more snow falls in a longer winter, substantially increasing the total accumulation of snow for any year. The snow, in turn, lowers the summer temperature because of the radiation of cold off of the ice, because the snow reflects sunlight back into space, and because it creates dense fogs. Thus the snow transforms the relationship between the area and the amount of sunlight the area receives.[81]

Yet even this was not enough, in Croll's understanding, to plunge a hemisphere into an ice age. High eccentricity results in one hemisphere accumulating more snow and becoming substantially colder than the other; this situation "brings into play the agencies which lead to the deflection of the Gulf-stream and other great ocean-currents."[82] The difference in temperature between the two hemispheres, due to the presence of snow and ice, in other words changes the trade winds and therefore also the ocean currents. The other various climatological agencies stop the gulf steam, which

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[81] Croll 56–60
[82] Croll 62

would in turn bring Europe to glacial conditions. Finally, changes in air circulation also bring more moisture to the north, creating even more snowfall.

In order to understand the poetics or style of this complex theory, and how it qualifies as a specifically "uniformitarian" story, it is important to look closely at the (relatively long) paragraph in which Croll attempts to summarize this idea fully:

> We have seen that the accumulation of snow and ice on the ground resulting from the long and cold winters tended to cool the air and produce fogs which cut off the sun's rays. The rays thus cut off diminished the melting power of the sun, and so increased accumulation. As the snow and ice continued to accumulate, more and more of the rays were cut off; and on the other hand, as the rays continued to be cut off, the *rate* of accumulation increased, because the quantity of snow and ice melted became thus annually less and less. […] Further, as the snow and ice accumulated on the one hemisphere, they at the same time continued to diminish on the other. This tended to increase the strength of the tradewinds on the cold hemisphere, and to weaken those on the warm. The effect of this on ocean currents would be to impel the warm water of the tropics more to the warm hemisphere than to the cold. Suppose the northern hemisphere to be the cold one, then as the snow and ice began gradually to accumulate there, the ocean currents of that hemisphere would begin to decrease in volume while those on the southern, or warm, hemisphere, would *pari passu* increase. This withdrawal of heat from the northern hemisphere would tend, of course, to lower the temperature of that hemisphere and thus favor the accumulation of snow and ice. As the snow and ice accumulated the ocean currents would decrease, and, on the other hand, as the ocean currents diminished the snow and ice would accumulate,—the two effects mutually strengthening the other.[83]

If we view this passage as a plot summary of Croll's story about the ice age, the agents of the story, sometimes obscured by technical descriptions for how they function, become more apparent. For Agassiz, the ice age's actors were moving glaciers and

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[83] Croll 75-76

violently uplifting Alps. Croll's conception of agency is dramatically more distributed and global: the planet itself, moving around the sun, wobbling in ways that are essentially imperceptible to humans, is the determining agent; yet glaciers and ice sheets, reflecting sunlight and radiating cold, the trade winds slowly blowing in a different direction, catching moisture differently, and deep ocean currents carrying warm water, all also play crucial parts.

What marks such a complex narrative as uniformitarian is the way these forces interact: they are cyclical actors that repeat their interactions slowly, over thousands of years; they do not produce dramatic catastrophes.[84] Unlike in a catastrophic story, in which the narrative engine is fueled by conflict and destruction, Croll's theory involves interaction and cooperation rather than opposition. It proceeds through a kind of forceful cause and effect logic that we would today call a "positive feedback" loop.[85] "It is quite a common thing in physics," Croll reminds his readers, "for the effect to react on the cause."[86] But where they usually tend to "weaken" the cause (what we would call a negative feedback), Croll observes that with these ice-age forces "cause and effect mutually reacted so as to strengthen each other."[87] Formally speaking, then, Croll's narrative stands as uniformitarian because of the presence of mutually cooperative

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[84] It is tempting to think of this ultimately as a kind of "posthuman comedy" to appropriate a phrase from Mark McGurl, in which these forces do not act in conflict at the end of the story.
[85] Croll, indeed, was not merely aware of the importance of feedback systems, and mutual effects, he has been credited as one of the first scientists to assign significance to them. Imbrie and Imbrie.
[86] Croll 75
[87] Croll 75

forces producing cyclical changes over a long period of time: there is a harmony in the ice age story.

Yet, in focusing on the cyclicality of these agents, also produces the opposite of a historical narrative. Reading Croll's summary, it becomes clear that for him abstract system dynamics are more interesting than actual events: there is no sense of historical movement in that passage, or in the chapter more generally, no sense of the real chronological progression of events. There is, in other words, a feeling of ahistorical suspension reading Croll, as if these forces were reacting this way in the abstract, and not that they had already occurred in just this way in the past. When Croll asks his readers, in the above passage, to "suppose the northern hemisphere to be the cold one," he explicitly takes his narrative out of history, and places it into a kind of mental laboratory, running different experimental scenarios in which a different hemisphere, at any given time, might enter a glacial epoch. Something similar occurs throughout the book when Croll illustrates his physical principles with science fictional, imaginative, and indeed hypothetical acts of description. Discussing the cooling effect of ice sheets on the atmosphere, Croll writes:

> Were it not for the ice, the summers of North Greenland, owing to the continuance of the sun above the horizon, would be as warm as those of England; but, instead of this, the Greenland summers are colder than our winters. Cover India with an ice sheet, and its summers would be colder than those of England.[88]

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[88] Croll 59-60

Croll is of course not referring to a real event of continental glaciation in India; this passage merely intends to account for the cooling effect of ice. It is Croll's way of illustrating the conditions of possibility for a given climate, a writing trick for making bare the preconditions and necessities for given climatological scenarios. What would happen if I changed this or that feature of the global climate system? What can I substitute so that the whole climate changes to something radically different? Such a propensity to think through hypothetical laboratory situations, instead of real historical events, defines Croll's method. Croll's rigorous logical uniformitarianism lends itself to narrativization in the form of feedback loops, but it also lends itself to hypothetical scenarios that are equally ahistorical. In both cases, Croll may safely assume a set of physical forces that are still acting.

Croll's account of the ice age involves an abundance of nonhuman actors linked by a causal chain—from orbital changes, to snow and ice, to atmospheric temperatures, to trade winds and ocean currents. What has been noticeably absent from Croll's story of ice ages, especially when compared with Agassiz's, is life itself. Agassiz's catastrophism, as we have seen, involves the destruction of life, and its later rebirth in a fresh round of creation. Croll, so interested by the primary nonhuman causes of ice ages, appears to ignore what their effect might have been on life. But we may turn to two later chapters in Croll's book, in which he discusses his theory of glacial and interglacial cycles in greater detail, that we come to understand his view of life more clearly. Croll claims throughout his account that glaciation is devastating for life. He states plainly that "an extreme paucity of organic life is a characteristic of a glacial period."[89] Croll imagined that, during a glacial period, "nearly all places in the northern temperate regions" on the same latitude as England were "covered with snow and ice," a consequence of which was that "all animal and vegetable life within the glaciated area would to a great extent be destroyed."[90] Such a claim seems less tied to the geological records examined in these chapter—which are largely used to support the cyclical nature of glacial epochs, rather than the presence of life—and more tied to empirical examples from the present world: in particular, Croll references the Arctic region and Greenland, which are "almost wholly covered with ice, and as a consequence nearly destitute of vegetable life."[91]

No doubt, it would appear that Croll is convinced of just the kind of catastrophism that Agassiz and Schimper's theory proposed. But his treatment of life and its return differs considerably from theirs. Let me turn to a passage, perhaps one of the best of the entire book, that is both an illustration of Croll's excellent geohistorical imagination and his conception of life:

> There can be little doubt that during the warm periods of the glacial epoch our island would be clothed with a luxuriant flora. At the end of a cold period, when the ice had disappeared, the whole face of the country would be covered over to a considerable depth with a confused mass of stones and boulder clay. A surface thus wholly destitute of every seed and germ would probably remain for years without vegetation. But through course of time life would begin to appear, and

[89] Croll 286
[90] Croll 259
[91] Croll 259

> during the thousands of years of perpetual summer which would follow, the soil, uncongenial as it no doubt must have been, would be forced to sustain a luxuriant vegetation. But although this was the case, we need not wonder that now scarcely a single vestige of it remains; for when the ice sheet again crept over the island everything animate and inanimate would be ground down to powder. We are certain that prior to the glacial epoch our island must have been covered with life and vegetation. But not a single vestige of these are now to be found; no, not even of the very soil on which the vegetation grew.[92]

For Croll ice ages are in fact devastating for life—here imagined as a creeping and destructive force—yet never in such a catastrophic way that all life is eliminated from the Earth, needing to be subsequently reborn *ex nihilo*. For Croll life simply migrates: animals migrated during the glacial epoch between the north and south, although some species like the mammoths lived during the cold period of the glacial epoch.[93] Thus where it was clear that Agassiz's book was ultimately a way of advancing his view of the history of life in catastrophism, here we have the opposite: the ice age becomes a way of legitimizing and advancing a conception of Earth history that is primarily understood in terms of long temporality and the slow movement of agents, and in which life itself seems to move, essentially, in slow migration cycles.

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[92] Croll 256-257

[93] Croll 394-395. What else did Croll make of that famous creature of the ice age, the wooly mammoth? Mammoth bones indicate the cold of the glacial epoch (79) But mammoths were found in material thought to be from an interglacial (248); Mammoths were living in England during the cold period (252); From the time of the glacial epochs beginning to today, there is a hypothetical seafloor bed with mammoth bones (288).

1.5 Narratives of the Ice Age

As I observed at the beginning of this chapter, it is typical, in accounts of the discovery of the ice age, to emphasize the empirical progression from earlier theories to the present day. In such an account, Agassiz's book stands as an important—if flawed—contribution to the geological way of thinking: he offered a description of glaciers and how they work, as well as a largely speculative account global climate change that, at the very least, established the importance of having conversations about climate change in the recent geological past. Agassiz, in this way of thinking, invented a new way of seeing the Earth: what had once appeared to be the remnants of a gigantic flood had become the product of the slow agency of glaciers. Agassiz himself had a strong sense of this transformation as a revolution in seeing. "In my mind," Agassiz writes, "I have often compared these faint remnants of the past action of glaciers to the appearance of a lithographic stone, prepared for a long preservation, on which the traces of the inscriptions may be seen only if we know where and how to look for them."[94] This new way of seeing—itself lacking in both field evidence from around the globe and lacking any form of casual explanation——had immediate explanatory power for those scientists conducting field work in previously glaciated regions like Scotland and North America, where moraines, erratics, polished rock surfaces were in abundance. Nonetheless, it would take years to become normal science. Following the publication of

[94] Agassiz 133

Croll's *Climate and Time* (1875), which provided a plausible explanation for the cause, ice age theory became, by 1880 according to Tobias Krüger's estimate, the mechanism for explaining the geological features of the global north for much of the recent past. In this narrative, Croll's efforts to prove the astronomical theory, although disproven in the years following his book, was ultimately correct; whereas Agassiz, although credited with the discovery, has little bearing on contemporary scientific theory.

As a parallel to this story, I have suggested here that the birth of the ice age was a moment of narrative struggle, in which a uniformitarian account of ice ages ultimately came to replace the catastrophist story. This is not to say that Croll's account proved "correct"—numerous flaws were later discovered in his astronomical calculations, and his theory of alternating hemispheres was also incorrect—but rather to say that the form of his narrative proved to be more preferable, and allowed for a greater understanding of the planet's deep history. This discovery was not merely an empirical victory; it was also an achievement of the imagination.

Nothing would appear to reinforce this point better than the ways in which both theories ultimately remain connected to religious and mythic narratives. Agassiz's creationism, his commitment to seeing the living world as a product of god, directed his particular conception of biology that, in turn, informed his sense of Earth history: wrapped up in his notion of the ice age was the belief that a divine being could rekindle life. Although strongly called into question by Charles Darwin's *On the Origin of Species* in 1859, Agassiz retained this view of life's history well after Darwin, and remained a staunch creationist for the rest of this life. Indeed, this view of life was precisely what relates the relatively early writing in *Studies on Glaciers* to Agassiz's notorious career in the United States at Harvard, where he offered his disturbing propositions of scientific racism and his related opposition to evolution that still define his reputation in the humanities.[95] Agassiz began to work out his theories of "polygenism" only after he came to the United States in 1846, six years after he formulated his theory of the ice age, when he encountered African Americans for the first time. First published in an article in the *Christian Examiner* in 1850, Agassiz argued that each of the different human "species" were created at different moments in time, in varying environmental circumstances, and endowed with different natural abilities. Although Agassiz considered himself to be an opponent of slavery, it was made clear in the article that his creationism designated a strict hierarchy between the different human "species."[96] Nothing as sinister seems to have motivated Croll's gradualism. Yet Croll's "moderate form of Calvinism," as he referred to his religious preferences, were nevertheless present in his writing.[97] Croll held that a "Divine Mind" had predestined the various cyclical patterns of Earth's orbit around the sun, which in turn influenced the entire climatological history of the planet.[98] Croll's insistence on physical laws, on cycles, on patters of all sorts, all come to reflect

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[95] See, for example, Britt Russert's *Fugitive Science*.
[96] See Gould, *Mismeasure of Man*, 74-82.
[97] See Croll's autobiography (23).
[98] Croll 356

this particular conception of a divine "watchmaker" being that sets in motion the world, but does not interfere.

My point in drawing out the religious and mythic base of Agassiz's and Croll's work is not to discount their importance in the history of scientific development, but rather to emphasize the significance of narrative emplotment for the kind scientific "paradigm shift" that the ice age ultimately represented. For Rudwick, the discovery of the ice age constitutes the moment when planetary climate became historical and contingent, and not merely mechanical.[99] Before Agassiz, climate was seen was an arrow, operating in a steadily proceeding direction and cooling slowly since the inception of the planet as a molten sphere. The laws of thermodynamics dictated the climate in a relatively simple sense. The global climate was therefore relatively stable, even though it had been known to change locally in dramatic ways. Agassiz's theory of glacial spread required the Earth to have been substantially cooler than it was at the time he was writing, which fundamentally contradicted the consensus around the planet's long-term climate.

In Rudwick's estimation, such a transformation in the way people thought about global climate fundamentally represented a victory for catastrophists. "If any of them felt vindicated by the glacial theory," Rudwick writes of the geological community, "it was the catastrophists. For it reinforced the deeper sense, which catastrophists had

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[99] Rudwick 180

always emphasized, that the past history of the Earth had been radically contingent and was therefore unpredictable even in retrospect."[100] Of course, the story as I have told it is somewhat different: on the one hand, Agassiz himself introduced a sense of pattern and order into his catastrophist ice age story when he attempted to align his own theory with the consensus around the planet's progressive cooling. Agassiz conceded that the "primitive state of the planet" was an "incandescent body in fusion" that gradually cooled, and he suggested, in a staircase-like diagram, that in addition to its long-term cooling trend Earth also undergoes sudden—and unexplainable—catastrophic drops in temperature that constitute ice ages. Moreover, Croll's influential uniformitarian account of the ice age, "predictability" returned in an even stronger sense. It is my preference, then, to slightly modify Rudwick's argument about the significance of ice ages in the long term history of climate: more so than "contingency," Agassiz and Croll introduced sense of radical complexity to the global climate; they enabled a comprehension of climate as an entity operating in a way that involved a far greater variety of agents than had been previously thought. In this sense, the two narrative forms that come to the forefront of the geohistorical imagination—catastrophism and uniformitarianism—played a role in the fashioning of the ice age.

But let me conclude by emphasizing the contemporary significance of ice age science. In one sense, ice ages occupy a foundational status in the study of climate

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[100] Rudwick 180

change, as Spencer R. Weart demonstrates in his study of global warming's discovery.[101] Indeed, one of the most important works on global warming, Svante Arrhenius's 1896 paper on greenhouse gases, is grounded firmly in ice age theory.[102] Arrhenius's paper correlated greenhouse gases with the warming of global temperatures. It is therefore often referenced as an early predictor of anthropogenic global warming through fossil fuel release. But what is often forgotten is the context in which Arrhenius's paper was written. Arrhenius wrote that he would not have undertaken his investigation without the "extraordinary interest" surrounding the "probable causes of Ice Ages."[103] He was less interested in human CO2 production, as we are led to believe, and more absorbed with the causes of ice age cycles. Arrhenius's paper, indeed, was a response to Croll's theories. Arrhenius rejected astronomical cycles as the fundamental cause of ice ages in favor of greenhouse gases. The ice age, in this sense, serves as a bedrock upon which contemporary climate science rests.

In another sense, ice ages continue to inform how scientists understand the objective transformations happening to the planet today. Introductions to climate change like David Archer's *The Long Thaw* (2009) and Curt Stager's *Deep Future* (2011) emphasize the surprising geological fact that, for the past 2.5 million years, the Earth's climate has cycled between glacial and interglacial periods of an extended ice age. They

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[101] See in particular chapter 1 "How Could Climate Change?"
[102] James Roger Fleming notes this in passing in *Historical Perspectives on Climate Change* (77).
[103] Arrhenius 267

point out, in other words, that we are still living in an ice age today. During the most recent glacial period, which began 116,000 years ago, modern humans evolved and spread out of Africa, encountering woolly mammoths and enormous ice sheets as they migrated north; all of what we call human civilization began only after the start of the Holocene epoch 11,700 years ago, an interglacial moment contained within this long age of ice. Croll's glacial cycles, in other words, are still in effect today: our interglacial, although prolonged, will likely end.

2. The Ice Age and Us: Glaciation and Climate Fiction

Clothed in animal skins, the humans gather on a stone arch and gaze down at the river that passes through it. They are captivated by the muddy shards and temporary dams, and by the roaring, booming, and groaning sounds of crashing ice plates. Midway through the year, the river has finally begun to thaw. They pray it does not flood their camp, but they carry their most valuable possessions as a precaution. Despite their concern, they feel a sense of collective liberation as the fracturing ice reveals the flowing water hidden beneath: the animals they hunt will return, the nuts and berries they gather will grow, they will be less confined to the tight, fire-lit human spaces needed for warmth, and they will be able to socialize beyond their pack. They stretch their arms to a cloudless sky; they grin; they shout and howl but are drowned out by the sounds of the cracking ice that signal the beginning of a brief stretch of warm weather.

This scene, a brief but remarkable passage in *Shaman*, does not occur on some distant frozen world, or on our own planet, devastated by climate change in the future, as we might expect from its author Kim Stanley Robinson. It takes place, rather, on Earth thousands of years ago during the last ice age. Grounded in the experience of a seasonal transition, it encompasses the human and the geological all at once: human rhythms and affects—like joy for the winter's end—are tied to the environment of Europe during the most recent glaciation. It thereby previews in miniature what I aim to argue in this chapter about Robinson's novel and Johannes V. Jensen's *The Long Journey* (1922): that ice age fiction narrates the entanglement of the deep history of humans with the planet's geology.[1]

My aim in analyzing these two novels—one composed originally in Danish in the twentieth century, the other written in English in the twenty-first—is both to rethink the genre of "climate fiction" and to argue for the value of ice age fiction in a moment of global warming. As in the previous chapter on the birth of the ice age, I approach these novels with a focus on narrative form, in particular the kinds of "catastrophism" and "gradualism" that shaped Louis Agassiz's and James Croll's representations of the ice age. I begin by characterizing Jensen's novel in terms of its vision of human evolution, which proceeds through strictly gendered forms of technological advancement; I then explore its catastrophic vision for the ice age, which for him formed the basis of his racist conception of human evolution. Turning to *Shaman*, I note how it pays special attention to the presence of science and art in deep history and works to forge an identity between us and the apparently modern ice-age humans. Next, I open my analysis to consider the novel's gradualist narrative of climate, exploring how the human experience of the ice age consists of the slowness of glaciation, and the possibility of daily life in the uneventful environment of the Pleistocene. Differing from Jensen's story of glaciation, *Shaman* reorients the ice age from rapid catastrophe toward gradual glaciation and the

[1] Deep history, as I use it here, refers to the Earth's 4.56 billion year history, as well as the evolutionary history of *Homo sapiens* dating back roughly 200,000 years. I adopt these two ways of discussing deep history from Rudwick's *Earth's Deep History* and Daniel Lord Smail's *On Deep History and the Brain*. My sense of these distinct but related "histories" derives from Dipesh Chakrabarty's work ("Climate and Capital" 1).

persistence of daily life. It refuses the apocalyptic tone and the temporal compression that defines Jensen's ice-age imaginary.

After drawing out the narrative form of Jensen's novel and Robinson's novel, I move on to provide a more explicit characterization of these books in terms of their genre. Typically, fiction about the last ice age is referred to as "prehistoric fiction." Prehistoric fiction concerns itself with human history before the invention of writing. As Nicholas Ruddick explains in his comprehensive survey of the genre, its roots are grounded firmly in the latter half of the nineteenth century when European scientists first began to widely accept the possibility of both deep time and human antiquity.[2] Beginning with Pierre Boitard's *Paris avant les hommes* (1861), and continuing through relatively well-known Anglophone examples like Jack London's *Before Adam* (1907), William Golding's *The Inheritors* (1955), and Jean M. Auel's *The Clan of the Cave Bear* (1980), prehistoric fiction has held tightly to its thematic conventions. As Ruddick maintains, all these novels, at their core, tend to be interested in the status and shape of human nature: how humans supposedly escaped nature from our origins through inventions like fire; how *Homo sapiens* differs from Neanderthals, and why one species ultimately survived the other; how sex and gender operated in the deep past; and how human practices such as language, religion, and art appeared in prehistory.[3] Putting this

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[2] Ruddick 1
[3] Ruddick 8

in slightly broader terms, prehistoric novels, just as other texts about the deep history of humans, attempt to give us an "image of ourselves," to borrow a phrase from the paleoanthropologist André Leroi-Gourhan.[4]

But in this chapter I argue that the extent to which the ice age climate plays a role in these novels suggests that they can be regarded as both prehistoric fiction and climate fiction, a form that gained recognition after anthropogenic global warming became a commonly-known problem.[5] Climate fiction has been defined by its essentially speculative attention to the future of global warming: it attempts to draw out the consequences of both CO2 emissions and other forms of ecological damage.[6] But in this chapter, I turn to *The Long Journey* and *Shaman* in order to expand our narrow sense of climate fiction to include those stories concerned with representing the planet's climate past.

Although this might seem to be a counterintuitive claim, common to both climate fiction and prehistoric fiction is an effort to think environments historically, a capacity I

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[4] Leroi-Gourhan 3

[5] Prehistoric fiction might, at first glance, appear to be a subcategory of historical fiction. But the traditional aspects of the historical novel—great events, important historical figures—are all by necessity absent, because the content of these novels comes from before the invention of writing and our ability to record those very events and figures. More appropriate, as Ruddick remarks, is to see prehistoric fiction as a kind of "fraternal twin" of science fiction, because both rely on scientific discovery for their plots, to varying degrees, and are equally speculative (3). Reviewing Elizabeth Thomas Marshall's *Reindeer Moon* (1987), Ursula K. Le Guin maintains a similar comparison: the sciences of the prehistoric novel are "anthropology, archeology, paleontology," instead of physics, and the success of the novel depends in part on the novelist's extrapolation from known scientific facts, or in Le Guin's words prehistoric fiction's "speculations take off from the author's knowledge of what science has established" (17)

[6] See Milner and Burgaman's list (18-19).

defined more broadly in the last chapter as the "geohistorical imagination."[7] There, I demonstrated how early geologists, in inventing the concept of the ice age, saw the planet undergoing enormous environmental changes over time, picturing the landscape before them morph from one environment to another in a sequence. The geohistorical imagination is a recognition of the historicity of nature, and is therefore not merely an acknowledgement of the existence and importance of the nonhuman world, as in the "environmental imagination" of nature writing.[8] In fostering this way of confronting the environment as historical, these geologists, I showed, laid the very groundwork for understanding climate change today.

In this chapter, I describe how a similar form of this imagination may be found in *The Long Journey* and *Shaman*, and in climate fiction more broadly. Questions about human life during the ice age would have been foreign to Agassiz and Croll. Despite their mutual concern for life in general during that period, in both *Studies on Glaciers* and *Climate and Time* the particular issue of human life remained untouched. Such questions only began to emerge when connections were made between human history and the ice

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[7] I should emphasize that not all prehistoric fiction involves the ice age. Prehistory, it should be remembered, designates a vast swath of time and geography; prehistoric fiction therefore may be set both after and before the last ice age, and in locations where the distinctive glaciers of ice age are absent. Moreover, many prehistoric novels have little interest in foregrounding the environment. While Auel's novels, for example, are set during the last ice age, the Pleistocene environment generally does not play any kind of active role in the narrative. By contrast, the two novels to be examined here— Johannes V. Jensen's *The Long Journey* and Kim Stanley Robinson's *Shaman*—have an environmental focus; more so than many works of prehistoric fiction, they are worth considering as climate fiction.
[8] I loosely borrow this term from Lawrence Buell's *The Environmental Imagination*.

age.[9] Up until the 1860s, it was thought that humans only emerged after the ice retreated; indeed, the French scientist Louis Figuier asserted in his widely-read *La terre avant le deluge* (1863) that "[i]t was only after the glacial period, when the Earth had resumed its normal temperature, that man was created."[10] James Geikie's *The Great Ice Age, and Its Relation to the Antiquity of Man* (1874) in particular coordinated the new knowledges of both the ice age and the deep history of humans and popularized.[11] The subgenre of "ice age fiction" began with Austin Bierbower's *From Monkey to Man, or Society in the Tertiary Age: A Story of the Missing Link* (1906) and Louis Pope Gratacap's *A Woman of the Ice Age* (1906).[12] Unlike Agassiz and Croll, then, Jensen and Robinson consider the agency of the nonhuman geological world in conjuncture with human life and thereby produce a recognizable form of climate fiction.

Although I approach *The Long Journey* and *Shaman* from two perspectives (human history and geological history), my aim is not to insist on their incompatibility, but on their coming together. As I argue in the concluding section of this chapter, it is in

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[9] Matthew R. Goodrum writes that although human remains had been discovered with those of extinct animals like mammoths in the early nineteenth century, it was not until the middle of the century that scientists became convinved that humans had lived during the ice age. Goodrum explains that "it was excavations at Brixham cave in Britain and similar excavations conducted by French geologists in the Somme valley from 1858 to 1861 that provided the evidence that convinced important elements in the scientific community that humans had lived during the Pleistocene" (Begun 18).
[10] 415. *World Before the Deluge* in the English translation from 1872) (1863 in French, translated 1872)
[11] It is important in this sense to remember that both were relatively recent discoveries at the time—while Agassiz's book came out in 1840, and Darwin's *Descent of Man* didn't come out until 1871, and Charles Lyell's *Geological Evidence of the Antiquity of Man* first appeared in 1863).
[12] Whether these early novels informed Jensen's book is unclear, although it bears a number of similarities with Bierbower's novel. Both are occupied with the impact of the ice age on the evolution of prehistoric humans.

its capacity to figure both histories at once that ice age fiction ultimately bears significance for us today. Both novels encourage us to see a continuity with the past that empowers us to look at our contemporary climatic and environmental situation—broadly conceptualized with the concept of the Anthropocene—in deep history. I therefore offer some speculations about how the novels' ice ages place us in a position to comprehend global warming and the Anthropocene historically.

2.1 Jensen and Glacial Catastrophism

Although largely forgotten today, Jensen won the Nobel Prize in Literature in 1944.[13] Much of his reputation in Europe was built on *Den lange Rejse* [*The Long Journey*], which was originally published in Danish as a series of separate volumes that were written out of chronological order: *Bræen* (1908), *Skibet* (1912), *Norne-Gæst* (1919), *Det tabte Land* (1919), *Christofer Columbus* (1921), and *Cimbrernes Tog* (1922).[14] When *The Long Journey* was translated into the English, the first and fourth volumes were combined into a single volume titled *Fire and Ice*. This first part of Jensen's novel will occupy most of my attention here.

Fire and Ice moves across thousands of years of history, although precise indications of time are never given, and therefore defies concise plot summary. The

[13] See the Nobel Prize's website here: https://www.nobelprize.org/prizes/literature/1944/jensen/facts/
[14] For an overview of interpretations of this novel see Peter G. Christensen's article. In the past this novel has mostly been addressed in terms of its Darwinian positions, rather than its climate.

opening chapters of Book 1 (Fire) are entirely inhuman: the narrative struggle takes place between Gunung Api, a powerful volcano located somewhere in Scandinavia, and a dense and lush forest that has emerged around it. This "forest of change" covers the entire planet; it attempts over and over to climb the volcano, only to be wiped out by an eruption.[15] Once humans emerge in this forest "out of the primeval state together with the beasts," the story follows human development by focusing on one individual human, a mythic succession of great men or "mankind in one person," as Jensen writes later.[16] We first follow "the Man," who leads a kind of primal horde and whose great accomplishment is to guide the people into a swamp to survive an immense forest fire. Next we learn of a child of this horde, "Fyr," who goes off to live by himself on the volcano, where he learns to manage fire (although not produce it himself); this is also where he learns to keep time, and understand the seasons. Fyr eventually carries a burning stick to the people below the mountain; tamed fire gives those humans a huge natural advantage, substantially changing their situation in the forest—humans begin to eat meat at this time, which disturbs the relatively balanced relationship they have with mammals.[17] Fyr also develops the first weapons and trains the first hunters, and creates

[15] Jensen 5

[16] Jensen 10 and Jensen 78.

[17] Jensen 45

the first cave paintings.[18] Despite these remarkable accomplishments, his tribe ultimately sacrifices him in order to appease the sudden eruption of the volcano.

Book 2, "Ice," focuses on Carl, likely a direct descendent of Fyr. Carl observes the way in which the climate of the forest is changing; rather than migrate south, Carl wants to stay and directly confront the cold of the coming ice age.[19] The process of adaptation happens quickly; he starts to wear fur coats and eat different forms of meat, and rediscovers how to ignite fire with flint stones. Eventually pairing with a woman he meets, he starts a family, and settles on the ice sheet. White Bear, their ancestor and the final figure of this narrative, too faces banishment from his social community, just as Fyr and Carl did. He settles further south, drawn to the warmer climate, and begins to sail south of Scandinavia, just as the ice age is coming to a close. He begins a family, and the narrative ends, in an extremely disjointed fashion, with a man named Swain (presumably a relative of White Bear) founding Denmark.

All writing about prehistory, to varying degrees, functions as a meditation on human nature. The moment a writer decides to imagine humans of the deep past, they must decide what characteristics persist over the course of time, and they inevitably theorize a basic form of human essence. Jensen is no exception to this rule. Over the course of this sprawling text, he offers up a series of interconnected theories of

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[18] Jensen 76
[19] Jensen 99

technological development and gender. From this perspective, the first two books of *The Long Journey* may be summarized as a narrative of the discoveries that were most important to human history. The chosen technologies themselves are generally unsurprising: fire, stone tools, cave painting, weapons, clothing, the wheel, agriculture, sea vessels, and so on. But what should surprise us is the particular way these technologies come into existence. It is not through thousands of years of collective attempts and failures but rather through individual genius. For the most part, these inventions come slowly to these men. Fyr, for example, only gains control of fire after years of living on a volcano, slowly realizing that a single tree branch may be carried away. Carl, later, makes yet another technological leap in fire starting when he discovers that flint stone may be used to create sparks that can ignite grass and wood.[20] He discovers this essentially by accident when making stone tools. White Bear, finally, makes a similar accidental discovery of fire: the wheels of his chariot create sparks and fire through friction.[21] But Jensen often sways from this model of technological development into a more obviously presentist notion of technological discover through individual passion and directed, quasi-scientific experimentation, as when Fyr seemingly decides, having invented fire, that it was now necessary to invent both the first weapons and the first hunters, or when White Bear invents a raft and then boat.[22]

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[20] Jensen 136
[21] Jensen 194
[22] Jensen 61 and 170

For Jensen, the motor of history is not collective activity but rather individual innovation and directed imagination; it is within the bounds of human nature to produce, every so often, an individual "prolific brain" that moves humans collectively forward.[23] We may further specify Jensen's aims by noting that this structure of the individual genius is coded explicitly male. Women, in Jensen's representation, are also capable of making important historical discoveries, but only by accident. Take for example the discovery of pottery, which Jensen imagines happens through sheer happenstance.[24] Perhaps more interesting is the discovery of agriculture, which is also invented entirely by accident by a woman named May, White Bear's wife.[25] Jensen seems to dismiss these two discoveries as unimportant for the course of history; they never seem to carry the same significance in the novel as the discovery of fire, or the creation of the first ship. Jensen's devaluation of the development of containers and the Neolithic revolution (arguably two of the most significant changes in human material life) speaks most clearly to his commitment to thinking about human nature, grounded in biological difference, as a determining force in history's unfolding.[26]

But Jensen's more surprising narrative achievement specifically relates to his catastrophic narrative about the oncoming ice age and its effects on humans. Jensen's story of the ice age, indeed, is an explicit effort to spread post-Darwinian notions of

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[23] Jensen 64
[24] Jensen 130 and 155
[25] Jensen 178
[26] See Clive Gamble's *Origins and Revolutions* for a discussion of both of these transformations.

history through a counter-myth to the biblical "Garden of Eden." Jensen's mythic, retrospective style of narration immediately alerts us to this goal: daily life and characters are largely beside the point, time is left unspecified, and we often encounter something like an aerial overview of history in which we zoom in on moments that strike Jensen to be of particular importance, but then hundreds of years appear to pass unremarked.[27]

Jensen's preface, simply titled "The Plot," explicitly frames the jungles of Northern Europe as the "Garden of Eden," a place that both does and does not resemble the biblical version.[28] On the one hand, the Northern European jungle resembles the biblical one in the sense of immense abundance. The "Forest Folk," Jensen's name for his early humans, live "entirely free from care and without thought for the morrow" because "the forest served them out of its abundance."[29] These forest people, Jensen continues, "had no dwellings or fixed places of abode but moved about from one wild orchard to another, according as the fruit ripened and offered itself; when they had cleared one place or amused themselves by shaking all the fruit down, they went off with noisy mirth to another and shook the trees there."[30] Jensen's humans, in their freedom, live in a world that fulfills all of the human senses: they move around touching, tasting, smelling everything they encounter. They live in a world of pure

[27] See 157 for an example of the story's retroactive narrative style.
[28] Jensen vii
[29] Jensen 11
[30] Jensen 11

perception of the present; there is no time or memory. The Garden functions as a place of absolute freedom from any form of necessity: in this "eternal summer," humans want for nothing: food simply appears in all of its forms. Environmental abundance makes any form of labor, even hunting and gathering, unnecessary; nor is anything resembling the state form necessary for accumulating and distributing resources. In the "wild joyous forest," human life is "bound by no laws but nature's own."[31]

On the other hand, Jensen's Garden of Eden is quite different from the biblical version, for it is profoundly historical, and filled with Darwinian relationships between various nonhuman species and forces:

> It was the forest of change. It grew from year to year but changed in its growth through the ages. It had adopted the primitive forms and was reaching out towards other new, unknown futures. The simple plants of vanished ages found a place here and developed according to their nature, the soul of a warmer time; dark conifers stood in the heat fermenting with fecundity and sweating resin; their thick juices were distilled from baking sunshine, tepid rain and the volcanic soil and smelt of a younger earth, but the forest had room for them. The plants of a yet earlier time, those that formed the vast steamy forests of the carboniferous age, could not hold their own, they had had their time; and yet the fern and the horse-tail grew in the forest; the forms that were extinct as trees still kept their place as plants.[32]

For Jensen, the forest is itself the product of competitions and "adversity": the forest is that which persists and survives, and is not made up of particular trees or species.[33]

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[31] Jensen 10
[32] Jensen 7
[33] Jensen 8

Whatever trees survive the "pitiless race" in the forest become the forest. But it is worth noting that this particular interpretation of Darwin—in which biological life is understood purely in terms of competition—becomes contested within Jensen's descriptions, leaning more toward a concept of nature centered around Peter Kropotkin's sense of "mutual aid."[34] For the forest is also seen as a "community growing together," in which "reciprocity" is that which "makes the forest rich."[35] Thus for Jensen what defines this new Garden of Eden is not the divine presence, but rather the Darwinian evolutionary forces of competition and reciprocity or cooperation, both of which produce an ever changing site that "in itself only persists through change."[36]

Jensen's version of the biblical myth derives directly from his sense of nature's constant flux: the eventual human expulsion from this Garden of Eden has nothing to do with the procurement of "forbidden" knowledge, but rather has to do with climate change. Suddenly and without warning, the climate becomes cold and rainy, seasons begin to emerge, and an ice sheet appears north of the jungle and slowly progresses south, destroying the "ancestral gardens" of the humans:

> The Ice was coming on; before it went incessant rain and cold nights which drove men out of their shiftless jungle existence. They would not and could not learn what was coming, and so they had to go. They froze, poor innocents, tried to make themselves cloaks of fig-leaves against the raw weather; they sang sweet songs of lamentation, but the north wind with its cold scourge had come between them and their leafy booths

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[34] See the selection from Kropotkin in *Darwin: A Norton Critical Edition*, 398–403
[35] Jensen 8 and 10
[36] Jensen 7

> under the plantains. Their home was no more, they were forced to migrate.[37]

The fall, for Jensen, is entirely inhuman: it is caused by the growth of the ice sheets. Where we might have expected that for Jensen the initial human domestication of fire would represent a kind of "fall" or expulsion from this Eden, the nonhuman growth of glaciers becomes far more significant.[38] Thus Jensen reworks the biblical myth substantially. It is more than a simple rewriting and a transportation of mythic structure; it is a complete undermining of that myth, in the sense that human moral agency is displaced by geological forces.

There are two elements to this climatological, catastrophic rewriting of the Garden of Eden that deserve further attention. Focusing first on Jensen's "geohistorical imagination," it is important to consider the impressive degree to which he reconstructs the agency of glaciers, the temporality of an oncoming glacier, and the effect climate change has on both the plants and animals of a particular place. First the temperature drops, the rain slowly transforms into ice and then snow, and the forest begins to struggle, and the animals start to migrate. Jensen is equally careful in tracking the march

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[37] Jensen 89

[38] Although Jensen imagines this moment to give humans "an enormous advantage over all other creatures," it hardly removes them from Eden (53); it merely represents a destined growth in the mastery of nature no more significant than the technological development of weapons, and excessive hunting (69). When Fyr—the second of Jensen's prehistoric great men—begins to live on the volcano, he slowly develops a new relationship with fire: where humans instinctually fear fire, Fyr comes to seek it in the relative cold of the mountaintop, sleeping in caves close to lava for warmth (46). He eventually begins to cook his meals on the mountain; but the important discovery comes when Fyr discovers that by igniting a tree branch, he could control and transport the fire down the mountain (52).

of glacial development—waning and waxing with the seasons, but growing larger every year—and the poetics of glacial action: on the peak of a mountain, “The snow pressed upon itself and was kneaded into a mighty flowing mash of ice which slid down from the mountain tops and began to fill the valleys. The short summers could do little to wear away the glacier but melted it into a mass and thawed the snow on its surface, where it froze again to ice.”[39] The ice age and its glaciers do not suddenly arrive: Jensen wishes to attend to the temporality of something inhuman. But it is not so slow, as it was in “gradual” geological history, that an individual human life might not witness the transformations. As Carl adjusts himself to the climate, learning to dry meat and store it in a “deep and solid house of stones,” learning too to sew together animal skins, he is also witness to the persistent growth of the ice:

> Meanwhile the winters grew steadily longer. The ice-sheet lay far down over the country. It could not be seen to move, but month by month and year by year it had come farther. Its extreme edge now lay right down in the lowlands, where the broken green ice came in contact with the remains of the dead forest. Where once bamboo and mimosa had grown, there now arose a shield of ice, high as a mountain; where the pitcher-plant had flourished in the warm swamps, dirty gateways now yawned in the wall of ice, from which cold rivers gushed with white, opaque waters. The icefield ran continually, froze again by its own cold and grew, moving forward and seizing one tract after another.[40]

[39] Jensen 115
[40] Jensen 117

Jensen presents these transformations in catastrophic light. Carl confronts the kinds of environmental destruction that climate change may bring about: scanning the plains, he sees nothing alive; the ground is broken, furrowed, and now frozen over with rain, there are dead and fallen trees, animals of all forms fleeing south, and perhaps most disturbing to him: silence itself. Jensen thus imagines the violence of glaciers, the results of which are readily visible in the Northern Hemisphere thousands of years later: fiords and carved valleys, immense rock formations like arêtes, horns, and cirques; scratched and striated bedrock from dragged boulders and gravel, accumulations of soil and rock known as moraines, left by retreating glaciers, and gigantic erratics.

Jensen's descriptions here have a deep similarity to Agassiz's descriptions of the oncoming ice age from the previous chapter, even though it is quite clear that Jensen's conception of the events of the ice age was substantially more advanced.[41] Yet the similarities between their thinking run deeper still, for Jensen's story of the ice age makes an explicit connection between race and climate change that was only hinted at in

[41] Our first impression of the Earth during the ice age, of course, is of a permanently icy planet in which the seasons have vanished, like Gethen from Le Guin's The Left Hand of Darkness. But the situation of the last ice age was more complicated than a universal winter, as both novels observe to varying degrees. Both ice ages and seasons are cyclical products of Earth's orbit around the sun: seasons occur because the Earth is tilted towards the sun, whereas ice ages have occurred because of transformations in the Earth's eccentricity, obliquity, and precession over cycles that last tens of thousands of years (Woodward 92-95). During the last ice age, the Earth's particular tilt remained, and the planet still experienced seasons; what changed, as a consequence of orbital variations, was the strength of the sunlight reaching the Earth. This allowed ice sheets to remain for longer and longer periods of time, until they covered substantial portions of the Northern Hemisphere. The rest of the planet, excluding Antarctica and other mountainous regions, was ice-free, and experienced colder climates instead of permanent ice coverage. To varying degrees, both Jensen's novel and Robinson's novel provide an imagined snapshot of this world.

my discussion of Agassiz. At first glance, the icy "fall" is here not coded with a moralizing story: the purpose is not to punish the humans who were banished from God's grace, but rather to demonstrate how humans are parts of a vast ecological system that may change without their consent. They must, like all species, adapt. But in Jensen's mind the ice age has a much greater importance in human history. Indeed, the "adversity" of the ice age stands as a necessary evolutionary condition of human progress toward European modernity. Carl, Jensen's third great man, faces a decision when confronted with oncoming glaciers: he may migrate south with all of the other humans, remaining in the "eternal summer," or he may remain in place. Carl fatefully chooses to stay: "Carl could not yield. His heart fed upon defiance, he are in adversity. And when the primate people were brought to the crossways between the cold and the forest, he was the one who chose the impossible. He became the first man."[42] Carl adapts to the cold: he learns to wear animal skin clothing, to hunt for new kinds of animals, to use flint to start fire, and to even invent monogamy. For Jensen, necessity teaches everything: it is the ice age catastrophe that places adaptive pressure on Carl and forces him to learn new skills.

The racializing implications of such a theory of "climatic determinism" become immediately apparent in the descriptions of Carl's "sons" and descendants.[43] At first, the

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[42] Jensen 90

[43] In general, this concept refers to the particular notion that national achievements are based in geographical possibilities.

"Ice Folk" breed with the nearby remaining "Forest Folk;" slowly but surely, however, "distance and time" divide the "two races":

> Thus the gulf between the two races parted by the Ice became a profound eternal chasm. They were no longer each other's like. The division between them was fateful in its effect. The primitive people who continually gave ground remained the same, whereas Carl, who could not yield, had become another and had passed on his changed nature as a heritage to his descendants. The Jungle Folk continued to give way before the winters, went farther and farther south that they might still live the same life, and this retreat, coupled with their continual increase, was destined to lead them into distant climates and to spread them over all continents. But Carl's race remained settled in the North and adjusted itself to ever more difficult conditions, which necessitated progress at home. They no longer resembled the naked and forgetful savages from whom they were originally descended, they were other men.[44]

The ice age, in Jensen's reading, is precisely what separates Nordic Europeans and their ancestors from the rest of the world; those who migrated to the global south failed a kind of evolutionary test created by the ice age. What we must conclude, then, is that the myth Jensen wishes to create is not grounded in an effort to explain Darwin; it is designed, rather, to explain and justify European hegemony and the condition of possibility for colonial encounters from a pseudo-evolutionary perspective. The proto-European Carl confronted rather than avoided "adversity," and this allowed him and his descendants to develop technology. European colonial destiny is explicitly implied, toward the end of this section of *The Long Journey*, as White Bear develops larger and

[44] Jensen 147

more powerful boats (and indeed enslaves a native population in order to row one of them): the ships, built through "adversity," would expand away from "ice-sheet covered Europe" over "every sea into what became in time the white man's social order."[45] The final volume of *The Long Journey* ends with a relatively triumphant account of Christopher Columbus, who fulfills a deep historical desire to return to and claim warmer climates. Jensen's novel, in that sense, attempts to locate the birth of European hegemony not merely in the contemporary environment, but in deep history.[46]

Where for Agassiz "catastrophism" functioned as a particular way to emplot the geological past, for Jensen it becomes a way to mythologize and naturalize European racial hegemony in precisely the way that Sylvia Wynter critiques as an "overrepresentation" of man bundled with the "subjugation of Human Others."[47] Jensen's vision also stands in conflict with the originally Darwinian purpose of his writing. Throughout the novel, Jensen seeks to reject the notion of nature as a static object and the idea of human beings as separated from their environment. But Jensen's myth contradicts this interpretation: various forms of human nature emerge grounded in gender and race, and towards the end of this story of the ice age, the environment itself fades into the background, as if, having achieved a certain technical prowess,

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[45] Jensen 202

[46] It is tempting to read this in terms of Horkheimer and Adorno's dialectic of enlightenment: the "myth" to be displaced here is the myth of the original Garden of Eden in a literal sense. But this particular form of Darwinian "enlightenment" itself clearly becomes a myth in Jensen's hands.

[47] See in particular Wynter's essay on "Unsettling the Coloniality of Being/Power/Truth/Freedom," 288

humans were no longer subject to climate. These run up against the very ideological core of the novel in Darwinism: the ice age, paradoxically, serves to both remind us of nature's ceaseless transformations, and to reinforce particular static human natures based in gender and racial dynamics.

2.2 Robinson, Human History, and Ice Age Gradualism

Today, despite his Nobel Prize, Jensen garners little public or academic attention.[48] Some of this, no doubt, has to do with his representation of the deep history of race and gender. But I would also like to attribute it to an aesthetic shift in prehistoric fiction that has made *The Long Journey* almost unintelligible even to those interested in the genre of prehistoric fiction. Beginning with Jean M. Auel's *The Clan of the Cave Bear*, the genre has shifted toward a more anthropological vision of prehistory, against the mythic or the romantic.[49] Auel's reconstruction of Neanderthal life—as seen from the perspective of her Cro-Magnon heroine, Ayla—aims to accurately represent the limitations of their social life, but also the many features and capabilities that make them identifiably human. Elizabeth Marshall Thomas's *Reindeer Moon* (1987)—in my opinion a substantially more successful novel than Auel's—follows a similar anthropological aesthetic. But where Auel's novel is narrated from a distant third person perspective

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[48] In his lengthy survey of prehistoric fiction, Ruddick only mentions Jensen in passing.
[49] I speculate that this may also involve a similar "anthropological" shift in science fiction described by Darko Suvin in his essay "On the Poetics of the Science Fiction Genre."

(one that often slips into scientific vocabulary), Thomas's novel embraces the perspective of the ice age humans it represents. It is told by Yanan, who has already died in childbirth but who now remains with her tribe, a spirit caught by the shamans. There are deeply mystical elements here—many scenes involve Yanan morphing into various animals and travelling the steppe—but the anthropological impulse remains central.

Kim Stanley Robinson's first and only prehistoric novel *Shaman* is most readily categorized along these lines. Robinson sets the novel, unlike Jensen, in a specific time and place in Europe's past. The novel depicts Upper Paleolithic humans living in what is today the Ardèche region in southern France.[50] Set roughly 32,000 years ago, it unfolds during the period that we generally call the last ice age, or simply "the ice age," which began roughly 116,000 years ago during the Pleistocene epoch and reached its maximum extent 21,000 years ago.[51] This last glacial period ended only 11,700 years ago, marking the start of the Holocene.[52] Despite the presence of what Fredric Jameson calls "generic discontinuities," Robinson's novel is readily approached as a work of prehistoric

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[50] The Paleolithic—succeeded by the Neolithic and then by metals—began with the earliest stone tools roughly 2.6 million years ago. It is broken up into the Lower, Middle, and Upper Paleolithic, which correspond roughly with ancient, medieval, and modern, as Andrew Shryock and Daniel Lord Smail suggest (xiii-xvii).

[51] Marshall 208

[52] Woodward 20. The term "ice age," as Doug Macdougall has noted, is somewhat ambiguous (9). Jürgen Ehlers, Philip Hughes, and Philip Gibbard define "ice age" as "a period of the Earth's history in which at least one of the poles was glaciated" (43). By that definition, there have been many ice ages throughout Earth's history; the Quaternary ice age (sometimes called the Quaternary glaciation or the Pleistocene Ice Age), which began 2.5 million years ago, is only the most recent. In this conception, the "last ice age" of *Shaman* is technically a "glacial period" in a longer ice age.

fiction.[53] The novel opens as a *Bildungsroman* following Loon, a member of the Wolf pack, as he enters into adulthood and prepares to become the pack's next shaman, a figure whose purpose includes leading spiritual ceremonies, creating art, telling stories and myths, and healing the sick. Through the novel's eight sections, Loon completes his wander, a rite of passage ritual in which he must survive alone in the wilderness; he then participates in daily life with the pack and trains with Thorn, the elder shaman, to paint caves. After making a yearly trip with the pack to the "eight eight" festival, Loon meets Elga, a woman from a different pack, whom he marries and has a child with. At this point, the narrative transforms into an adventure story, because at the festival the following year, after a devastatingly long winter, a different tribe, the "northers," captures Elga. Loon devises a rescue mission to liberate her but is caught and forced to live as a captive. Thorn and a Neanderthal they call Click (whom Heather, the pack's herb woman, has healed), however, come to rescue them. The story closes in the aftermath of this rescue: Click dies, Thorn becomes exhausted and eventually dies as

[53] Jameson 267. *Shaman* stands as Robinson's first prehistoric novel but does not break significantly with his earlier work. Prehistoric fiction fits comfortably within the bounds of science fiction because both are speculative and reliant upon scientific discovery, to varying degrees, for their plots.[53] Moreover, Robinson has long been fascinated by human encounters with hostile environments, or what we might call, following Ursula K. Heise, "reduced ecologies," whether that be in *Red Mars* (1993) or *Antarctica* (1998). *Shaman* also continues Robinson's interest—most evident in the Science in the Capital trilogy (*Forty Signs of Rain* [2004], *Fifty Degrees Below* [2005], and *Sixty Days and Counting* [2007]), recently republished in the single volume *Green Earth* (2015)—in the prehistory of human biology: Frank Vanderwal becomes enthralled with a return to Paleolithic life, even purchasing a hand axe (376-378). Meanwhile, Robinson is, of course, well-known for his climate fictions, including *Green Earth*, as well as *New York 2140* (2017). Both novels give speculative attention to the futures of global warming, drawing out the consequences of CO_2 emissions and other forms of ecological overshoot. While *Shaman* happens in a different moment of climate history, it may be grouped with these other works on contemporary climate change.

well, the Wolf pack's social cohesion splinters, and Loon takes the position of shaman, painting cave walls and peaceably dividing the pack.

There is much to say about Robinson's striking contribution to the genre of prehistoric fiction. We discover humans with psychological depth, as when Loon feels a sense of social confinement in the small pack after his wander, and a culture that is rich with technological products and oral narratives.[54] We find Neanderthals who are different rather than lesser, and women whose social status and importance to the pack are equal to men (Loon remarks that "women run every pack").[55] All of these observations may be commented on at length, but here I focus on two elements that Robinson himself underscores: science and art.[56] For him, the birth of science occurs with the trial and error mentality of herb women. Heather, an important member of the Wolf pack and mentor to Loon, builds her knowledge about different kinds of herbs through a process of testing them on a cat, leaving meat with a sample of a new herb, and

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[54] Robinson 70-73

[55] Robinson 451

[56] See Robinson's "Authors at Google." We may roughly associate these two topics with the two contemporary inspirations for the novel: the discovery of the "ice man" in the thawing glaciers of the Alps in 1991, and Werner Herzog's 2010 documentary, *Cave of Forgotten Dreams*, which examines the paintings of the Chauvet Cave. What struck Robinson in particular about the ice man was the fact that he carried tools that were essentially identical to what you might carry today with you to hike in the alps. It is precisely this kind of identity across deep history that we may associate with all of the various forms of technology Robinson's humans possess in the novel. Perhaps the most interesting piece of technology is also the one that seems to be least certain that they possessed: snowshoes, which become an object of trade and circulation by the end of the novel, not just a practical device but rather a symbolic item in atonement and gift exchange.

waiting for the cat to either digest or regurgitate it.[57] She also insists on the importance of memory, and the need to mentally archive the scents of particular plants.[58] The method of experimentation and memorization carries over into technological advancement, too, as when Loon tests different fire-starting kits for Heather to determine which works best (203-204), or when he attempts to construct a superior pair of snowshoes, jumping on different iterations to test their pliability.[59]

Where Heather may be said to stand for science, Thorn, her personal antagonist, serves as a figure of the artistic impulse, here primarily associated with rock art.[60] According to Robinson, the novel portrays the creation of the paintings that were rediscovered in the Chauvet Cave in 1994.[61] The cave preserves magnificent works of art: animals like rhinoceroses, lions, mammoths, horses, bison, bears, and reindeer rendered in charcoal and ochre line the walls of the cave, some static, others appearing to swirl across the wall, drawn with perspective and motion. There are, as Jean Clottes outlines, many approaches to this stunningly-resonant art. Some view it as art for its own sake, a product of a society centered around leisure and hunting; others attribute it to a kind of totemism, in which particular animals are attached to a tribe and possess powers that

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[57] 126-127
[58] 202-203
[59] 203-204 and 376-379
[60] As Jill Cook reminds us, there were many other art forms in this period of time, like sculptures and ornaments (12).
[61] See Robinson's "Authors at Google." For an introduction to the Chauvet Cave and its rediscovery, see Chauvet, Deschamps, and Hillare's *Dawn of Art: The Chauvet Cave*.

must be respected and honored; still others contend that it involves a form of "sympathetic magic," for which the drawings are meant to exert power over hunted prey.[62] Clottes himself, meanwhile, hypothesizes that the paintings are a manifestation of shamanism, a belief system in which "the spirit can leave the body to travel between worlds and to gain direct access to the supernatural forces that govern life processes in our own world."[63] Through visions and cave paintings, shamans act as a point of contact between the spirit world and the world of the everyday.

Robinson's novel, as the title indicates, pursues a version of the shamanic interpretation. The Wolf pack views the cave as a way of entering the "womb" of Mother Earth; for them, the painted animals are meant to be cast in shadows and danced with as a way of connecting with "cave spirits." Thorn and Loon, more specifically, view their paintings as a way of communicating to Mother Earth which of the "scared animals" are loved most.[64] They paint with clarity: they know precisely what their paintings mean, even though they have been lost to history for us. Thorn produces his paintings methodically, with an impulse toward realism rather than internal expression. When Loon, toward the end of the novel, begins to paint, he consciously adopts a similar method. The paintings he produces derive from his memory, and not from hallucinations or dreams. Loon draws two rhinos fighting, a scene from earlier in the

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[62] 7-15
[63] 16
[64] 183-186

novel; he then composes a series of horses, which also reference an earlier scene. These paintings, it is worth noting—the lions and bison drawn by Thorn, the rhinos, horses, and bison drawn by Loon—appear to reference the actual art in the Chauvet Cave.[65] The novel simultaneously offers a secret history that allows us to peer into the creation of these paintings and a shamanistic explanation for the presence of the paintings themselves.

By emphasizing the presence of both science and art in deep history, Robinson seems committed to working against our modern sense that prehistory is discontinuous with the present and that early humans are consequently irrelevant to us today.[66] *Shaman* recognizes the fundamental continuity between prehistoric and contemporary humans, constructing an image of ourselves that works against our desire to separate human histories. There are, to be sure, moments of substantial otherness—the lack of

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[65] Thorn's painting (188-192) appears to be "The Lion Panel" (Chauvet 106-109), and Loon's painting (432-439) is the famous "Panel of the Horses" (Chauvet 60-66). Loon's red dot bison (447) is also in the cave (Chauvet 25); the bison man mounting a woman drawn by Pika, an older shaman (188), is described as a "composite being, half human for the bottom part of the body, and half bison for the upper part" (Chauvet 122-123).

[66] Such a belief is certainly tied to the common absence of deep history in textbooks, as Smail observes (1-2). Constructing a novel about the last ice age, Robinson commits to solving a compounded version of a problem that all writers of history face: the struggle to locate the contours of identity and difference between now and then, between the writing of the document and the moment of historical inquiry. As the moment of inquiry moves further back in time, the more challenging the problem becomes. Writing about the medieval period, I am compelled to recognize certain forms of identity between subjectivities then and now; but at the same time, I am obligated to understand that those subjects understood the world radically different from me. For writers of planetary history and deep history, this conundrum is more acute, because modern readers often assume that prehistory is largely discontinuous with the present. History textbooks commonly assure us that humans before writing were so radically apart from us that to even think of them participating in "history" would be all but impossible. Assuming to find only difference, the reader must be confronted with a cascade of similarities that will eventually lead to a sense of recognition.

writing is the most striking, but so is the absence of agriculture and anything that resembles a modern economy or political structure—but they are throughout the narrative subordinated to the similarities: science and art, of course, but also the biological drives of eating and copulation, the bodily changes that come with aging, and so on.[67] There is, to put it in philosophical terms, a movement between human identity and difference running throughout *Shaman* that often, although not always, resolves in identity.[68] Robinson depicts humans that are more identifiable than alien, and thereby enables us to grasp human history in its great temporal depth: what is normally before human history becomes a vital part of that history. Like the Bering Strait land bridge, exposed during the ice age as the sea level fell, the continuity between Paleolithic humans and us is always there; it merely needs to be revealed.

But *Shaman* is not merely an effort to picture early humans; it is also, less obviously, a "gradualist" fiction about climate. For the climate of the ice age—its cold, its weather, its particular form of seasonality, its glaciers, and its animals—occupies Robinson's attention in ways that distinguish *Shaman* immediately from other prehistoric novels that take place during the Pleistocene.[69] The ice age is the condition of

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[67] Deep historians themselves use similar categories to create forms of continuity between contemporary and past humans—including the body, energy and ecosystems, language, food, kinship, migration, and goods. These categories are the chapter titles of Shryock and Smail's edited collection, *Deep History*.

[68] See Jameson's *Archaeologies of the Future* for a deployment of this dialectic in the study of science fiction (170-171).

[69] Many prehistoric novels, in their concentrated pursuit of human nature, relegate the environment to the background. While Auel's novel, for example, is set during the last ice age, the Pleistocene environment

possibility for much of the novel—the necessity to invent better fire-starting kits and snowshoes comes from the consistent presence of cold and snow, the cave paintings derive from the animals of the ice age such as the woolly rhinoceros—but is also an object of description. As in *The Long Journey*, climate is not merely the stage upon which the action of the novel takes place, something noted only in passing, but is central to the novel. Robinson describes humans and their culture but also the entire world of that culture.

Certainly the most distinctive features of the last ice age are ice sheets, the sublime products of thousands of years of winter accumulation. When Loon travels north, he encounters an entire environment formed through the agency and activity of ice, like the "drunken forests" of pine spruces, larch, birch, and alder trees tilted in various directions by the underlying ice, which constantly melts and refreezes.[70] As Loon continues on, he beholds the glacier on the horizon, a "mass of ice overtopping all the hills in a stupendous white wall":

> Ice fingers fell down from this wall, filling the valleys between the hills under it, then splaying out onto the steppe in steep-walled ends, rounded like horse hooves. Some of these ice splays had overrun forests, so that crushed trees lay in a tangle under the bottom of the ice hooves. The big ice mass above looked like the ice caps in the mountains west of the

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generally does not play an active role in the narrative. Amitav Ghosh, in the first part of his *The Great Derangement*, discusses literary fiction's inability to engage with climate change along similar lines.

[70] 250-251

> Urdecha, but immensely bigger. Everywhere they could see to the north, ice ruled.[71]

Here we catch the smallest glimpse of the nearly-imperceptible glacial movement that will leave behind scratched bedrock from dragged boulders and gravel, moraine accumulations of soil and rock, and gigantic erratics. Glaciers, moved by the weight of accumulated snow and ice, here enact a form of really "slow violence" on the landscape, to borrow Rob Nixon's phrase: the ice has "overrun" the forest, crushed it under its "hooves," as if it were some gigantic horse. Glaciers have a nonhuman agency, usually only attributed to living matter. Indeed, Loon views the ice as a living force. When the northers force him to scale the glacier, the "frozen curve at the edge of the great salt sea," he refers to the ice sheet as something living, "a white cold thing of the north, devouring the world."[72] The encounter shatters Loon's picture of his planet. Ancient stories explained the existence of three worlds—"one inside the earth, one in the sky, one on the surface between them"—but here Loon distinguishes a "fourth world," neither geosphere, atmosphere, nor biosphere, but cryosphere.[73]

Yet much of the novel does not consist of passages like this, in which the sublime, slow event of glaciation appears. Indeed, where Loon's glacial ascent might evoke a profound sense of the last ice age as a moment of difference, with environments

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[71] 251
[72] Robinson 272
[73] 275

unique to a particular place and time, most of his experiences are of a world that resembles contemporary Earth rather than a permanently icy planet in which the seasons have vanished, like Gethen from Ursula K. Le Guin's *The Left Hand of Darkness*.[74] In *Shaman*, the ice-age climate often appears as unremarkable and cyclical. Seasonal cycles punctuate the novel, particularly in the repetition of the river's thawing: once toward the beginning of the novel, mentioned at the start of this essay, again when Loon, Elga, Thorn, and Click escape from the northers, and finally, at the end of the novel, when Loon converses with Thorn's spirit.[75] These seasons certainly vary, but the vagaries of the environment have become well known: indeed, one of Thorn's stories warns of the dangers of the Pleistocene climate.[76] When Loon, Elga, Thorn, and Click flee the northers in the midst of a blizzard, they simply think that "Summer storms could be like that," and attempt to carry on.[77] In this sense, what *Shaman* represents is the relative banality of the Pleistocene environment: "The short days, the cold; the storms rolling in from the west, low and snowy. Ice on the river and the creeks, snow over that. The white world. The midday sun just peeking over the southern gorge wall. All the birds gone except for the snow birds; all the animals sleeping or hiding under the snow, or caught

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[74] See Jameson's "World Reduction in Le Guin" in *Archaeologies of the Future* for a commentary on that novel, and Ursula K. Heise's article "Reduced Ecologies" for an important response to Jameson. I should also note that there are scientific theories of a "Snowball Earth" in the deep past (Macdougall 150-160).
[75] See 336-339; 455-456
[76] 84-85
[77] 334

in the people's traps, quietly enduring."[78] The "white world" is rendered normal, expected, reliable, a circumstance humans can become accustomed to through a profound awareness of their environment—migration patterns of caribou and geese, what berries and nuts are edible, how to preserve meat, and so on. Climate becomes habit, just as daily tasks and chores do. The ice age lends itself to the cyclical rhythms of human communities and daily life.

Where we might have expected Robinson to construct an epic, like *The Mars Trilogy*, in which the waxing and waning of the ice age became the direct subject of narrative representation over the course of thousands of years, humans evolving through various forms of social organization, struggling to survive as ecosystems and food sources eventually disappear, *Shaman* envisions an enduring, stable environment . While there are seasons in *Shaman* and therefore changing environmental circumstances, they are cyclical and vary only to a small degree; and although there are moments of great hunger for the pack, they are ultimately sustained by a relatively stable ice age environment. Avoiding altered climates or socio-ecological collapses, *Shaman* represents climate change gradually. It features humans within the context of a major planetary climate shift that they are unaware of. Loon and the Wolf Pack are not witness to climatic alterations: it is a geological event that moves as slowly as glaciers. They have a profound awareness of their environment—migration patterns of caribou and geese,

[78] 218

what berries and nuts are edible—and how to go about surviving the challenges daily life presents, but they know nothing of the kinds of climate change that would occur in their home. Only we as readers, revving up our imaginations of the contemporary environment of southern France and its Pleistocene counterpart, are aware of the major alterations in climate that the novel contains; only we are conscious of this moment as one in geological progression.

Robinson's "gradualist" novel therefore stands in stark contrast to Jensen's *The Long Journey*, in which the past ice age is represented as catastrophic and temporally-compressed (although not necessarily apocalyptic); glaciation happens quickly, within the bounds of narrative time, and devastates the social situation that preceded it. *Shaman* refuses this particular figuration of the ice age: geological history happens so slow it is nearly imperceptible, and climate does not abolish daily life, but rather shapes it. To imagine the ice age is not to envision unending disruption to human life, but to evoke the necessity and possibility of human adjustment to the glaciated environment. *Shaman* depicts this major climatic shift in geological and human history in a way that neither relegates the ice age to the background, as in much prehistoric fiction, nor compresses climate change into a catastrophe.

2.3 Climate Fiction and the Geohistorical Imagination

Needless to say, neither *The Long Journey* nor *Shaman* resemble our typical concept of climate fiction, which narrates the consequences of climate change, anthropogenic or otherwise, on modern human civilization.[79] But they both share with all climate fiction a particular commitment to what I called in the previous chapter the geohistorical imagination. The geohistorical imagination references the way in which nineteenth-century geologists extrapolated the Earth's past from its contemporary environments. They envisioned the planet undergoing enormous changes over time, picturing the landscape before them morph from one environment to another. Where an environmental imagination draws its energy from the nonhuman world, recording the ecosystem, the geohistorical imagination draws on the changeability of those environments. The geohistorical imagination is a recognition of the historicity of nature, and not merely an acknowledgement of the existence and importance of the nonhuman world, as in the environmental imagination. It takes this kind of attention, in which one realizes that all forms of life depend on one another, and historicizes it.

Here, I suggest that although the geohistorical imagination most often emerges in scientific articles and textbooks, popular books on climate science and geology, and overviews of the planet's geological history, it also forms the basis of climate fiction.

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[79] See See Rebecca Tuhus-Dubrow's article for an overview of the genre.

Climate fiction is the literature of the geohistorical imagination.[80] Climate fiction too relies on the sense of environmental history that characterizes this imagination, even when it speculates on the future of the planet, rather than its past: when we read of disasters that are either local or global, catastrophic or gradual, and caused by people or by nonhuman forces, the environment becomes part of a particular moment in a longer sequence of planetary metamorphoses. What distinguishes it from the other forms of imagining geohistory is its absorption with the way that humans are enfolded into dramatic changes in geological history. Climate fiction draws on the implications of geological history to work out how humans respond. In my formulation, then, climate fiction is not only about "ecological futurity" as Rebecca Evans theorizes in an illuminating essay, but also about ecological historicity.[81]

Such a rethinking of the basic definition of climate fiction can still accommodate the central problematic of the genre introduced by Amitav Ghosh in the first section of his now widely read book *The Great Derangement*. Ghosh emphasizes the ways in which the novelistic representation of climate change is impossible; for him climate change is as much a crisis of politics and history as it is of the literary "imagination" itself.[82] Ghosh argues that particular features of climate change confound both "literary" novels and science fiction novels. On the one hand, literary novels typically recount the everyday;

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[80] I borrow this phrasing from Darko Suvin, who famously calls science fiction "the literature of cognitive estrangement" (372).
[81] Evans 95
[82] Ghosh 9

they examine the realistic and the likely; they delve into the joys, successes, regrets, and hardships faced by a family or individual over a relatively constrained space and period of time. Yet climate change as a phenomenon occurs beyond the everyday. It is "improbable" and nonhuman, both local and planetary all at once. All of these features seem to exceed the classic literary novel. But, on the other hand, science fiction confronts a representational problem as well: where Ghosh sees improbable climatic events, nonhuman entities, and geological time scales exceeding literary fiction, he sees the "here and nowness" of global warming as confounding science fictional imaginations, which he suggests are more often occupied with "disaster stories set in the future" and not the present.[83]

The point of Ghosh's text was originally to lament the absence of literary efforts to tackle these representational problems in 2016; as many critics of Ghosh have already observed, there were then and continue to be today many novels engaged in these efforts.[84] Yet I want to retain, in thinking about the geohistorical imagination's presence in climate fiction, Ghosh's essential claim about the impossibility of a narrative engagement with climate change. Ghosh's theory is not to be seen as one of complete impossibility; it is a theory that highlights challenges and problems that can be resolved in different ways. Climate change pushes against representation—improbable climatic

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[83] Ghosh 72

[84] I think of Stef Craps and Rick Crownshaw's special issue of *Studies in the Novel* on "The Rising Tide of Climate Fiction" to be one of the earliest major responses among literary critics.

events, nonhuman entities, and geological time scales paradoxically both far away and disturbingly present, all challenge our representational capacities—but it does not elude it. With our new working definition of climate fiction as the literature of the geohistorical imagination, we may now identify that it is precisely the problem of agency in deep history—both human and nonhuman—that stands as a representational problem for geologists and writers of cli-fi alike. The representational problems raised by Ghosh are therefore not inherent merely to contemporary global warming, but also to climate change more broadly. In that sense, the representation of climate change and its accompanying challenges are not new to this particular period; climate fiction has a long lineage that is deeply indebted to the ice age imaginary.

With this expanded concept of climate fiction, it becomes easier to see what a traditional example of the genre—such as Robinson's *Green Earth*—shares in common with a host of other novels, short stories, and films that involve climate change in general, not merely anthropogenic global warming, as in J.G. Ballard's *The Drowned World* (1962). For my purposes here, we can also now recognize the presence of a largely unexplored subcategory of climate fiction that surrounds ice ages in particular.[85] We can investigate the vast array of what Brian Fagan has referred to as "ice age fiction," not only those that qualify as prehistoric fiction but also those that speculate into the future like John Gribbin and Douglas Orgill's novel *The Sixth Winter* (1979) or the post-

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[85] Andrew Milner and JR Burgmann briefly mention a series of novels that speculate on future ice ages (16).

apocalyptic graphic novel *Snowpiercer* (1982).[86] They all derive their settings from the raw material of geological history; they are all statements about how humans live that history and make it meaningful. In that *The Long Journey* and *Shaman* meticulously reconstruct a moment in the planet's geological history, rendering it at the level of generational and individual human experiences respectively, they draw on the geohistorical imagination just as other forms of climate fiction.

In order to demonstrate the effectiveness of this different identification of climate fiction, I want to briefly touch on one of the more popular climate fictions of the millennium, Roland Emmerich's film *The Day After Tomorrow* (2004). This film is credited with being the first major Hollywood product to have openly discussed anthropogenic global warming, and yet Emmerich seems to have drawn his inspiration from the extensive body of science and pseudo-science on global cooling. Indeed, Emmerich has openly acknowledged Art Bell and White Striber's *The Coming Global Superstorm* (1999), which mixes together pseudo-science and fictionalized narrative accounts of a devastating storm, as a source of inspiration. My interest in *The Day After Tomorrow* is not in reprimanding the film for scientific inaccuracy, or in discussing it merely in terms of its "imagination of disaster," as Susan Sontag might call it. Rather, I want to understand how it imagines geohistory through the ice age, and for what purpose; I

[86] See Fagan, "Jean Auel and the New Phenomenon of Ice Age Fiction."

want to consider, in other words, what it means that one of the first widely popularized narratives of climate change turns to the ice age.

The film begins in Antarctica, where Jack Hall (a paleo-climatologist) is drilling ice cores with a team. As they are drilling, a massive ice shelf the size of Rhode Island breaks off, right in the middle of their camp, nearly killing them. We cut to Hall, in India, explaining to an international group the findings of his study: abrupt climate change from warming has happened in the past, he explains, and may very well happen again. His warnings go unheeded, and severe storms promptly begin to emerge all over the world—a series of tornados, for example, obliterate Los Angeles; and New York, where Hall's son Sam happens to be, floods entirely. When scientists in Scotland notice a massive drop in Atlantic Ocean temperatures, Hall asserts that all of these weather events are connected to a "critical desalinization" of the North Atlantic Current. It quickly becomes clear that Hall is right, and conditions worsen for the Northern Hemisphere: three gigantic storm cells, pulling cold Arctic air into their hurricane-like vortexes, cover the global north in snow and ice, bringing about the next ice age. At the film's conclusion, a sizable portion of the US population has been exiled to Mexico, where it is still temperate, and, implausibly, Hall manages to rescue his son Sam in glaciated New York.

We may read this film along similar lines to how we have already approached the central objects of this chapter, *The Long Journey* and *Shaman*: as efforts to bring together human history and geological history. In this particular sense, there is a dialectic between catastrophism and gradualism in this film that aligns well with these novels. To be sure, the film is most directly catastrophic: in imagining the ice age as it does, this film compresses geohistory. The geological event of the ice age—something which hardly qualifies as an event in the human sense because it took place over hundreds of thousands of years—is reduced to a series of spectacular storms, temporally constrained for the purposes of a blockbuster thriller.[87] Our own surprise at the speed of these events is indeed shared by the characters—Jack Hall remarks, at the start, that climate change might happen within the next hundred or a thousand years; then he is shocked to discover that his climate model projects six to eight months, only to discover moments later that it is in fact six to eight weeks; finally, Hall comes to understand that entire climactic shift would occur within the confines of a single storm's life. The ice age becomes something human, in this sense; it may be experienced just as any other destructive weather event.

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[87] This is a profoundly inaccurate representation (see Stager's commentary). Jack Hall's ice core research, for example, posits that climatic cooling that began roughly 10,000 years ago, and lasted two centuries. We are meant to be concerned by this discovery; it is in the relatively recent past, and it lasted for many human generations. Such an event, of course, never happened: 10,000 years ago marks the end of the last ice age, which in fact lasted for thousands of years. Far more scientifically egregious errors emerge in the actual representation of the ice age. As we saw in the last chapter, ice ages tend to begin due to changes in the Earth's orbit, along with several other feedback mechanisms in the Earth's system; such a process takes thousands of years to unfold, as glaciers form over many seasonal cycles. Emmerich imagines this process happening over the course of a week; and the cause of such a process is a simple shift in the North Atlantic current. Such a change would no doubt have immense consequences for North America and Europe, but they would fall quite short of an ice age.

Yet the film also embodies a humanist spirit of resilience and survival: while it is true that countless people perish throughout the film, crushed by hail or debris, drowned in floods, frozen to death while outdoors, and so on, many of the film's characters manage to survive the storm, and indeed the entire global south evidently emerges unscathed from this crisis. The film seems to be well aware of this gradualist undercurrent: toward the end of the film, Hall, when asked about what will happen to "us," responds by explaining that "mankind survived the last ice age. We're certainly capable of surviving this one." It would thus be misleading to refer to this film as apocalyptic, or to equate the ice age with apocalypse. Rather, it views the ice age—and climate change more broadly—as a form of disruption: this is to say that various activities in our daily lives that we expect to do uninterrupted are suddenly impossible. Emmerich's strange habit in this film of shooting people being woken up from sleep at strange hours—the head of a weather station in LA, Jack Hall woken by Terry Rapson, Sam Hall and his friends themselves abruptly woken at the end of the film by Jack himself—would all seem to speak to the way in which human cycles and rhythms are disrupted by climate change.

In moving between catastrophism and gradualism, Emmerich's film also certainly carries with it a political message, just as Jensen's novel. Emmerich's film stands as an allegory of climate justice. Emmerich portrays modernity as a result of pollution and carbon emissions in the global north. The ice age, in this reading, amounts to a particular way to punish these historical polluters, forcing their populations to return to the less responsible nations of the “third world.” Such an understanding of the ice as a kind of Gaian “revenge,” to borrow Lovelock’s term, is never made explicit, but it is implied throughout, especially toward the end of the film, when the extent of the global superstorm’s destruction has been made evident. As we see an overview of the U.S. refugees in Mexico, a voiceover of the U.S. president denounces the tendency toward endless pollution and extraction, and announces a new beginning in international relations and human history. That the ice age has rectified some kind of imbalance in human and ecological history seems to be enforced when, in the final shot of the film, we see the planet from space, the Northern Hemisphere one sheet of ice, and an astronaut remarks that the air “looks so much cleaner,” as if Gaia itself had conjured the ice storm. The earth enacts, in other words, an inhuman climate justice on the nations of the global north. To reincorporate our earlier readings of the film, we might suggest that climate change disrupts the global political order itself, bending it toward a kind of justice.

My point about this inaugural film of climate fiction, then, is that reading it through the lens of the geohistorical imagination, as a film struggling to imagine the conjuncture of human history and geohistory, unlocks some of the deeper themes sedimented beneath an otherwise typical Hollywood apocalypse film. The film fantasizes about geological history bringing about justice in human history.

2.4 Ice Age Fiction for the Anthropocene

We are now in a better position to grasp how both *The Long Journey* and *Shaman* may be engaged in two generic categories. As prehistoric fiction, *The Long Journey* mythologizes a gendered history of technological development while *Shaman* invites a sense of the importance of scientific practice and artistic creation as continuous activities in human history. As climate fiction—which I have proposed we rethink as the literary manifestation of the geohistorical imagination—Jensen's novel emplots a catastrophic ice age as a mythical retelling of the human fall from Eden that ultimately justifies European racial superiority, while Robinson's novel fosters a sense of Earth history that does not require disaster or abrupt climate change but sees rather the slow pace of glaciation and the ability of humans to build daily routines. These narratives demonstrate widely different capacities for imagining geohistory, different narrative solutions to representational problems: Jensen's novel imagines the ice age as a catastrophe with a strong sense of relatively fast glacial growth and climatic shift. Robinson, meanwhile, provides gradualist account of the ice age, in which we are able to glimpse only a sliver of that vast geological phenomenon. Both of these narratives imagine the conjuncture of human existence and geohistory.

In conclusion, I want to dwell on the conjuncture of human and geological history in these two novels, because ice age fiction speaks to our own geohistorical situation only when these two ways of reading, one which views the novel as mediation on early humans, one which sees the pace of the ice age, are viewed in tandem. Both novels encourage a sense of the deep continuity of human history. In doing so, they situate the ice age as a relevant moment in that history. The ice age becomes something more than an interesting relic of the Earth's past; it becomes significant to our history, just as global warming is important today. In this way, ice age fiction allows us to consider the similarities between the human experience of the ice age and our contemporary encounter with global warming. Expanding our sense of what counts as history, enabling us to think of our own time and its climate in the context of deep history, these novels speaks to a wider understanding of global warming and the Anthropocene.

Jensen's novel, imbued with a profound sense of catastrophism and change, would appear to be all too relevant in a moment, as I suggested in the previous chapter, that has come to embrace an apocalyptic form of thinking about the relationship between human life and climate change.[88] It gives us, perhaps more so than Robinson's novel, a profound sense of the agency of the nonhuman world in the figure of advancing glaciers, accompanied by a sense that these nonhuman forces can be staggeringly dangerous. In our contemporary world, of course, the nonhuman world abounds with human influences, and yet in our encounters with rising sea levels, superstorms,

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[88] David Wallace-Wells bestseller adopts this tone most clearly.

hurricanes, and devastating wildfires, the nonhuman world appears to persist in a particularly threatening way.

However positive a lesson this might be to draw from Jensen's novel, it is strongly mitigated by a more negative point to be gained centered around the dangers of climatic determinism and species thinking. In Jensen's novel, we find evidence for the ways in which the category of the "human" has been used to exclude people of the global south from "humanity" rather than include. Such discourses are precisely the reason that many scholars object to the concept of the Anthropocene, which also adopts a form of species-thinking with potentially dangerous implications: it universalizes responsibility for the planet's ecological condition when only a small segment bear responsibility.[89]

Shaman's most direct implication, meanwhile, lies in the capacity for human survival and adaptation. In it, daily life and climate change are narratively compatible. There is no catastrophic moment of destruction, simply life that emerges through survival, which depends on forms of flexibility and adaptability, a stubborn willingness to survive with little food during the winter, an expectation of moving with large mammal herds. This is especially clear when we consider the unmistakable fact that Robinson's humans have adapted to their ice-age environment, evidence for which appears throughout the novel: in the first section during Loon's wander, when the pack

[89] See Kathryn Yusoff's interesting essay "Geologic Realism" for a discussion of race in a similar sense.

expects a twelve-year-old boy to not merely live on his own for two weeks, but to "survive in style;" during the "hunger spring," when the pack's copious stores of food finally run low; when Loon is stunned by the northers' ability to catch and store food; when Click, the novel's only significant Neanderthal, dies during Loon and Elga's rescue, as if the "old one" failed to truly adapt.[90] Perhaps most subtly is the way the human body itself is evoked as an adaptive feature: out checking traps, Loon and his friend Moss discover a dead stag at the bottom of a pit. After working all day, they must hurry home in the cold; the warmth generated by the active body balances out against the cold, and Loon thinks "they were made to run in cold like this."[91] Here, humans encounter the environment as one which they have adapted to and may continue to endure and struggle against.

Although our own climatic situation is substantially different from that of the Pleistocene—our challenges will potentially differ from those of the last ice age, due to the rate at which the climate is changing—the same possibilities for survival hold true for us, precisely because we are already a species capable of remarkable adaptive changes. Discussing his *Green Earth*, Robinson explains that even in instances of abrupt climate change "events still resolved to individual humans living variants of ordinary life." The "story of climate change" needs to be narrated around daily life, rather than

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[90] Pages 35, 231-236, 255-256, and 345-347.
[91] 233

told as a thriller.[92] For Robinson, whether the climate changes relatively rapidly, as in *Green Earth*, or it changes imperceptibly slowly as in *Shaman*, events "resolve" themselves into daily life, and humans adapt. In a moment saturated with catastrophic writing on global warming, this point is crucial. To claim climate change as apocalyptic is to eliminate the political seriousness of the situation, for if we face apocalypse, there is nothing to do. But when daily life remains front and center, so do the abundance of political activities for mitigating and adapting to global warming. That we can change and respond to alterations in the climate, just as humans of the Pleistocene, may be the most important possibility we learn to conceive from Robinson's novel.

[92] Canavan and Robinson 244-245

3. Unfrozen: Narrative and Geohistory in the New Arctic

You can't read about climate change without reading about the Arctic. In December 2019, several major news outlets reported on the 2019 Arctic Report Card, a document issued yearly by the NOAA that assesses the status of region. *The Washington Post* recounted the NOAA's findings with the most dramatic flair: "The Arctic is undergoing a profound, rapid and unmitigated shift into a new climate state, one that is greener, features far less ice and emits greenhouse gas emissions from melting permafrost." The Arctic, we have known for a while, is warming twice as fast as the rest of the planet. It was no surprise, therefore, that Arctic temperatures were again near record highs for 2019; the average temperature in September was the second highest since records began in 1900. There were low levels of summer sea ice, breakdowns of "regional food webs," and sea level rise. But for major US news outlets, there is an even deeper threat lurking in these changes. "The consequences of these climate shifts," the *Washington Post* article continues, "will be felt far outside the Arctic in the form of altered weather patterns, increased greenhouse gas emissions and rising sea levels from the melting Greenland ice sheet and mountain glaciers."[1] Changes in the Arctic not only predict what is to come; they will also have an effect on what it is to come. The melting Greenland ice sheet will impact global sea level rise, the melting Arctic sea ice will alter

[1] https://www.washingtonpost.com/weather/2019/12/10/arctic-may-have-crossed-key-threshold-emitting-billions-tons-carbon-into-air-long-dreaded-climate-feedback/

global weather patterns and the thawing permafrost will release an enormous amount of CO2. "What happens in the Arctic doesn't stay in the Arctic," as *The New York Times* put it succinctly.[2]

Given the importance of the Arctic—here defined as the space of the Earth above the Arctic Circle, or the latitude 66 33'—for discussions around climate change, it is no surprise that an enormous amount of recent nature writing and nonfiction have emerged in response to these rapidly changing conditions. Some, like John Gertner's *The Ice at the End of the World*, tie together Arctic exploration with scientific research about ice cores and climate history; others like Mark Serreze's *Brave New Arctic* tell a story about research on climate in the Arctic from the perspective of a scientist at the forefront of Arctic research. Still others, like Shelley Wright's *Our Ice Is Vanishing*, focus specifically on the threats that climate change poses to indigenous communities around the circumpolar north. This chapter aims to understand the features of this new body of writing, and to suggest that it might be referred collectively as "New Arctic" writing.

The term "New Arctic" derives from social science and science publications. It refers to an Arctic in which sea ice is melting, glacial ice and ice sheets are retreating, and flora and fauna exist in new locations. In a much-cited early article on the subject, Ronald Doel, Urban Wråkberg, and Suzanne Zeller use the term to refer to "a recent era in circumpolar history set in motion by an unparalleled confluence of political and

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[2] https://www.nytimes.com/2019/12/10/climate/climate-change-arctic-warming.html

natural phenomena."[3] For them, the "New Arctic" not only includes changes brought about by climate change, but also new kinds of international interest and cooperation in the region. In the introduction to their book, *The New Arctic*, Birgitta Evengård, Øyvind Paasche, and Joan Nymand Larsen adopt a similar sense for the term that moves between natural and cultural events; they describe a dramatic cultural as well as natural and biological shift in the region. With the melting of the sea ice and glaciers, the Arctic has transformed from a space seen to be "pristine," "sparsely inhabited," and essentially "unchanging" to a space of immense ecological alternations with the potential for other "rapid non-linear" responses in the future.[4] It has gone from a place seen to be remote and isolated to one increasing globalized, with interests in mining, shipping, and oil extraction creating whole new kinds of international questions around policy; social changes for the indigenous inhabitants, already dramatic, will only increase in their rapidity.[5] Although an exact periodization of the New Arctic is contestable, dramatic transformations seem to be mostly clearly established by the early 2000s, which is roughly when the Arctic Report Card dates this new Arctic period.[6]

But the New Arctic may be understood in a more geohistorical framework as well. In *A Farewell to Ice*, Peter Wadhams, a professor emeritus of ocean physics at

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[3] Doel, Wråkberg, and Zeller 2
[4] 2
[5] 2-3
[6] Arctic warming has been observed since the 1970s, and so it would not be unreasonable to date the New Arctic to this period of time as well.

Cambridge University, suggests that the "new Arctic" is much more than an ecological and political transformation; it is a geohistorical change for the Earth that might be verifiable in the geological record. Wadhams views the melting Arctic within the planet's longer geological development, which is to say that he views it in the context of ice ages. By working through a "brief history of ice on planet Earth," Wadhams observes that, contrary to what we might assume about the normalcy of the Holocene climate, most of Earth's history consists of a substantially warmer climate. The "natural" state of the Earth is to be "unglaciated."[7] Permanent ice, as there is now on the Earth's poles, is a relatively rare thing in Earth history. According to Wadhams, 75% of the Earth's 4.5 billion year history took place in what is called a "hot-house" state in contrast to the much more infrequent instances of "icehouse Earth" when the planet is even cooler than it is now. Our own moment, seen from this perspective, falls somewhere in-between ice and hothouse. Wadhams periodizes "our modern climatic world" towards the end of the Pliocene, when the global climate cooled, an ice sheet formed on Greenland, and the Earth began to have alternating periods of warm and cold that we call glacial cycles, effected by the orbital transformations theorized (as we saw in chapter 1) by James Croll.[8] Periodic moments of glacial growth and glacial decline have defined our planet for the past 2.5 million years.

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[7] Wadhams 27
[8] Wadhams 27-32

In this context, the New Arctic signifies a dramatic shift in climate history. Wadhams explains that we might have disrupted these ice age cycles completely, not merely delaying the next glacial period but also completely breaking free of cyclical ice ages entirely.[9] "It could be," Wadhams warns, "that future ice ages are now abolished, or at least postponed."[10] He continues by suggesting that "it could be that the set of glaciations that the Earth has had in the last 2–3 millions years is all that it is now going to have, since our own impact on the climate will have taken the Earth out of a state where it can sustain periodic glaciation."[11] In other words, the New Arctic is a harbinger for a major shift in climate history: we are intervening in the long term ice age cycle that began 2.5 millions years ago; where the ice in the Arctic would have normally began a slow expanse over the course of time, we have now potentially made it stop. Our intervention in other words isn't merely into some contemporary environment that we have now changed, it is into something that far precedes us. We have changed something inhuman. Wadhams drives this point home most effectively by recalling the photo taken by the Apollo 8 astronauts, now called Earthrise. Wadhams reminds us that we have literally changed the color of the planet seen even from outer space: "Today, from space, the top of the world in the northern summer looks blue instead of white. We have created an ocean where there was once an ice sheet. It is Man's first major

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[9] Wadhams 30
[10] Wadhams 44
[11] Wadhams 45

achievement in reshaping the face of his planet, and it is of course an unintended achievement, with dubious and possibly catastrophic consequences to follow."[12] For Wadhams this aerial view confers the strongest sense of both scientific objectivity—still important in a world of climate denial—and planetary implications. The New Arctic, in this deep sense, represents the end of the ice age in Greenland and the far North. It describes a geological transformation in the region that acts as a container for other substantial changes. The New Arctic refers to a layered historical space, where the political and ecological strata of the transformations ultimately derive from deeper geological transformations.

The purpose of this chapter is to explore how nonfiction writing—especially environmental and nature writing—has come to terms with this new geohistorical, ecological, and political moment. I begin by characterizing old Arctic fiction, represented here by Barry Lopez's famous work *Arctic Dreams* (1986). Right at the historical cusp of when climate change in the Arctic became a serious concern, Lopez's book represents a time capsule, an ice core record of Arctic thinking right before substantial changes began to set in. I suggest that while *Arctic Dreams* unearths some of the deep themes of Arctic history and life, it is substantially more focused on ecological thinking rather than climatological and geological considerations. New Arctic writing, by contrast, begins to think more substantially about geological time. I demonstrate that both William

[12] Wadhams 2-3

Glassley's *A Wilder Time* (2018), a work of nature writing that considers Arctic transformations from the perspective of a geologist, and the Inuit activist Sheila Watt-Cloutier's memoir, *The Right to Be Cold* (2015), are dominated by a geohistorical rather than environmental imagination. The shift I intend to trace between Lopez's work and New Arctic writing is from a primarily environmental imagination to a geohistorical one. All three works contain elements of both, to be sure, but the primacy of geological historicity begins to take over Arctic writing after it becomes clear that, due to global warming, the Arctic age of ice is coming to an end. New Arctic writing, in other words, reveals how human life is grounded not merely in particular environmental circumstances, but also in geohistory.

As we have seen in previous chapters, to imagine geohistory is to "emplot" changes in the nonhuman world in a particular narrative form. In this chapter, I continue to trace the same narrative emplotment of earlier chapters in New Arctic writing. Glassley's *A Wilder Time* considers Arctic transformations from the perspective of geological time, and thereby writes a story about the Arctic that remains "gradualist" even as it recognizes and laments substantial changes coming to the Arctic "wilderness." By contrast, the Inuit activist Sheila Watt-Cloutier's *The Right to Be Cold* (2015) represents a much stronger sense of the "catastrophic" nature of climate change in the Arctic and ties together political concerns, especially for the indigenous populations, related to the changing ecosystems. These differences in narrative form correspond to radically different political implications, one urgent and human centered, the other unperturbed. In the concluding section of this chapter, I show how both texts, despite these differences, rework our sense of the Arctic and enhance our conception of the ice age. Both texts touch on themes that have been central to Arctic writing for the duration of European exploration—Arctic "remoteness," human habitability, and timelessness—and make it clear that these are insufficient categories for understanding the New Arctic. Importantly, Glassley and Watt-Cloutier also provide a sense of how the experience of the Arctic right up to the present moment has been one of the experience of the ice age. Life in the Arctic is itself life in the ice age, even if it will not be for much longer.

3.1 Dreams of the Old Arctic

Published in 1986, Barry Lopez's *Arctic Dreams* draws on five years of experience traveling in the North American Arctic, from the Bering strait to Greenland, along with an impressive array of research into the human and natural history of the Arctic.[13] It remains one of the most widely acclaimed works of Arctic nature writing; it won the National Book Award in the year of its publication and remains a reference point for much Arctic nature writing today. John Gertner's recent book *The Ice at the End of the World*, for example, functions as a response to that particular book: one of Lopez's strongest points in Arctic Dreams was to suggest that "temperate zone people" have largely ignored the Arctic, but that the Arctic would one day "prove to be inestimable;"

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[13] Lopez xxii

Gertner's book, an examination of climate science in Greenland, "asks whether that moment has now arrived."[14] Gertner's reference both attests to this book's remarkable longevity and suggests that the experiences and the world it records are becoming slowly but surely dated with the emergence of climate change in the Arctic. Indeed, a similar sentiment may be found in a short essay by Robert MacFarland on Lopez's book, in which he remarks that "*Arctic Dreams*, composed as a celebration of the polar landscape, might well turn into its elegy."[15]

It is precisely in light of these transformations that I want to claim Lopez's book as perhaps the last masterpiece of Arctic writing before global warming, or what I refer to as "old arctic writing" for the purposes of this chapter.[16] The point I want to argue, by way of example in Lopez's book, is that old Arctic writing tends toward an environmental imagination, where new arctic writing embraces a more geohistorical perspective. Such a shift is made possible by the fact that the Arctic was not yet known to be under the threat of climate change; changes in geological history in this sense do not need to take center stage in old Arctic writing. None of this is to say that the Earth's history has no place in Lopez's book; rather, I mean to show that while present, it is always secondary to observations and effects of present ecology. In order to better

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[14] Gertner xix
[15] https://www.theguardian.com/books/2005/apr/02/featuresreviews.guardianreview35
[16] Other works in this genre would naturally include Scorseby.

understand what I mean be these terms, my aim in this section is to consider the kind of "environmental imagination" at work in Lopez's nature writing.

For Lawrence Buell, whose ecocritical classic *The Environmental Imagination* has inspired much of my thinking here, a work of the environmental imagination will include the nonhuman world in the narrative as a presence, much more than a framing device; human desires will be shown to be situated among other nonhuman interests; the text is ethically oriented toward our "accountability" to the environment; and the environment is seen as a "process" and not merely something given.[17] But in a more general sense, the environmental imagination is primarily a way of bringing us closer to the ecosystems and the nonhuman world that surrounds us, or as Buell puts it "reanimating and redirecting the reader's transactions with nature."[18] Buell is aware of the paradox of such an idea—that works of literature and writing more generally, usually consumed indoors, might bring us closer with the outdoors, and that verbal stylizations might bring us closer to material reality. For Buell, indeed, the central theoretical challenge with understanding the environmental imagination lies around mimesis, and whether literary texts ever really represent their environments.[19] But he claims that it is through representation that we can come closer to nature. Nature writing aims to be more attentive to and "responsive" to the "physical world's nuances"

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[17] Buell 7–8
[18] Buell 97
[19] Buell 84

than a normal person would be.[20] Along these lines, he develops the idea of the idea of "dual accountability," which suggests that the environmental imagination tends to be dedicated to both the internal workings of discourse and to the external world; texts have a "dual accountability" to both "matter" and what he calls "discursive mentation."[21] This vision of dual accountability does not overcome what he refers to as our limited "secondary capabilities"—we are better at seeing objects as discrete rather than relationally, and we perceive objects close to our own size better than smaller ones. Buell states firmly that "Our reconstructions of environment cannot be other than skewed and partial."[22] But dual accountability does affirm that literature can capture some partial truth of the objective world, and that it might be held to that particular reality. In this way, the environmental imagination can "invent, stylize, and dislocate," and also pursue "a decidedly referential project."[23]

For Buell himself, Lopez's *Arctic Dreams* stands as a primary example of dual accountability because it is sensitive to "the limits of objective representation" even though it is nonfiction.[24] It is not hard to see how it fits together with Buell's other criteria as well. *Arctic Dreams* is fundamentally occupied with place and with the effect of the land on the mind; the Arctic ecosystem is like a character to developed, rather

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[20] Buell 90
[21] Buell 92
[22] Buell 84
[23] Buell 99
[24] Buell 92

than a setting. Lopez estranges us from the ecological landscape features we regard as normal in the temperate zone; his point is to show us a kind of radical difference inherent to the land: there are really two seasons in the Arctic instead of four, the sun rises and sets in a radically different way; biological diversity is substantially lower (although ecosystem complexity remains).[25] Meanwhile, human desires are always seen in conjuncture with nonhuman agencies; particularly the many animals that fill the pages, from the musk ox and the polar bear to the narwhal and the whale; this is perhaps most evident in the chapter on migration in the Arctic, which situates human migration among the arrival of other animals; it considers, moreover, how current human movements in the Arctic are now impacting the movements of other species. Here, too, we can see Lopez's occupation with the "process" of the environment, with nature as something historical rather than static: the beautiful passages, for example, on the patterns of migration in the Arctic show how they shift with changing environmental circumstances, including past forms of climate change.[26]

Going beyond Buell's concerns, Lopez's environmental imagination is also occupied with social changes to the Arctic as part of his larger project to think about the

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[25] Lopez writes that, in terms of biological life, "the overall impression, coming from the South, would be of movement from a very complex world to quiet simplified one," an impression that he warns is merely an "illusion," for there is a great deal of complexity to Arctic ecosystems having to do with light, temperature, and population fluctuations (Lopez 24).
[26] Lopez 160

land and the way people relate to it. "It is hard to travel in the Arctic today and not be struck by the evidence of recent change," Lopez remarks. He continues:

> What is found at modern campsites along the coast points to the sudden arrival of a foreign technology—new tools and a new way of life for the local people. The initial adjustments to this were fairly simple; the rate of change, however, has continued to accelerate. Now the adjustments required are bewildering. And the new tools bring with them ever more complicated sets of beliefs. The native culture, from Saint Lawrence island to Greenland, is today in a state of rapid economic reorganization and of internally disruptive social readjustment.[27]

The changes invoked in this passage—new technologies, shifts in food consumption, new modes of transportation and fossil fuel consumption, social transformations, and economic overhauls—are precisely those of modernity. Modernity's spread across the planet has been "uneven," to borrow a term from Marxism, meaning that the distribution of material and social qualities of modernity are not consistently visible across the globe all at once.[28] This is especially acute in the Arctic, where the particular ecosystem creates challenges for a significant precondition of modernity: agriculture and settlements. Agriculture is largely impossible in much of the Arctic. Because of this, hunting techniques developed for survival in the Arctic "continued to make ecological sense in the Far North long after farming and pastoral cultures supplanted hunting cultures in Europe during the Neolithic," as Lopez reminds us.[29] The historical contrast

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[27] xxvi
[28] Citation on uneven development?
[29] Lopez 185

between modernized humans, backed by the imagined communities of states, taxes, armies, cities, and economies all supported through agriculture, is enormous with a group of people still practicing hunting and gathering.[30] In adopting an anthropological viewpoint that sees the Inuit's plight at being thrown into modernity without, necessarily, any kind of collective consent, Lopez attempts to walk a fine line.[31] On the one hand, he writes about modernity with skepticism and concern: he laments, for example, the way we have become divorced from a relationship with animals; similarly, he laments the loss of an "archaic affinity for the land," which he speculates is "an antidote to the loneliness that in our own culture we associate with individual estrangement and despair."[32] Yet at the same time he warns strongly against thinking nostalgically: it is also wrong to think of the Eskimo as living in "harmony" with nature.[33] For Lopez, it is therefore worth emphasizing, the environmental imagination is also by necessity one occupied with is social and economic preconditions.

Lopez's environmental imagination is there profoundly historical—his meditations on the Arctic do not take place merely in the present, paying attention to both the natural history of the Arctic as well as changes in Eskimo life—but it is also

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[30] Yuval Noah Harrari refers to these collectively as imagined entities, borrowing the term from Benedict Anderson.

[31] There is powerful anecdote in this regard about the Nunamiut, a group of Eskimos. They were nomadic, but have been concentrated into a single kind of settlement for trade purposes; their lives are changed dramatically to adapt to a trade and monetary economy, and with the erosion of the economy there is a cultural erosion as well. (195).

[32] Lopez 200 and 266

[33] Lopez 201

accompanied by a geohistorical sensibility as well. Unsurprisingly, Lopez finds it crucial to meditate on the last glacial epoch and its "pulsations of ice."[34] Scattered across his many descriptions of the landscape are references to the ice age: he emphasizes "the Pleistocene stillness of the Greenland ice cap" and notes that within "the interior of Greenland the Wisconsin Ice Age continues, as it were, unabated."[35] What seems to bring Lopez to these thoughts about deep history is less the urgency of climate change today, than two other aims. On the one hand, the Arctic landscape itself brings him to think on deep history; as Lopez writes, Arctic temporarily encourages us to meditate on the past:

Long, unpunctuated hours pass for all creatures in the Arctic. No wild frenzy of feeding distinguishes the short summer. But for the sudden movements of charging wolves and bolting caribou, the gambols of muskox calves, the scamper of an arctic fox, the swoop of a jaeger, the Arctic is a long, unbroken bow of time. Twilight lingers. There are no summer thunderstorms with bolts of lightning. The ice floes, the caribou, the muskoxen, all drift. To lie on your back somewhere on the light-drowned tundra of an Ellesmere Island valley is to feel that the ice ages might have ended but days ago. Without the holier of contemporary life, that constant disturbance, it is possible to feel the slope of time, how very far from Mesopotamia we have come.[36]

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[34] Lopez 173
[35] Lopez xxiv and 204?
[36] 172

The Arctic landscape changes our sense of periodization, making the ice age feel all the more present. For Lopez the ice age also explains current ecosystems. Thinking about the forms of life that inhabit the Arctic, Lopez notes that "The ecosystem itself is only 10,000 years old, the time since the retreat of the Wisconsin ice. The fact that it is the youngest ecosystem on earth gives it a certain freshness and urgency."[37] The development of northern ecosystems, in contrast to other southern ecosystems, is constantly halted by the growth of glaciers, and indeed some animals are still adjusting their behaviors to the retreat of the glaciers 20,000 years ago.[38] The past, for Lopez, is very much present in the Arctic's biological life.

By including these geological references, Lopez indicates the way in which the geological past remains present. He also thereby allows us to see how substantially different ways of thinking about an ecosystem, a place—one geohistorical, the other environmental—come together productively in the effort to understand how humans relate to the nonhuman world. But I want to emphasize that, just like the references to the Eskimo, geohistory and the ice age are not Lopez's primary aims; this is not a work primarily aimed at geohistory. The text's environmental imagination reabsorbs these remarks, however interesting they may be; they serve the purpose of understanding a present, persisting landscape. As we will see shortly, the other texts we will look at

[37] Lopez 37-38
[38] 30? and 160-162

similarly confront geological history, but with substantially different aims. What we can say in sum about the imagination of the old Arctic, then, is that it was concerned about the particularly of the ecosystem, but also with its history. None of this will necessary change when we move on to Arctic fiction later on; these concerns will persist but will layered with the new conditions being created by climate change.

3.2 Gradualism in the New Arctic Wilderness

William Glassley's *A Wilder Time* records, in an impressionistic fashion appropriate for nature writing, moments from five different expeditions to Greenland taken by the author.[39] Glassley, a geologist at the University of California, Davis, traveled to Greenland along with two other scientists for the purpose of studying its bedrock. Specifically, their aim was to search for signs of "mountain building episodes." Although in our time Greenland does not appear as a space of intense geological activity, somewhere between two and three-and-a-half billion years ago, as Glassley explains, "There is evidence of movements along enormous faults; of volcanic systems that would rival and the Andes; of ocean basins the size of the Atlantic. All are now vanished, swallowed in the onward rush of Earth's evolution."[40] For Glassley, as well as the broader geological community, what is particularly interesting about these remnants is what they may reveal about how mountains were made in the planet's deep past.

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[39] Glassley 29
[40] Glassley 17

Today, geologists explain the construction of mountains through the theory of plate tectonics: that continental and oceanic plates are involved in a movement across the surface the Earth, powered by heat from the interior. When these plates converge, mountains form. But the evidence for this process's existence extends back only 900 million years; how mountains formed before that time, the majority of Earth's history, is not particularly clear. This is why Glassley finds himself so interested in Greenland's bedrock. Ultimately, in the process of reconstructing Greenland's geological history, Glassley and his team discover what he refers to "the exposed remnant of the earliest known plate tectonics and subduction."[41] They discover, in other words, that the system of plate tectonics has been around, shaping the Earth, for billions of years.

For the purposes of this chapter, Glassley's *A Wilder Time* represents a transition toward the subgenre I am calling "New Arctic writing." As Glassley explains, the purpose of his book, much more broad than the actual geological research attempted in the expedition, is to record and lament the disappearing "wilderness" of the Arctic: for Glassley, this is a wilderness disappearing not because of direct human development, which is to say the construction of towns and cities, but rather because of anthropogenic global warming and the way the planetary system is "responding naturally to climate change forces."[42] Although Glassley's book returns to many of the same themes as

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[41] Glassley 210
[42] Glassley 22

Lopez's work, its occupation with climate change in the Arctic pushes its horizon of concern away from the environmental imagination and towards a geohistorical imagination. More so than Lopez's, Glassley's mediation on wilderness and the place of humans in nature moves from ecology to geology, from environmental to geohistorical concerns. Glassley's concern over climate change and the end of the wilderness in the new Arctic has a particularly "gradualist" form of narration that stands in contrast to our typical sense of an oncoming climatic apocalypse. Such a gradualist understanding of change ultimately results in writing about the new Arctic that occludes the transformations happening in the Arctic (both cultural and environmental) in favor of poetic meditations on the past and present of the nonhuman world.

Like Lopez's *Arctic Dreams*, Glassley's *A Wilder Time* may readily be interpreted for its "environmental imagination." What marks Glassley's environmental imagination most directly in his occupation with wilderness. Glassley's thoughts about wilderness are grounded in a historical narrative about modernity. He notes that wilderness derives from the Old English "wildeornes," meaning "the place where only wild animals live." As Glassley claims, this etymology implies that wilderness was initially seen as a place of " struggle" for humans in which it was "not easy to settle, to farm, raise families, or enjoy an evening with friends." "Wild places," Glassley continues, "where only animals live are the frontiers, the lands through which humans may have wandered, but within which living is likely to fail. Wilderness is not welcoming. It is the place where humans may be prey."[43] These wild spaces once defined the entire planet—they were the "ambience for wandering humanity from the time of our origins"—but with the rise of settlements, we began to name wilderness because it grew to have an opposite.[44] Today, as humans "have flowed over the surface of the planet like a massive tsunami, inundating the world with more and more beings while pushing to the fringes any possibility of the experience of deep wilderness," this space largely no longer exists. Wilderness is that which is undisturbed by human agency.[45]

Repeating the relatively recent conception of wilderness as a beneficial space, as opposed to a region of moral questioning and essential fear, Glassley sees wilderness as a necessary component to fully understanding what it is to be human. Glassley holds an essentially dialectical sense of the value of wilderness in defining the human— it shows us what we are not and thereby defines what we are: without wilderness, we cannot truly know ourselves, and we lose the "foil for humanity."[46] He views wilderness as the only way for us to perceive, in experience, the unique existence of consciousness in the universe. He writes that "When wilderness is gone, even that which is responding naturally to climate change forces, all that will remain are memories and impressions of its textures and forms, its silences and screams, its smells and tastes. We will have lost

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[43] Glassley 20
[44] Glassley 20
[45] Glassley 20 CITATION. What Glassley ignores in this narrative, of course, is the changing valence or attitude toward wilderness, the explanation for the switch between a fear of wilderness and its contemporary reverence, itself a product of modernity. See Cronon.
[46] 20

the only reference point we have for the significance of mind in the universe."[47] Expanding the significance of wilderness further still, he writes that "wilderness becomes, in our presence, the only threshold through which we can freely perceive the significance of our ability to reason, imagine poetry, and create what we cherish as beauty."[48]

Glassley's environmental imagination remains grounded in this particular narrative about wilderness. Indeed, the other components of this book that characterize its imagination as environmental all appear to flow from this commitment to the importance of wilderness. Like Lopez, Glassley is also occupied with "dual accountability," and the limitations of language to comprehend and describe the objective world: "Wandering and sailing from outcrop to outcrop, immersed in the grandeur of that wilderness forces daily life to become a practice in humility. Time fractures, languishing in some backwater of perception. Viewing ice, somnambulant fjord waters, rocky defiles, and tundra plains becomes a repeated experience of confronting the incomprehensible, each thing expressing a subtle essence of existence that can be known only by being present."[49] Place, too, features strongly in this work; like Lopez, Glassley wants us to experience, as directly as possible, the differences of the Arctic ecosystem: "It was a panorama that defied comprehension. There was nothing

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[47] 22
[48] 198
[49] 19

familiar there. The abbess of trees, of houses or streets, of cars or people, the lack ion movement of any kind—all contributed to a sense that I was walking alone in an alien world, not of Earth, but of some planet where forces and processes played out there dramas according to different rules."[50] Human forms are also situated among so many nonhuman processes, and encounters with the nonhuman world find a privileged space in Glassley's writing.

And yet Glassley's sense of the environment is ultimately subordinated to a deeper concern for the geohistorical layer of the Greenland. Wilderness itself, more than just serving as a "foil" for consciousness, is also an arena in which deep history is to be recognized and understood. For Glassley, the wilderness is also the place of unconcealment for modern humans; it is where we come into contact with what we are in "our true origins:"[51] "What we are a part of cannot be known in our engineered and manufactured world. We are the product of billions of years of unfolding change unaffected by our own intent. To truly understand what we are, and what we are part of, requires knowing that unshaped wild—that is where the bones lie."[52] The truth to be unveiled in the wilderness is a geohistorical one: that we are part of a process of the Earth's "unfolding," a process that does not have humans as its central concern. In the world of modernity—evoked here as a world "engineered" and "manufactured," but

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[50] 55
[51] 20
[52] 145

also described elsewhere in terms of “parking lots and buildings and city streets”—this fact becomes occluded: without direct contact with a more-than-human world, we come to see ourselves as separate from those other forces that predate us entirely. Wilderness is where this modern cover is pulled away.[53] To lose wilderness would therefore be to lose our ability to get at human essence: “My hope in writing this book,” as Glassley explains toward the beginning, “is that the value of truly pristine wilderness, as a place from which to sense how we each fit within the grand unfolding universe, will inspire its preservation. If we lose wilderness, finding our roots, personally and as a species, will be virtually impossible” (30). Wilderness is where we can still encounter deep history, it is where nonhuman is uncovered.

Glassley’s sense of geohistory is therefore profoundly important for his sense of wilderness—indeed, more than his imagination of ecology and environment. The purposes of many of the passages in which Glassley meditates on Greenland’s past are an effort to awaken the reader to this form of perceiving the world through the geohistorical imagination. Shifting out perception to see the presence of the past, in this passage, transforms the environmental imagination to a geohistorical one:

> Over ten thousand years ago, during the last Ice Age, the landscape I stood on had been buried under thousands of feet of ice. Every valley and ridge that could be seen, every hillock and defile had been the floor to that ponderously migrating sea of frozen water. This was a young, inherited landscape, shaped by the grinding ice of that ancient time. As

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[53] 199

> the Ice Age melted away and exposed the bedrock, the sculpted land provided footholds for pioneer plants. Season after season, as plant life slowly but incessantly blossoms, withered, and died, plant remnants found in ice-wedged cracks, lichen attached to bare rock, and dust settled into pockets and irregularities, nurturing an unimagined future that included our little camp." (55)

Here, the "little camp," and indeed the entire present of Greenland, becomes part of one larger geohistorical event in the same place: the wilderness landscape of Greenland would have once been entirely inaccessible, buried under ice, but is now part of the human world. It should be clear, then, that when Glassley refers to the wilderness he does not mean a landscape that itself entirely unchanged. Wilderness here is not a place that is absolutely pristine and unchanging, but merely unchanged by humans.

But this geohistorical perspective also comes to bear on the conditions of the New Arctic. In this work, it is not merely that geohistory is imagined in the past, as in the other scientific and literary texts we encountered in the previous chapters; it is experienced directly as both social and environmental transformation Perhaps more than anything else, what this perspective yields is a dramatic sense of "gradualism" surrounding contemporary climate change. Recall that, in previous chapters, this term came to mean a few different things. In the simplest geological sense, gradualism is a way of "emplotting" earth history that sees change occurring over relatively long periods of time: to explain the presence of a given land formation, a geologist would imagine the agency of many different relatively slow processes. In the second chapter, we saw that this geological narrative form could be transferred to a work of fiction, Kim Stanley Robinson's ice age novel *Shaman*, which climatic change happens slowly in conjuncture with human history. Here I want to suggest that Glassley too retains a relatively gradualist perspective, not merely on the geological past, but on the geohistorical present.

There are plenty of passages in which a gradualist view of the deep past takes hold. But what is more interesting and relevant for us is how these views about the past are transferred into the present. The moments where Glassley describes climate change are instructive. Glassley's vision of the changing climate tends to see it as a slow process that has happened before. Glassley, in one passage, notices small tundra mounds on top of rocks, and then he realizes that these little patches are an "erosional remnant" of the tundra plain that had originally reached out to the bay. The tundra plain was being driven back by rising sea levels; this in his reading is highly significant: "The edge of wilderness," he writes, "offering little resistance, was silently retreating into new future we unknowingly are shaping."[54] The idea of a "silent retreat" of the tundra plain does not inspire any sense of urgency to these transformations. Glassley's lament is strictly to be thought of in terms of gradualism, the end of the wilderness as a relatively slow process.

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[54] Glassley 22

Glassley communicates a lack of urgency, too, in the way climate change appears throughout *A Wilder Time* as a relatively casual feature of the landscape like any other, rather than a rapidly unfolding crisis; he places it in continuity, in other words, with the past. This is clear in a passage in which he describes a particular site in Greenland that "few other researchers" had visited. He observes how the "tundra biome" covers the ground right up to the point where the ice had advanced earlier, exposing the bedrock that had been scraped by the glaciers for "millennia." What is interesting about this particular passage is the way in which climate change begins to appear, as if unexpectedly: "We were at the southern end of a lobe in the ice cap. To our right, the ice was bounded by a moraine of rocks and dirt over fifty feet high that ran for many miles along the ice front. The moraine had been pushed up as the ice migrated over land. But as climate change took hold and warmed the air, the ice was melting back and was barely in contact withers rimming moraine."[55] This passage is gradualism at its finest because a continuity emerges between processes of glacial growth and climate change today, both of which are described in way that does not communicate urgency. Elsewhere, such a sense of continuity and a lack of urgency become almost wistful, as if nothing could be done about the problem whatsoever: "In my mind I again see the dissolving landscape of tundra tufts resting on boulders in that encroaching bay from years ago. I watch reindeer bones decay, ice melt, new surfaces appear. Despite its

[55] 175

inevitable dissolution and change, what wildness remains will forever quietly, irresistibly beckon."[56] Glassley becomes wistful here, lamenting climate change's effects as if they were purely inevitable, as if there were no serious consequences for anyone.

What, then, are the consequences of Glassley's gradualism? To begin with, his sense of uniform change allows him to refer to Greenland as a "wilderness" in the first place. Glassley represents his work as a pre-elegy for a wilderness that is still fundamentally present. In his mind, Greenland is still "one of the world's greatest untouched wilderness expanses."[57] This claim of Greenland's continuing status as wilderness is strange. When we take into account Bill McKibben's important work in *The End of Nature*, where he suggests that humans very modification of the atmosphere, measurable with scientific instruments everywhere even if it not literarily visible, means that wilderness no longer exists.[58] There is no space where humans have not made some sort of modification. Yet, for Glassley's gradualist, deep historical sense of space, wilderness is more about human settlement and development, rather than change or influence in a broader sense. Glassley does not hold the illusion that landscapes are unchanging, nor does he maintain that the Inuit have had no impact on the space whatsoever. But he does yearn for landscapes that have been largely unmodified by

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[56] 210
[57] 16
[58] Nature, meanwhile, as an entity separate from humans, never existed in the first place.

humans. The consequence of global warming—however slow it is happening—is that the wilderness will become entirely human over longer stretches of time.

Another, perhaps more important consequence of Glassley's gradualist and geohistorical vision of the New Arctic is that it leaves little room for the social realm. It is true that wilderness discourse in itself frequently avoids calls for collective action and human politics. There is, as in many pieces praising wilderness, a strong sense of anti-humanism that would appear to undercut Glassley's humanist sense for why the wilderness might be important in the first place. There is an emphasis on the importance of being "voluntarily isolated from the rest of humanity," as when Glassley entertains a fantasy, observing the Greenland landscape, that "no other person existed" and that he was "the lone human soul in all the world."[59] While isolation in itself is not condemnable, it also seems to accompany for Glassley an abandonment of the social entirely: "Separation from the clutter of culture," he asserts, "removes the incessant challenges of having to judge, act, and react to bombarding options and information. There is no need to struggle with the effort to make sense of the right and wrong of anything, for in this aggressively wild space, there is no judgment, simply the act of being."[60]Wilderness—the space where geohistory gradually unfolds itself—is escape from the social, from politics, and the kinds of responsibilities that they require.

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[59] Glassley 18 and 54
[60] 168

When considering climate change, this type of quietism seems even more egregious. Toward the end of the book, Glassley recognizes that these changes are not merely geohistorical transformations to a landscape; they are also cultural changes happening to the indigenous people of the Arctic. Glassley, like Lopez, displays a clear degree of admiration for the Inuit, suggesting that their small settlements near the wilderness are the best example of living in harmony with nature.[61] And he recognizes that their efforts to live sustainably are threatened by climate change.[62] It might be expected that such care and admiration would convert into a sentiment of outrage, an expression of injustice, but it does not. It is simply another instance of the loss of "wilderness" rather than some larger and deeply unequal political event:

> [O]n every continent, wilderness is being consumed, and the people who have depended on it, living at its fringe and within its embrace, are forced to relinquish what they cherish. With infinite hubris, the modern world is imposing the consequences of its industrial avarice on lifestyles it knows nothing of. The moral bankruptcy of the rationalizations for the destruction of wilderness and the people who live in harmony with it is staggering. That many are, in fact, angry and seeking ways to mitigate impacts is heartening, but the pushback is formidable. The moral outrage we all should feel is meager against the economic juggernaut.[63]

Here, more than any other passage, Glassley expresses concern: the problem with the modern world then is that "economic self-interests" are destroying the wilderness and "the people who live in harmony with it." And yet nowhere is there a call, or even a

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[61] Glassley 211
[62] Glassley 212
[63] Glassley 213

suggestion, that something might be done to mitigate the effects of climate change or aid in adaptation. It is in this sense that Glassley's sense of gradualism undermines his care for the political consequences of the New Arctic.

3.3 Catastrophic Warming and the Right to Be Cold

Sheila Watt-Cloutier's *The Right to Be Cold* stands in contrast to Glassley's *A Wilder Time*. Where Glassley tells the story of a US geologist on a scientific expedition, Watt-Cloutier's memoir recounts the long process of her becoming an international environmental and indigenous activist, from her childhood in Kuujjuaq (in the northern part of the Quebec province) through her ascent into international politics through the ICC (Inuit Circumpolar Council) and the Unites Nations. But a similar pattern may be discerned in both of their work: As a way of addressing climate change, both authors shift from an environmental imagination—fundamentally occupied with the ecological connections between different entities—to a geohistorical one, occupied with long term changes to the nonhuman world. Doing so, Watt-Cloutier in particular shows us the ways in which, in contrast to Glassley, the New Arctic is not merely a long-term geological transformation; it is also a catastrophic cultural shift for Inuit. Equally important, Watt-Cloutier makes it clear that, from the perspective of the Inuit, climate change must be seen in continuity with the many changes befalling Inuit communities during the long process of modernization itself.

The environmental imagination of Watt-Cloutier's memoir is, like both Lopez and Glassley, based in the space of the Arctic, here specifically the Canadian Arctic. But unlike either writer, it is fundamentally occupied with environmental justice and the ways in which environmental change is bound up with the social changes that accompany modernization. Watt-Cloutier frequently defends the Inuit as the last "hunting-and-gathering Indigenous peoples in the world," pointing out that their way of life is hardly a fact of the past; it is present in the contemporary world just as any other modern form of living. Yet it is certainly threatened by the processes of modernization (and indeed neocolonialism); with the encroachment of modern culture on Inuit life during her childhood, largely in the form of Canadian efforts to bring these territories under more strict governance, Watt-Cloutier began to notice enormous changes to her home. "The safe, nurturing Inuit world of my childhood," she laments, "a world in which family and community members were strong in their resolve, with a great deal of integrity and dignity, was in large part gone."[64] These changes included respiratory illnesses related to the cheaply-made homes the Inuit were brought into, viral infections related to crowding and a lack of running water, and public drunkenness, fighting, and robbery.[65] No doubt the most traumatic of these transformations of the Inuit way of life during her childhood, and most symbolic, was

[64] 81
[65] 61

the murder and removal of the Inuit dog sledding teams.[66] Canadian officials replaced animal transportation, virtually overnight, with snowmobiles that require oil, an exchange that brought them not merely into modernity but into what Imre Szeman would call "petromodernity."

Yet for Watt Cloutier the most dramatic of these environmental transformations due to modernity concerns the emergence of eco-toxicity. The problem of environmental toxicity has been written about elsewhere by a number of ecocritics, including Lawrence Buell, Stacy Alaimo, and Rob Nixon. Buell, writing in 1998, recognized that "toxic discourse" pushed the traditional environmentalism of conservation toward environmental justice. For Alaimo, toxicity relates environmental justice to bodily porousness, which she refers to as "trans-corporeality." Writing about what she calls "material memoirs," Alaimo explains that, in the modern world, bodies are often seen from essentialist perspectives that slice them out of the environments and power structures they are always already embedded in.[67] Material memoirs develop as a correction to this way of thinking; they tie personal narratives with scientific and medical information to understand the trans-corporeal self in the uncertainty of a risky environment.[68] Material memoirs, she writes "complement the studies of risk culture, popular epidemiology, and the ordinary expert by revealing how profoundly the sense

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[66] 69-73
[67] Alaimo 86
[68] 87 and 93

of selfhood is transformed by the recognition that the very substance of the self is interconnected with vast biological, economic, and industrial systems that can never be entirely mapped or understood."[69] The environmental imagination of the material memoir, then, attempts to situate the human body within its artificial ecosystem.

Watt-Cloutier's book is not strictly speaking a "material memoir" in Alaimo's sense, in that it is not an investigation of personal illness, and yet it works through similar issues. The environmental threat to Inuit populations that most concerns Watt-Cloutier in this book are what is known as "Persistent Organic Pollutants." These POPs, as Watt-Cloutier explains, had been discovered in the 1980s to be "poisoning the Arctic food chain, resulting in devastating effects in our populations."[70] They are made, as she details, from the "burning of waste, plastics, fuel, tobacco, and wood; through the production of iron and steel; and by electric generators."[71] But establishing the science of POPs was for Watt-Cloutier only one small component of the problem; environmental justice could only emerge if activists could "bring the human dimension to the scientific, chemical related-discussion."[72] Watt-Cloutier addresses these pollutants in language of environmental justice; she writes that "I wanted to make sure that the global environmental issues affecting our Inuit world were not disconnected to the many other

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[69] 95
[70] 121
[71] 171
[72] 142

health-related challenges we were facing in our communities."[73] Importantly, she speaks about toxicity from precisely the kind of bodily perspective that Alaimo presents. Here is how she explains her involvement with political work to manage POPs: speaking of the birth of her grandchild in 1997, Watt-Cloutier remarks:

> Here was another generation that I now knew was at risk. As Sylvia nursed her newborn, I was struck by the injustice of what we were facing. No mother anywhere in the world should have to worry about whether her breast milk will poison her child. Ultimately, the POPs issue was not about politics, but rather about families, parents, children, and grandchildren— and our right to lead our lives and continue the strong traditions of our hunting culture. Traditional Inuit wisdom, the powerful teachings of the land and the hunt, and our country food were all vital to confronting the historical problems and the rapid changes that arrived with the modern world. I wanted to see grandson, and the grandsons of many, grow up and live in the Inuit hunting and food-sharing culture that had sustained me during my upbringing, and that had fulfilled the physical and spiritual needs of Inuit for generations before.[74]

This is a remarkable passage because the issue of POPs moves from merely "political" concerns for Watt-Cloutier to daily life, to the problem of reproduction not merely of healthy children but of the culture itself. Pollutants make it unsafe to have children born into the traditional world of the Inuit, where the "country food" remains a potential source of further risk. The body of intergenerational family members becomes a trans-corporeal site of "risk," in which traditional activities that once provided sustenance now also expose people to harm.

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[73] 122
[74] 141

The issue of eco-toxicity and POPs also makes evident the extent to which Watt-Cloutier's environmental imagination is strongly committed to thinking about the global sources, global consequences, and international solutions, to local environmental issues. In this sense, Watt-Cloutier's environmental imagination is defined by a commitment to environmental justice and to having what Ursula Heise would call a "sense of place" as well as a "sense of planet." In the passage above, Watt-Cloutier frames her claim about motherhood international terms: it is not merely that no Inuit mother should be subjected to the horrors of pollutants; it is "no mother anywhere." Watt-Cloutier insists too that pollution "was not a North-South issues, but rather a global issue."[75] At a meeting in Geneva, she memorably insists that "A poisoned Inuk child, a poisoned Arctic, and a poisoned planet are all one and the same."[76] It is through speeches and presentations like this at a stunning variety of national and international organizations, including the ICC and the UN, that Watt-Cloutier was eventually able to contribute to the creation, in May 2001, of the Stockholm Convention on Persistent Organic Pollutants, which established legally-binding guidelines about the use of these chemicals.[77]

Watt-Cloutier's environmental imagination is therefore strongly bound up with modernity, with justice, and a global perspective. But Watt-Cloutier's political life transforms dramatically when it becomes clear that climate change poses significant

[75] 142
[76] 163
[77] 178

problems to the Inuit way of life, an intensification in the narrative of this memoir of pre-existing problems of western encroachment; her politics too, I want to suggest, moves from having an environmental to geohistorical imagination. Watt-Cloutier's imagination, like Glassley's, is not the same as the imagination of past environments, as in the texts we encountered in the first chapter, in which the agency of the planet in deep history is confronted. This geohistorical imagination is that of the present, a recognition that large-scale transformations are happening that have Earth-historical implications, this is to say implications in geological history. But unlike Glassley, Watt-Cloutier narrates the events of climate change through catastrophism: here, climate change moves from being something in the abstract future to an event happening at this very moment, severely impacting local indigenous groups. It is not so much the past that matters, but the present suffering, caused by geohistorical transformations, that she is witnessing in her community.

Watt-Cloutier's imagination of geohistory is informed by the many different ways that Inuit know of climate change directly, and how they experience geological change directly in daily life as a series of different "catatrophic events," and she calls them.[78] She recounts, for example, a man named Caleb Pungowiyi from Alaska explaining two of the different changes he has encountered. Rivers no longer breaking up in "big chunks" at the end of winter but rather slowly melting away, a change with

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[78] 193

surprising ecological consequences: chunks of ice do not scour the riverbanks, removing the "dead tops of willows," meaning that new growth cannot occur. Pungowiyi observed too that polar bears, without normal sea ice patters, were changing their hunting patterns and showing up in human communities. Watt-Cloutier also mentions that new species also began to arrive in the Arctic: "many were seeing robins, pintail ducks, barn owls, and salmon in the High Arctic for the first time."[79] The permafrost—the ground ought to remain permanently froze—has begun to melt; "as a result," Watt-Cloutier explains, "what was once terra firma is now unstable, slumping terrain."[80] This is not merely an aesthetic issue. The soil is more vulnerable to erosion, infrastructure and homes begin to collapse under the soil, travelling for hunters becomes more difficult, and traditional forms of food storage—hunters frequently store meat in "cellars deep into the frozen earth"—are becoming impossible.[81] And, finally, floods and more frequent rain disrupt the natural flow of animal migrations.[82] In contrast to Glassley's calm, unpurturbed, unworried picture of the New Arctic, in these passages, the extent to which climate change is catastrophic—rapid, and difficult to adapt too—becomes clear. Watt-Cloutier writes about, as she says, the "immanent devastation of the Inuit way of life."[83]

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[79] 191
[80] 191
[81] 191-192
[82] 192
[83] 221

Watt-Cloutier importantly portrays the Inuit here not as a group of people passively receiving knowledge about geohistorical change from scientists, as many of us are; rather for her the Inuit have long known about climate change through direct experience. Yet she also emphasizes that the direct experience of the Inuit of geohistorical change is not meant to be seen in contrast with scientific accounts of global warming. Her thinking occupies a borderland space between Inuit knowledge and climate science, which she does not see as being in any sense incompatible; indeed she speaks of the "marriage of Western science and traditional knowledge" as a "groundbreaking" possibility.[84] For her, Inuit knowledge is itself scientific because it consists of "rigorous observation," and scientific reports for her do not establish truth; they "confirm" what the Inuit were observing.[85] Indigenous knowledge becomes a contribution rather than an unnecessary side show in the discourse around climate change; the Inuit contribution and petitions to governments and international organizations is framed by Watt-Cloutier as a "gift": "In a very real sense," she writes, "our petition was a gift from Inuit hunters and elders to the world and to those most negatively affected by climate change. It was an act of generosity from an ancient culture deeply tied to the natural environment and still in tune with its cycles and rhythms. It

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[84] 214
[85] 199 and 201

was a gift to an urban, industrial, and 'modern' culture that had largely lost its sense of place and position in the natural world."[86]

Bringing Inuit knowledge to the perception of geohistory is fundamentally about galvanizing political change for Watt-Cloutier. For her, geological transformations become folded into politics. "Climate change," she asserts, "is about people as much as it is about the earth, and the science, economics and politics of our changing environment must always have a human face."[87] In part, she views the Arctic as the space in which "dangerous" climate change is in full evidence; and it could be used as a political representational tool to spark great change.[88] Because the Arctic is changing so quickly it can be used as direct, incontrovertible, evidence against the "conservative politicians" who denied the existence of climate change. Seeing it, Watt-Cloutier says, "no one in the Arctic could possibly have believed the jury was still out."[89] Watt-Cloutier's recognition of geohistory is not so much centered on the planetary implications for the future; it is about the present, and specifically about the evidence that can be mustered to help the people caught in the path of climate change. The geohistorical changes in the Arctic can convince people that climate change is happening, and that it is dangerous.[90]

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[86] 241
[87] 259
[88] 195
[89] 196-197
[90] The image they chose to go with, the metaphorical figuration for the struggle, is the figure of the Inuit sentinel, the hunter on top of the world that is signaling the dangers that are to come (205)

Perhaps this point is most clear in Watt-Cloutier's notion of a "right to be cold," in which geohistorical change becomes tied to the language of international politics and rights discourse. For Watt-Cloutier, the right be cold refers to "how Inuit culture and economic independence, as well as Arctic wildlife, depended on the cold, the ice, and frozen ground, how the great shifts in temperature and weather patterns were upending an entire way of life, and denying us our economic, social, cultural, and health rights."[91] She describes these disruptions in vivid detail: the hunting season transforms, as do the places where hunting can take place; hunting techniques that depend on ice will no longer be as effective; a loss of "country food" sources; elders no longer able to tach how to predict weather patterns; navigational skills became less reliable when coastlines change; snow houses cannot be built with the absence of dense snow, and so on.[92] Given that, as Watt-Cloutier writes, "To Arctic Indigenous peoples, therefore, climate change is emphatically a cultural issue, it is therefore possible to suggest that "human-induced climate change in the Arctic amount to violation of the human rights of Inuit."[93] Here Watt-Cloutier yokes a human right to a geohistorical contingency in the Earth system: that the poles are cold enough to support ice year-round. The right to be cold in other words is fundamentally grounded in the Earth's current ice age our "ice house" state. This is a remarkable claim because human rights are almost always grounded in claims

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[91] 230
[92] 202
[93] 202 and 225

related only to the human; here a human right is being extended not merely to a region, but to a region's entire climate: she explains further that "the right to be cold doesn't refer to individuals. It refers to the circumpolar environment, the Arctic land and the way of life that depends on ice and snow."[94] In the petition Watt Cloutier drafts for this idea, Inuit culture is deeply tied to its particular environment; destroying that environment through climate change is therefore a violation of human rights. She claims Arctic "cold" as a right because of the way in affects Inuit culture. In this sense, geohistorical change becomes an issue of daily life as much as science.

The passage in Watt-Cloutier's book, then, from an environmental to a geohistorical imagination does not necessarily mean a radical break in concerns. In both Watt-Cloutier's writing about POPs as well as her climate justice advocacy, a strong critique of modernity, along with a sense of justice, remain central throughout: for Watt-Cloutier, there is an almost lack of surprise in the revelations of climate change, in the sense that these catastrophes have, in different forms, already happened before. Nor is there a change from present and urgent concerns for justice to a less committed historical view. It is a matter of how political concerns are framed, and their scale: in Watt-Cloutier's work on toxicity, health concerns must be primarily phrased in terms of the effects on the body, and the ways in which bodies are ecological entities, embedded in the various webs of life that support them. To allow POPs into the food sources of

[94] 231

indigenous communities is to undermine their bodies, rights to safe reproduction, and cultural practices directly. When narrating climate change, Watt-Cloutier frames her concerns too around cultural practices, but the scale of the impacts, and the challenges in overcoming them, become greater: the conditions of possibility become challenged in new ways with changes to life, like the melting of ice or the shifting of the permafrost, that are significantly more frightening than POPs, and therefore all the more difficult to make concrete positive changes. The right to be cold, indeed, finds substantially less success toward the end of Watt-Cloutier's book in making changes than her campaign against POPs.

3.4 The Ends of the Ice Age

I have suggested two ideas in this chapter: first, that in New Arctic nonfiction, the geohistorical imagination becomes a more prominent feature than the environmental imagination that dominated Arctic writing before climate change. I have suggested further that both gradualism and catastrophism mark this new way of imagining the Artic world, even as it comes to narrate the present, rather than the deep past. Where the previous two chapters have explored how geologists and literary writer have imagined climate change in the past, here the present warming comes to be included in geohistory.

The important contrast between Glassley's *A Wilder* Time and Watt-Cloutier's *The Right to Be Cold* is how the ice age's end has been emplotted. Glassley's book represents climate change as a relatively gradual, and indeed cyclical, process; for him what is to be lamented is the loss of wilderness, the end of a landscape that does not have the mark of humans on it. Watt-Cloutier, meanwhile, envisions climate change in the Arctic as a catastrophe for the people living there. Given this contrast, it is relatively easy to condemn Glassley's account for its nostalgia and its lack of concern for the people who already inhabit the "wilderness" of the Arctic. Following William Cronon's crucial work, Glassley's claims about the Arctic wilderness are untrue in the sense that Greenland is far from "untouched" and pristine; indigenous people live there—some of them appear in Glassley's narrative—and so to claim it as pristine appears to ignore the presence of the Inuit, repeating the kinds of settler colonialists claims of wilderness at the moment when indigenous tribes were forced off "pristine" land North America.[95] Such a critique falls in line with the standard complaint against conservation by environmental justice advocates. The nonhuman world becomes a kind object in itself, devoid of social relations and other people, something to be appreciated and held at a distance and preserved, a process that frequently comes at the expense of actual humans. Watt-Cloutier, meanwhile, takes into changes happening in the nonhuman world into accounts, but does not allow them to eclipse the forms of human suffering that are always contained by those consequences. In that sense, it is easy to prefer Watt-Cloutier's account of the new Arctic. But despite the significant limitations of Glassley's

[95] See Cronon, "The Trouble with Wilderness."

text, I want to suggest in conclusion that his book, seen as a companion to Watt-Cloutier's, has something important to tell us. My point in looking at both gradualist and catastrophist narrative forms is not to disparage either one, but to show how they both may contribute to the ever-complex ways we are coming to understand planetary history and our relationship to it. Specifically, I want to suggest that these texts reveal something about both ice ages and about reframing the Arctic today.

The Arctic is traditionally a space imagined to be "remote," "uninhabited," and "timeless."[96] It has been, for most of human history, difficult to reach or move through. During the expansion of European exploration in the 1500s, the Arctic posed particular challenges to navigation and cartography. As John McCannon explains in his important history of the Arctic, "The short navigational season left little time for uninterrupted and consistent surveying, and the glare office, snow and airborne ice crystals meant a higher incidence of mirage. Shore ice concealed the contours of coastlines. Summer fogs could hide the landmarks most useful for mapping. Compasses became less reliable once one came too close to the Magnetic Pole."[97] That is not to mention the simple fact that wooden boats could readily be destroyed by the floating ice bergs, as in Caspar David

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[96] The Arctic, as Sarah Jaquette Ray and Kevin Maier write, has a "paradoxical place in the Western Imagination." "As a region," they continue, "it is often seen as simultaneously empty of life and full of promise, the home of indigenous communities yet utterly conquerable, pristine and desolate yet marked by a long human history, isolated from the problems of civilization while at the same time the stage for a planet's climate drama. Symbolically, the North as resource has justified explorations both scientific and colonial, and continues too attract prospectors and adventurers in search of escape, transcendence, and fortune." (1)

[97] McCannon 80

Friedrich's famous painting of a wrecked ship *The Sea of Ice* (1824) depicted, and even modern ships of metal face particular difficulties in reaching the Far North, namely navigating through the sea ice.[98] Managing to reach land in the Arctic, humans have consistently faced difficulties in establishing settlements. This is as true for the ancestors of the Inuit as it was for European attempts at colonization. Indeed, the first humans to roam above the Arctic circle were forced out around 28,000 years ago, when the Pleistocene glaciers began to advance once again.[99] More recently, the Thule culture—the ancestors of Eskimo and Inuit—experienced a severe disruption to their culture when the Little Ice Age began in 1500, a setback that caused certain cultural transformations for them but that played a strong role in the demise of early Norse settlements in Greenland.[100] The Arctic's "timelessness," finally, seems to have as much to do with the lack of human development as it does with the sense that the ice preserves the past, that it quite literally freezes time as much as progress.

Everything about the New Arctic challenges these assumptions. The Arctic can no longer be called remote. As Sarah Jacquette Ray and Kevin Meier write, "Recently, the North has taken on a profound environmental significance. Images of melting ice caps and starving polar bears as well as internationally publicized debates about the Arctic National Wildlife Refuge (ANWR) place the North at the center of discussions

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[98] McCannon 133

[99] McCannon 31

[100] McCannon 66 and 73

about the urgency the planet's environmental crisis."[101] For Watt-Cloutier, as we have seen, the Arctic stands as a warning system for the planet, the first place to experience the devasting effects of climate change. In that sense, the Arctic takes on a global significance. But this is true in another way: with the melting of the ice, new opportunities will emerge in shipping (as in the opening up of the Northwest Passage), as well as in mining and oil drilling. With the loss of the remoteness of profitability will no doubt come, to a degree, the loss of the Arctic's habitability barriers, or at least a strong reduction of it. But perhaps most obvious of all, the Arctic's timelessness is now strongly coming into question. This is not merely because we have learned more about climate history, and are aware of the long term changes to the Earth's polar regions; it is more importantly because, with the melting of the ice, the Arctic has become a profoundly historical entity.

We might rephrase some of these lessons about the Arctic to speak more broadly, too, about what New Arctic fiction tells us about the ice age. What is perhaps most immediately clear from reading nonfiction about the Arctic is that it is a place where, as Marcia Bjornerud says of Svalbard, Norway, "[t]he Ice Age had not yet loosened its grip."[102] The ice age is not some long eliminated element of the past; it is a present condition for a significant portion of the planet. Life in the Arctic is life in the ice age.

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[101] Ray and Meier 2
[102] Bjornerud 3

Looking at the Arctic tundra biome—"that unique collage of grasses, mosses, sedges, dwarf, plants, and lichens"—and seeing how it flourishes among the landscape of rock and water, Glassley remarks that: "Time is frozen in such a place. Whether I walked in a twenty-first-century landscape or a primordial, Ice Age epoch could not be told. That inability to know time riddles the experience of place, dislocating perception into an insecurity that, in my case, made it seem as though I had trespassed into some other world."[103] Watt-Clouiter, meanwhile, maintains a similar sense of the Inuit world as one that is still in the defined by ice: "In a sense," she explains, "Inuit of my generation have lived in both the ice age and the space age." She means this in both a geological and social sense. Both because "ancient traditions" like hunting and dog sledding have been eroded by the rapid flood of modernity and because "what seemed permanent" began to "melt away," which is to say the rapid melting of the ice.[104]

Taken for their deepest philosophical import, these statements suggest that the experiences recorded in these nonfiction accounts speak to the everyday qualities of living in a moment, and a place, where ice is the all-consuming feature of the landscape, and that both aesthetic and cultural experiences in the Arctic may be ultimately tied back to geological history. When Watt-Cloutier writes of "The concept of ice as the life force for an entire people at the top of the world," and claims that "ice is something that

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[103] Glassley 50
[104] Watt-Cloutier xviii

people depend on not just for survival but to thrive," she means that the historically determined cryosphere has a direct link to cultural life. "for us Inuit," she insists, "ice matters. *Ice is life*."[105] For Glassley, meanwhile, the aesthetic component of ice—touched on by so many explorers, scientists, and nature writers who have ventured to the Arctic—is substantially more important than its cultural content. Glassley addresses the ice directly, as if he were writing a phenomenology of ice: "Ice has no permanence on this planet, but its metamorphosis from snow to ice fields to massive calving ice walls is more than a shift in form. It alters light, shapes sounds using its own voice, and responds to touch. It is a separate world of experiences, one that is rich and deep."[106] The "experience of ice" is more than being cold; it is to come into contact with a particular form that changes sounds and light itself. Nowhere is this clearer than in the passage in which Glassley consumes a piece of ice, and discovers, after the initial "impression of cold," that that it tasted clear and clean, and that it smelled of stone and "graveled river edges."[107] These moments give us the ability to see how much of our space is still so strongly determined by ice in a climatic and scientific sense. For both Glassley and Watt-Cloutier—indeed for Lopez as well—there is something special about the aesthetics of the Arctic in its current form, in its ice age.

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[105] 258
[106] 174
[107] 178

Yet, in the final instance, these accounts show us how the ice age in this space is rapidly coming to an end. Our attention is drawn to this space right as it is disappearing, like a star we never considered suddenly going super nova and drawing our interest. Just as much as this moment is that of the Anthropocene, in which atmospheric carbon, atomic radiation, concrete, and plastic seem to define our time, it is also the case that the retreat of the ice will leave its mark. It is the lesson of Earth System Science that all of the planet's elements are inevitably connected. Even those of us living far away from the Arctic will feel its effects. As Watt-Cloutier insists, "The future of the Inuit is the future of the rest of the world—our home is a barometer for what is happening to our entire planet."[108] Ultimately, then, what these accounts do for us is to reveal a truth about the world that are can easily be blind to; to see the Arctic collapse is to truly understand climate change in all of its geohistorical significance. The New Arctic is the truth of climate change.

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[108] xxi

4. Resurrecting the Ice Age: Geohistory and Politics in Pleistocene Park

Grant Slater's 2017 short documentary, "Mammoth," consists primarily of captivating aerial shots, accompanied with minimal piano and violin music, of the Russian Arctic. It is immediately clear that this Siberian landscape—the grass, boreal trees, mud, hills, and the Kolyma River—has not been remade for human settlement. But for whom it might be a dwelling remains unclear, until the drone's camera passes over the many different forms of mammalian life that roam the landscape: there are horses, bison, reindeer, all spreading out to graze the grassy expanse.

Despite appearances to the contrary, this space is anything but natural and pristine. It was initially home to the Northeast Science Station, housed in what the residents refer to as a "decommissioned Soviet TV antenna." But in 1996, Sergey Zimov, a Russian geophysicist at the station, also established a 50 square mile nature reserve, and began filling it bison, musk oxen, and wild horses, all of which still freely roam the grassland.[1] Pleistocene Park, as the reserve is called, is not a tourist attraction akin to what was imagined for dinosaurs in *Jurassic Park*; it is rather an ecological project aimed at restoring the steppe's ice-age ecosystem from roughly 30,000 years ago. By reproducing this ice-age environment—including its inhabitants, even the woolly mammoth, pending its successful de-extinction—the reserve aims to prevent permafrost

[1] Andersen 75

from melting, thereby reducing the release of carbon into the atmosphere and mitigating global warming.

Although called Pleistocene Park, the historical context for this singular reserve is that of the Anthropocene, a proposed but not yet ratified stratigraphic concept that nominates the human species as a geological force.[2] Within the last decade, this periodizing concept has gathered together a host of environmental problems under one enormous and colorful tent. At a conceptual level, it has come to signify "the end of Nature," which is to say the end of our notion that humans have no effect on global ecosystems. The Anthropocene describes an ontological shift in the status of human activity: as humans have become a geologically recognizable force, they have impacted the planet to such a degree that the category of "nature" apart from humans has become entirely meaningless.[3] At the material level, this pronouncement refers to the emergence of anthropogenic climate change—with which it is often and incorrectly conflated—but it can also refer to alterations in land use, plastics, extinction, changes in ocean composition, nuclear detonations, and so on. Chapter three of "Our Ice Age" has suggested another way of understanding the Anthropocene: as a moment of interglacial melting, when the agency of ice that dominated the planet during the Pleistocene is

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[2] Dipesh Chakrabarty's "The Climate of History" remains one of the most interesting assessments of this term from the humanities.
[3] See, for a description of the Anthropocene in these terms, Jedediah Purdy's *After Nature*, 2. This interpretation of the Anthropocene derives from Bill McKibben's book *The End of Nature*, which was composed well before the term Anthropocene began to circulate.

rapidly giving way to the agency of humans. A defining landscape feature of the iceless Anthropocene is the New Arctic, a space in which the once frozen landscape, dominated fundamentally by the cryosphere, is rapidly becoming an entirely different ecosystem.

Beyond the many disagreements over the start date of the Anthropocene, and beyond the various polemical attacks on the very concept of the Anthropocene from different humanists, perhaps the most important question raised by the Anthropocene is centered around collective responses to the material circumstances that it attempts to label.[4] There are in essence two opposing positions.[5] There are those "modernists" who view the Anthropocene as an opportunity for humans to shepherd the planet, to control

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[4] The complexity of the concept of the Anthropocene lies in periodization. In Paul Crutzen's early formulation is in his 2002 article, "Geology of Mankind," he argues that the Anthropocene began in the later part of the 18th century, as a result of the rapid growth in fossil fuel consumption. Crutzen also mentions rapid population growth, the immense increase in Earth surface area exploited by humans, the disappearance of the rainforest, dam building, and the invention of nitrogen fertilizer, as other major defining markers of the Anthropocene, but the major transformation to be reckoned with is the presence of greenhouse gases in the atmosphere caused by industrial production. In 2015, Jan Zalasiewicz and his coauthors—including Crutzen and Steffen—from a slightly different stratigraphic perspective, later suggest that this mid 20th century date should actually mark the beginning of the Anthropocene as a geological epoch. They claim that the most recent date, around 1950, provides the most globally recognizable alterations in the strata, largely due to the global presence of radiation from atomic bombs, but also due to the presence of plastics, urban areas, the accelerated burning of hydrocarbons, and so on. It should be noted here that greenhouse gas levels in this definition play a more minor role, despite being nonetheless significant (see "When Did the Anthropocene Begin?"). But there are other theories that also deserve to be briefly mentioned here. Not long after Crutzen and Stoermer's brief initial formulation of the Anthropocene in 2000, William F. Ruddiman proposed a radically different start date, roughly 8,000 years ago, that corresponds with the widespread use of agriculture and the consequent deforestation that followed. Ruddiman's definition is primarily based on the amount of greenhouse gases in the atmosphere (rather than the many other ways in which humans have subsequently altered the planet, and he attempts to demonstrate that the presence of greenhouse gases had already altered the 'natural' trajectory of the climate (see Ruddiman). Yet another deviant Anthropocene proposal comes from Simon Lewis and Mark Maslin, who claim that, in addition to the mid-20th century start date, 1610 should also be considered. This has to do with stratigraphy: the sudden appearance of Old World plants in new world sediments, and vice versa, would be a tell-tale sign to a future alien geographer searching the planets sediments for past history.

[5] Nixon, "The Anthropocene."

the planet better, to demonstrate our mastery of the natural systems that we have been studying since the birth of science. This has been referred to as the "good Anthropocene" hypothesis.[6] Opposing them are an eclectic group of thinkers and activists who view the Anthropocene as an unprecedented catastrophe in the history of the planet and surmise that human efforts to control nature more expansively will drive the planet into a deeper crisis.[7] For Jamie Lorimer, both of these responses conform to typical reactions from different groups: it is unsurprising that some scientists and business executives would ultimately favor a more modernizing approach, an embrace of the practices that have in essence already brought them wealth. Meanwhile it is equally unsurprising that environmentalists—with their long history of opposition to development—would view the Anthropocene with some suspicion.[8]

In analyzing Pleistocene Park as it is depicted through a number of different media—including documentaries, several popular write ups, including an article in *The Atlantic*, and a series of essays by Sergey Zimov providing some of the scientific underpinning for the park—I argue in this chapter that the reserve paradoxically draws together both of these responses to the pressing questions of the Anthropocene. Reaching back to the Pleistocene, Zimov's park blurs the distinctions between modernist

[6] For an engagement with this position, see Hamilton.
[7] I take this to be the basic position of a book like Christophe Bonneuil and Jean-Baptiste Fressoz's *The Shock of the Anthropocene*.
[8] See the introduction to Lorimer's *Wildlife in the Anthropocene*.

and anti-modern responses to the Anthropocene, consistently raising questions about the status of "nature" and the human place within it.

This chapter begins by contextualizing Zimov's historical conception of the end of the ice age, which centers on the rapid demise of the woolly mammoth and informs his project in Pleistocene Park. As I have done throughout "Our Ice Age," I analyze Zimov's vision of the history of life, extinction, and climate change for its narrative form; like Agassiz's *Studies on Glaciers* from chapter one, Jensen's *The Long Journey* from chapter two, and Watt-Cloutier's *The Right to Be Cold* from chapter three, Zimov's story of the woolly mammoth's extinction is catastrophist. Zimov, in that sense, shares a similar attitude toward past extinctions that many environmental writers have toward the present "sixth extinction." Yet Zimov's catastrophic vision of the past grounds his environmental practice; it does not provide an opportunity for mourning and elegy, but rather proffers a fundamentally hopeful ecological vision for the future. In subsequent sections, I characterize this hopeful response to the Anthropocene along three different practices and theoretical discourses the reserve intervenes in: first in terms of "rewilding," then in terms of "de-extinction," and finally in terms of "geoengineering." Although these practices differ substantially in their attitudes toward the presence of humans in the natural world, they all constitute a "gradualist" response to global warming, in the sense that they are intended to solve issues of planetary significance over relatively long periods of time.

In conclusion, I argue that Pleistocene Park's unique intervention into the Anthropocene should be seen as valuable, not because it resolves the contradictions of the Anthropocene, or merely lays them bare, but rather because it opens contemporary environmental politics to the geohistorical imagination. Zimov's knowledge of deep history informs his environmental practice in several ways: he recognizes the impact that humans have had on ecosystems in the deep past; he is interested in resurrecting past ecologies that have proven stable for thousands of years; he understands Pleistocene Park as an intergenerational activity; and he recognizes the ways in which the Pleistocene epoch is very much still with us, and that the past is not really past. Such practices allow us to see Pleistocene Park to be an instance in which deep history meets up with green political impulses. The politics of the reserve do not derive from its intention to form a new community of humans—it is not a traditional utopia in that sense. Nor is it strictly a posthuman political endeavor, in which human problems are dealt with via the extinction of humans themselves. It is political in the sense that it is a space that attempts to take the agency of humans and nonhumans seriously, and that attempts to alter an ecological situation that will inevitably impact the lives of people all over the planet into the deep future.

In the broader arc of "Our Ice Age," then, this chapter traces how the geohistorical imagination—and the ice age more specifically—can inform particular kinds of environmental politics. Like the chapters in Part One, which have focused on the narrative challenges of imagining geological history, this chapter takes into account catastrophist and gradualist narratives. In contrast to those chapters, my analysis of Pleistocene Park focuses on how these narratives and timescales resolve into human ecological practices. We are not accustomed to thinking about our planet's deep past for the purposes of environmental activities. As Jedediah Purdy has argued, an "environmental imagination" has guided human efforts at shaping the natural world: environmentalism is concerned with the ways in which humans might fit in more harmoniously with the contemporary nonhuman world.[9] But Pleistocene Park awakens our sense of attachment to the past, and our sense that the deep past can make an impact on the future of the climate crisis.

4.1 Consider the Mammoth

Pleistocene Park as an institution is grounded in Sergey Zimov's catastrophic narrative about the planet's relatively recent ecological past. This particular story centers on the decline of the woolly mammoth at the end of the ice age, the causes of that decline, and its consequences for ecosystems in the Northern Hemisphere. The mammoth's story, as Zimov tells it, fundamentally alters our common conception of extinction and our sense of when the Anthropocene properly began. This story also shapes Pleistocene Park's attempt to return the ice age ecosystem to the present and

[9] This is true despite the fact that deep history already informs the way that climate politics is discussed today. That we can even talk about an optimum temperature for humans to live in; that we can speak of a record of historical climates; all of that is a product of our knowledge of deep history. See Archer and Stager. See Purdy's preface and introduction in *After Nature*.

informs at the deepest level Zimov's sense of the future potential of Siberian ecosystems. The woolly mammoth is one of the few mammals Zimov has as of yet not returned to Pleistocene Park, yet this animal—extinct for nearly 4,000 years—occupies its center stage, and it remains a crucial element of Zimov's vision for the future of his park.

The woolly mammoth has long been an important figure in the human cultural imagination, from its prominence in Upper Paleolithic cave art and artifacts and its status in European and Siberian myths to its prominence in the *Ice Age* films, a franchise that has ballooned into a total of five films, several short films and theatrical plays, and over a dozen video games.[10] Unlike other prehistoric creatures, we know a comparatively large amount about woolly mammoths.[11] Mammoths, contrary to common assumptions, are not the ancestors of contemporary elephants in Asia and Africa, but they did evolve along a separate line in the same family tree. Mammoth origins can be traced back about fifty-five million years, when a group of mammals called the "proboscideans" emerged, all of which are characterized by the feature of a trunk. The first mammoths evolved from this line about 5 million years ago in Africa, and then spread around the northern hemisphere. "Ancestral" mammoths lived in Europe about 1.5 million years ago, were not hairy, and probably fed on trees and

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[10] Lister and Bahn 114. Mammoth bones were also used to form anvils, tools, and even dwellings (113). There are over 500 distinct representations of mammoths in Paleolithic art, ranging from cave paintings in 46 different sites to engravings on bones, ivory, and stone and carvings.
[11] We know a great deal about the woolly mammoth because so much of them was preserved, including skin, stomachs, and dung. We also have records of mammoths from prehistoric humans. And we also have modern elephants. (BL 78).

shrubs, rather than grass; "Steppe mammoths" roamed Europe about 600,000 years ago; they ate grass and probably started to develop fur. Woolly mammoths—the central object of Zimov's attention—evolved from these creatures, emerging about 400,000 years ago in Siberia and spreading across much of the northern hemisphere, becoming most widespread about 50,000 years ago.[12]

The woolly mammoth is distinctly a creature of the ice age. Transformations in climate originally encouraged the emergence of the woolly mammoth from the older mammoth forms that lived in warm forests; the woolly mammoth was well adapted to the ice-age cold and the relatively dry grassland ecosystem called the "steppe," which it shared with an enormously diverse group of mammals including bison, horses, woolly rhinoceroses, giant deer, cave bears, reindeer, and musk oxen.[13] Mammoths were herbivores, eating grass, flowering herbs, shrubs, and tree parts, and so were suited to grazing among the other mammals on the steppe. Unlike modern elephants, mammoths had curved, spiraling tusks, which were used to fight and compete with other mammals, to strip tree bark and dig up shrubs and bushes, and possibly also to clear ice and snow; their trunks, meanwhile, could be used to curl around bunches of grass and pull them

[12] Lister and Bahn 11–13

[13] Lister and Bahn 25–29. Planets in this region would have included various kinds of grasses, as well as "dry-ground sedges, small shrubs, such as Arctic sagebrush, and many herbaceous plants including members of the pea, daisy, and buttercup families" (Lister and Bahn 88). Perhaps to everyone's surprise, there would have been little snow or ice in this space; it was dominated by high pressure systems (Lister and Bahn 88).

up, and to drink water.[14] Mammoths were likely social creatures, just like elephants today, living in matriarchal groups composed of around a dozen females and their offspring.[15] Perhaps most important for surviving the ice age was its thick fur coat, composed of two layers of brown hair, and its small ears and tail, which prevented it from losing body heat in the cold.[16]

Despite their prevalence across an impressive range of the globe, mammoths went extinct on the main continent roughly 10,000 years ago, but a small group of mammoths managed to survive on Wrangel Island in the Arctic until about 4,000 years ago. The cause of their extinction has been a question of serious debate ever since the modern understanding of mammoths emerged at the end of the 18th century, when the French naturalist George Cuvier proposed that the fossils composed a creature similar to, but not the same as, the elephant.[17] Cuvier's hypothesis was proved shortly after, when a mammoth—the so called "Adams mammoth"—was discovered fully intact, with some of its fur, in 1799 and subsequently investigated in 1806. This was definitive evidence that the mammoth was distinct from the elephant, and also strong evidence

[14] Lister and Bahn 78 and 95

[15] Lister and Bahn 100. Males would tend to live alone until it was time to mate.

[16] Lister and Bahn 86

[17] It was initially assumed, by Siberians who found them defrosting, that they were animals still living underground, and that they perished when exposed to the surface air. Meanwhile, Europeans often thought that large unearthed bones came from giants, and were displayed in a variety of locations like castles, palaces, and churches. It wasn't until 1613 that these bones were attributed to being from an elephant (by a man named Riolan), although that itself raised questions about what elephants were doing in Europe and Siberia, prompting a series of fantastic explanations: that they were brought by Hannibal's army, or that they had been carried by the Biblical Deluge (Lister and Bahn 48–50).

that the mammoth was extinct, as no one had discovered a living one.[18] Cuvier initially assumed that mammoths must have become extinct because of climate change, an opinion that was developed more thoroughly by his student Louis Agassiz, whose work on ice ages we encountered in chapter one. In *Studies on Glaciers*, Agassiz suggested that mammoths perished in the oncoming "glacial epoch" that froze them solid.[19]

Agassiz's theory proved to be incorrect—woolly mammoths were well-adapted to the cold environment—yet the idea that they were brought to extinction by climate change survives today: only now, with a better understanding of the climate history of the Pleistocene, it is thought that global warming, rather than global cooling led to their demise. The theory suggests that, at the end of the Pleistocene, the world began to warm substantially; the cool and dry Pleistocene climate was replaced by a relatively warm and wet Holocene one. Just as this warming enabled humans to begin practicing agriculture, it also caused grassland vegetation to transform into forests and snowy tundra, which were unsuited to the mammoths' survival.[20] The tundra could support lichen and moss, and animals that feed on them, while the new forests could support moose. But neither were appropriate for the mammoth.[21]

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[18] 1799 Ossip Schumakhov, a Tungus ivory collector, discovered a frozen mammoth. Shumakov sold the tusks (Lister and Bahn 51). Mikhail Adams, associated with the Russian Academy of Sciences, then went to investigate the carcas himself in 1806. The skeleton of the Adams mammoth was reassembled in 1808, and it stood about 10 feet tall, 16 feet long, a male who died around age 45.
[19] See Agassiz, *Studies on Glaciers* 167–168
[20] Lister and Bahn 156-157.
[21] "In this way," Adrian Lister and Paul Bahn write, "the mammoth steppe was replaced by landscapes of boggy tundra in the north and coniferous forests in the south (157).

Yet Paul S. Martin has suggested that this climate-driven explanation for the extinction of the mammoth is misguided. Martin observed that there were major climate cycles throughout the Pleistocene, and yet none of them eliminated the mammoth in the past; moreover, he argued that the climate theory failed to explain the many other "megafauna" extinctions that took place alongside the mammoth.[22] Martin proposed instead that the mammoth's extinction, and indeed the entire megafauna extinction event in the late Pleistocene, was actually caused by the spread of humans. Such a proposal would have been unthinkable at the time of Cuvier and Agassiz, when it was assumed that humans and mammoth were from distinct periods of history.[23] But today this anthropogenic model is entirely possible, given our knowledge of the extensive overlap of mammoth and human history starting roughly 35,000 years ago in the Upper Paleolithic. Martin's theory of anthropogenic extinction explains the near-perfect coincidence of human arrivals in North America and Australia with the disappearance of large mammals, including the mammoth; human hunting also explains why only

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[22] See Martin's *The Twilight of the Mammoths*; see also Lister and Bahn 159–160.

[23] It was long thought that humans and fossil animals could not have coextend at any point, but when more and more stone tools were discovered with the remains of extinct animals, this became a questionable belief. The definitive evidence that humans co-exited with mammoth came in 1864, when Edouard Lartet, a French paleontologist, discovered a lifelike engraving of a mammoth on a mammoth tusk (Lister and Bahn 116). The mammoths relatively recent demise may be remembered by its proximity to human history: there were still mammoths roaming Siberia as the pyramids were being constructed. There is no real reason to be surprised by this; and yet this fact seems to be jolting precisely because of the jumble we experience when contemplating deep history, when it seems like humans, mammoths, dinosaurs may very well have all coexisted at once.

large mammals were affected by this extinction event, rather than the rest of the biosphere.[24]

Sergey Zimov's own theories about the mammoth add yet another layer of complexity to this catastrophic narrative. For him, the extinction of the mammoth was not merely an unfortunate event for those specific animals; it also had severe consequences for the biosphere to which the mammoth regularly contributed. In his June 2005 paper in *Science*, he argued that the extinction of mammoths by humans had an impact not only on the species itself, but also on the broader steppe ecosystem.[25] Zimov suggested that the disappearance of the steppe ecosystem was a direct result of the disappearance of the mammoth:

> In the mammoth ecosystem, the collective behavior of millions of competitive herbivores maintained the grasslands. In the winter, the animals ate the grasses that grew the previous summer. All the while they fueled plant productivity by fertilizing the soil with their manure, and they trampled down moss and shrubs, preventing these plants from gaining a foothold. It is my contention that the northern grasslands would have remained viable in the Holocene had the great herds of Pleistocene animals remained in place to maintain the landscape.[26]

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[24] There are problems with this theory as well, and so the scientific community is still unsure. Challenges to the theory, as Martin notes, include the fact that there is little direct evidence linking humans to mammoth hunting (148); humans were in Europe long before the extinction even took place; moreover, the Clovis people were not likely the first people on the Americas (154); it is generally rare to find people completely wiping out their prey, except on islands, because hunters generally switch to another animals when their main target becomes scare (154–155). To my mind, having reviewed some of the evidence, it seems reasonable to suggest that the mammoth's extinction probably concerned a combination of both "factors," climate change making mammoths more vulnerable to human hunting.

[25] Elsewhere, Zimov describes his theory as the "ecosystem hypothesis" as opposed to the "climatic hypothesis." See "The Past and Furture of the Mammoth Steppe Ecosystem" 200.

[26] Zimov 798

For Zimov, mammoths made their ecosystem: their particular diet helped reproduce the grassland. Mammoths demolish the trees and enable grassland to grow. When they disappeared, so did their habitat. Thus the mammoth's extinction by humans was essentially an ecological catastrophe for the steppe, as it allowed forests to slowly reconquer the steppe ecosystem. Indeed, Zimov tells a compelling and disquieting story about human history and its relationship with the grassland steppe:

> In the Pleistocene, grassland ecosystems occupied about half of the world's land mass. *Homo* species emerged in these pasture ecosystems, where they left tools, weapons, cave paintings, and other signs of their presence. Starting with unpretentious ambitions to survive in a hostile environment, *Homo* ended up assuming the powerful role of ecosystem terminator. The mammoth ecosystem was the first large-scale victim, but the global destruction of grasslands only accelerated in the Holocene when people invented agriculture and began raising cattle.[27]

Zimov's account is that of a catastrophe; the loss of the mammoth and its ecosystem is a story of decline, complete with an arc of apocalyptic collapse. There is a "victim" and "terminator," one passing into history, the other forming the basis for the present. In this passage in particular it is clear that Zimov is not assigning anything like conscious menace to the humans, whose simple "ambition" was surviving the ice age. But there is a clear sense in which humans have risen from a state of survival to one of dominance; but unlike the broadly modernist narratives that typically describe human social

[27] Zimov 797

development, Zimov labels humans as an "ecosystem terminator," a title embraced only more fully with the development of agriculture and pastoralism.

In a moment of the "sixth extinction," this rewriting of the history of extinction and ecosystem change should give us pause, because the mammoth's history reshapes the common understanding of extinction. For although the form of Zimov's story remains similar to other extinction stories that have come to dominate the media, in the sense that it is based in catastrophe, loss, tragedy, decline, and to a certain extent, mourning for the extensive loss of biodiversity, the content is different.[28] Zimov's thinking does not eschew the typical tragic mode of extinction narratives, other words, but it pushes it backward in time. We are often made to believe that the problem of anthropogenic extinction is exclusively modern; this is to say that only we moderns, with our fossil fuels, industrialized agriculture, and urban spaces are the cause of extinctions. Before we came along, we have come to think, extinction occurred, but only

[28] This sense of mourning is perhaps most visible in Paul Martin's book. Martin's *Twilight of the Mammoths* an immense sense of mourning for megafauna extinction, similar to the sense of mourning demonstrated in other kinds of texts on extinction but extended, the web of human empathy moving into the deep past: "For starters, it is time to mourn our dead. The extinction of a few dozen species in North America in near time is trivial in a global fauna of unknown millions. What hurts is the quality of the losses and their late occurrence. The emotional impact of extinction of large warm-blooded mammals, species so late in the fossil record and so much like us, is extreme. The same can be said for flightless rails and megapodes or native pigeons (Ducula) on oceanic islands. Our world is far poorer for the lack of these creatures, and their loss is profoundly important, not only a tragedy to mourn but an event to commemorate. We need a Megafauna Extinction Day." (213) Martin's call here at the end of his book illustrates the way that our typical attitude toward contemporary extinction in the Anthropocene can easily be extended into the past, even when the memory of the actual extinction event has all but disappeared, and the visceral feeling of guilt and sadness are also no longer genuinely possible to recover. Although the affect is gone, Martin is looking for us to recover an intellectual sense of the loss. Typically our mourning concerns only the species that have recently gone extinct, for which we seem to have absolute knowledge that they were caused by us. Yet Martin articulates a form of sorrow for a creature long extinct.

naturally, caused by some unfortunate event like the meteor that killed off the non-avian dinosaurs. Such a belief plays naturally into what Ursula Heise refers to as the classic "story template" for environmentalism: that "modern society has degraded a natural world that used to be beautiful, harmonious, and self-sustaining and that might disappear completely if modern humans do not change their way of life."[29] The rhetoric of extinction reporting and scientific articles implicitly places the blame consistently on modern human practices, therefore implying that these events would not happen without them.[30] But the history of the mammoth challenges this seemingly obvious assumption; it decisively disrupts our essentially Rousseauian desire to see the human past as fundamentally better than the present, especially in the way that humans relate to their environments. While it is certainly true that paleolithic people lived in a much greater equilibrium with their ecosystems, it is not the case that it was a perfect Edenic harmony. Human-caused extinction has a deep history.

In a more expansive sense, Zimov's conception of history also complicates our sense of the Anthropocene's beginnings. Zimov's story changes how we see landscapes like the American plains and Siberia that appear to be "natural" and "wild." Both, according to this theory, are essentially impoverished landscapes, post-apocalyptic ruins that have endured a serious catastrophe. When European explorers thought they were

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[29] Heise 7

[30] See Elizabeth Kolbert's *The Sixth Extinction*, published in 2013, which moves on a kind of tour through the world of the sixth extinction, in which various forms of human activity, from pesticides and agricultural development to overhunting have decimated global animal populations.

seeing "nature" and "wilderness" in America for the first time, what they were really seeing was a landscape that had in essence already gone through immense human changes.[31] In contrast to the story of the Anthropocene, which situates modern humans at the center of a downfall narrative (starting with colonization, industrialization, or the Great Acceleration in the 1950s), this particular narrative locates human environmental destructiveness far earlier at the end of the Pleistocene. This tells us that the "end of nature" might have happened thousands of years before traditional start dates for the Anthropocene.[32] Thus this narrative of human destructiveness poses a challenge to those particular Anthropocene narratives that see only modern human developments as "the end of nature." Here, then, catastrophic geohistory disrupts some of the more comforting versions of the modernity story that we want to preserve.

4.2 Rewilding and Ecological Resurrection

Zimov's theory is not merely a contribution to the periodization of geohistory, or a recasting of the destructive role of humans in the environment, because he also aims to reverse the historical trend inaugurated by human migration through actively restoring

[31] "Prehistorians," as Martin explains, "find that any given land begins to lose its wilderness not when the first Europeans arrive, but when the very first humans do. In the Americas true wilderness was more than 10,000 years bones by the time Columbus reached our shores. It disappeared with the megafauna, awhile calls gave voice to the forest and prairies." (183).

[32] Ursula Heise notes a similar point. Indigenous people resahped environments long before European colonization (9); this makes it harder to want to restore landscapes and ecologies before Europeans arrived, because that wasn't pristine either (9). Thus McKibben's idea of the end of nature today seems like a "retrospective misperception." Heise writes that "Nature never really was separate from human society; it appears untouched only to those who did not know, or did not want to know, how much indigenous people had transformed it it long before European arrival" (10).

the grassland environment. What I want to suggest in this and the following two sections is that Zimov adopts an ecological practice that is fundamentally "gradualist" in the sense that it does not aim for relatively rapid fixes to the problem of global warming, but rather for solutions that will develop over deep time. These practices—gathered under the categories of rewilding, de-extinction, and geoengineering—are by no means uniform, however: at a philosophical level, these practices contradict one another over the question of human dominance in the environment.

Zimov has established Pleistocene Park as a space where hunting and development are prohibited. Beside Zimov's science station and the park's minimal fences, no other signs of human presence are visible. The park is not a zoo, a space designed to move visitors and tourists through a collection of disparately organized animal habitats: one plot for the lions, one for the giraffes, another for the monkeys, and so on. We are not, in other words, facing an ecological effort akin to *Jurassic Park*, in which dinosaurs are returned for the purpose of entertainment and commerce. Pleistocene Park, rather, is best understood as a "rewilding" project, which draws on the ideas and practices of conservation but embraces a geohistorical, rather than environmental, imagination.

Conservation as a particular human activity has its specific origins in the industrial revolution, when the desire to preserve "wilderness" regions emerged in the face of rapid anthropogenic human environmental changes. Western people began to perceive that humans had begun to endanger nature; it was no longer a particular threat or an unending bountiful resource requiring no human intervention.[33] Conservation is typically discussed as a US initiative, with the emergence of Yellowstone National Park in 1872 and the National Parks Service in 1917, yet there have been, and continue to be, countless other efforts across the planet.[34] In the present context, it is worth briefly mentioning Russian conservation, which began in January 1917, as Tsar Nicholas II created the nation's first *zapovednik* or "strict nature reserve," near Lake Baikal in Siberia. The reserve was designed to protect the Barguzin sable, a small mammal with luxurious and desirable fur. The reserve proved successful, and now there are an additional 102 similar reserves throughout Russia. These reserves, in contrast to US spaces, have little interest in providing a space for recreation; Russian laws view the space as completely banned for humans; the parks were not designed to be visited. Russia's natural wealth was to be left entirely alone. The International Union for Conservation of Nature for example places Russian *zapovedniks* in the highest protection categories because of their strict limitations.[35]

Although there are substantial differences between Russian and US conservation efforts—and other conservation efforts around the world—the principle idea remains

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[33] Heise 6. It is unsurprising that this is also one moment that has become important for efforts to periodize the Anthropocene.
[34] Purdy discusses U.S. conservation in *After Nature*, 153–187. See Heise for a discussion of conservation efforts around the world.
[35] See Conant. For a conceptual discussion of the origins of the zapovedniks, see A.A. Chibilev's article.

the same: the preservation of landscapes, ecosystems, animals, and nature in general as it is without human intervention.[36] It is based on the idea of a nature that exists apart from humans, that it preserves its authenticity and essence only if it is kept apart from human constructions of space, whether they are roads, homes, skyscrapers, malls, telephone and electric lines, and so on. Yet, for theorist Jamie Lorimer, conservation moves between viewing nature as something to be left alone and something that should be managed closely.[37] Traditional conservation—what Lorimer calls "conservation as composition"—sees landscapes as "fixed and timeless places;" the past is good, change is bad, and the future is not particularly important or relevant. Order and management are valued; ecological transformations and surprises are not. This form of conservation seeks to "rationalize nature" in order to "maximize the production of biodiversity."[38]

Although traditional forms of conservation remain an active and important global environmental activity, there is general enthusiasm for the new practice of "rewilding" taking place across the international conservation community, especially in

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[36] Ursula Heise has observed that "biodiversity conservation turns out to be a matter of culture, history, and politics ore than of biological science" (92). Russian conservation is no exception to this rule.
[37] "Traditionally, and still most commonly, conservation is reactive. It seeks to preserve a fixed Nature from modern, urban, and industrial Society by enclosing it in National Parks. These take the form of prehistorical "wilderness" in North America and much of Africa and South Asia or premodern countryside in Europe. This involves a combination of natural science and romantic iconography. It conjoins aristocratic patronage and state and civil society bureaucracy. Increasingly, though undoubtedly ambivalently, conservation is embracing the market. The past twenty years have seen the proliferation of financial, administrative, and biological technologies for commodifying Nature— from - ecosystem services to ecotourism to gene banks. Under the guise of naturalism or mastery, both of these approaches seek control over human and nonhuman life."
[38] Lorimer 95

Pleistocene Park.[39] Rewilding emerges in opposition to the standard form of conservation. By contrast, it shifts temporal scale of its imagination, the burden of human labor, and the object of its attention. In the first instance, rewilding shifts the temporal focus of traditional conservation. Where traditional forms of conversation focus largely on premodern landscapes—in the case of the United States for example this essentially means before European invasion and settlement—rewilding concentrates on reviving prehistorical landscapes. Rewilding projects, as Lorimer explains, "share a desire to shift the target baseline for conservation away from premodern agricultural archetypes toward the prehistorical ecological conditions that characterized the northern hemisphere at the end of the Pleistocene."[40] In this way, we might suggest that traditional conversation has an ecological imagination, whereas rewilding has a fundamentally geohistorical imagination.

Second, like the more extreme forms of Russian conservation, rewilding has an essentially anti-human component; it refuses management or human involvement to the greatest possible extent. Where conservation often places humans in the position of power, as if they were some godlike form over a specific area, rewilding views humans more as an absent god, a deist practice like a watchmaker: the environment is set to move all on its own. Rewilding in this sense refuses some of the more "biopolitical"

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[39] Lorimer 100. See Weisman and Monbiot for popular accounts of rewilding.
[40] Lorimer 100

tactics employed by conservation—various forms of census taking and monitoring, and an obsession with populations.[41] But it necessarily cannot ignore them completely, for the simple reason that some forms of human activity must be undone.

Finally, such change in the attitude of human involvement reflects a similar movement from the concepts of population and species in conservation to a focus on ecology and evolutionary processes in rewilding. Conservation often distinguishes itself from pure animal rights activism by its focus on the species as a whole, rather than on individual animals.[42] Rewilding makes a similar leap in focus: rather than addressing "species and habitats," it focuses on "ecological processes and function."[43] Rewilding will tend to focus on entire ecosystems, or as Lorimer puts it, "the delivery of ecological functions—grazing, predation, and decomposition, for example."[44] It aims at restoring "ecological process that are absent from contemporary landscapes," as Lorimer puts it elsewhere.[45]

Pleistocene Park fully embraces the practice of rewilding, as Zimov makes clear in his unfinished "Wild Field Manifesto." Pleistocene Park's sense of temporality, as we

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[41] See Lorimer 57-76.
[42] Heise 134-135
[43] Lorimer 78
[44] Lorimer 186. Lorimer bases this description of rewilding on the OVP: "Here, the integrity and even persistence of a species is secondary to the flourishing of an ecology. While the machair landscapes of the Hebrides are managed for corncrakes, the wild cows of OVP are introduced to manage a dynamic landscape. Animal advocates concerned with the welfare of the large herbivores at OVP and ecotourists and filmmakers after touching encounters focus on the individual animals that comprise a species or herd. Here, the suffering of an individual is primary to the flourishing of a species or its ecology" (186).
[45] Lormier 100

have seen in the last section, is substantially different from typical conservation efforts. Zimov is primarily interested in returning the mammoth steppe region to its state prior to human intervention 10,000 years ago. Zimov's speculative manifesto makes this historical perspective even more clear: it begins by theorizing the evolutionary struggle between plants and herbivores over hundreds of millions of years, an interaction that lead to the development of poisons by some plants, but also to the emergence of grasses and other "pasture herbs" that were designed to be eaten by mammals. Humans, unable to digest grasses themselves, functioned as scavengers in this ecosystem for thousands of years, until they turned to hunting the ecosystem's mammals or domesticating them. This shift, in which "former cleaners and scavengers became the main and only masters" of the ecosystem, eventually lead to the destruction of the steppe ecosystem.[46] Zimov hopes to restore this ecosystem.

The role of humans in Pleistocene Park in restoring this ecosystem is complicated. In Zimov's understanding, this particular ecosystem cannot be conserved; the steppe environment needs to be remade. Initially, such a process begins with the hard labor of clearing out trees and marshes to allow the grassland to regrow, a process that the Zimovs have accomplished so far with a Soviet rover that has been repurposed to bulldoze trees and shrubs. Yet the process of rewilding will also require the active reassembly of the land's mammals, which must be collected from many different parts

[46] Zimov, "Wild Field Manifesto"

of the northern hemisphere. As the process of ecosystem restoration unfolds, however, Zimov has little intention of interfering with the animals. Once they have arrived, as he writes, "the animals will remember how to live with each other themselves. They will divide pastures and occupy all ecological niches according to their professions. It is their job to self-regulate density; the weak will die, the strong will re-populate, the ecosystem assemblage will stabilize and, then, will be ready to reintroduce into new territories."[47] Zimov's ideal is to allow for natural selection, free from human interference, to regulate the park's wildlife, an unthinkable practice for most managers of conservation cites and reserves. Indeed, Zimov seems certain that such a practice of non-interference is in fact necessary for the steppe ecosystems return; "Right now," he writes, "we are not capable of constructing new ecosystems. But components of pasture ecosystems are capable of self-construction and evolution."[48] In this sense, Zimov's project is profoundly against conservation: a conservationist would want to preserve the taiga as it is, without any interference. Zimov wants to destroy it. His aim is to revive an ecosystem, rather than to preserve one.

As for the Park's view on animals, given Zimov's effort to return the mammoth to its pre-human ecosystem, it is tempting to think of Zimov as a radical animal rights activist. Yet Zimov has little interest in the individual animals themselves; his aim is not

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[47] Zimov, "Wild Field Manifesto"
[48] Zimov et al., 221

to care for any individual creature. Nor is he truly occupied, as a conservationist might be, with the survival of a particular species like the woolly mammoth: his interest lies more in the particular function of the mammoth in its ecosystem than in the species itself. Mammoths are a means to rewilding the steppe more efficiently and widely; Zimov has said that in order for the project to reach its full scale, mammoths will be necessary.[49] This is because mammoths, like living elephants, unceremoniously crash into trees and bushes, knocking them over, crushing them so they cannot regrow, thereby making room for the grasses that they eat to spring up. It is for this reason that Zimov consistently emphasizes that "the pasture ecosystems must be recreated," rather than that its particular animal species must be preserved at all costs.[50]

Although Pleistocene Park has been met with some skepticism by scientists, its rewilding effort has thus far received little direct criticism. But rewilding more broadly has received a number of important criticisms. Most prominently among humanists, Ursula Heise observes that rewilding projects tend to merely look backward. We would be better off, she argues, thinking about futures in which human interventions into the environment are embraced, even if we simultaneously attempt to ward off their most destructive tendencies. Heise suggests that rewilding is essentially a nostalgic activity;

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[49] See Zimov's interview in Grant Slater's documentary.

[50] Zimov, "Wild Field Manifesto." Pleistocene Park is, in other words, not about making recompense to forgive "our original ecological sin," as Ross Andersen speculates (82).

whereas the construction of "multispecies" urban centers represents a better way forward in the Anthropocene.[51]

Yet this criticism seems to misunderstand the practice of rewilding. Perhaps most clearly, although rewilding looks to the past, it aims toward the future. The idea of Pleistocene Park is not to create a living natural history museum of reanimated animals for its intrinsic value, or to reproduce the "pristine" wilderness more broadly. It is not, in other words, a project fundamentally built on the idea of a simplistic return to nature. Zimov has no illusions about perfectly reproducing the environment from 30,000 years; he does not imagine himself to be creating an exact replica, something snatched from the past and brought to the present using a time machine. He uses the past as a referent for the present from which to be inspired, rather than a blueprint for the present to be followed precisely. "The aim is to create analogs of what emerged after the retreat of the glaciers and before agriculture, forestry, and animal domestication," as Lorimer explains of rewilding in general.[52] It is to create a living ecosystem that thrived for thousands of years and that could potentially survive far into the future without human interference. According to Zimov, mammoth steppe ecosystems have a high rate of "biocycling," which means that nutrients flow between different parts of the ecosystem relatively quickly. Grass efficiently absorbs sunlight and water, and its growth is actually

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[51] It is ironic that it also works as a space in which the wild functions as a "multispeceis common." (Lormier 116), for this is precisely what Heise envisions for urban centers.

[52] Lorimier 100

stimulated by the grazing and trampling of large mammals; the large mammals, in turn, return the nutrients to the soil. Such a "dynamic" ecosystem, according to Zimov, not only serves as a way to preserve biodiversity, it is also resilient to natural disasters and changing climates.[53]

But in a more speculative sense, it is also important to see that the accusation of nostalgia retains the simple assumption that something has indeed past, and that it must therefore stay in the past. But rewilding sees both the presence of the past, the way in which the past is never really gone in the first place, and the possibility for elements of the past to return to prominence. The past of the Pleistocene is still present in the genetic and biological material of the many animals that Zimov wants to reintroduce into the environment, but also in the grass itself. As Zimov reminds us, "all species of vegetation and animals once inhabiting Wild Field are still present."[54] It is precisely because of this fundamental persistence that the mammoth steppe, given the right conditions, can return again. The moment humans step back, the collective force of the nonhuman world begins to take back over. What rewilding ultimately demonstrates, in this sense, is the resilience of various kinds of nonhuman life, and the temporal insignificance of many kinds of human niche constructions and spaces. As Nikita Zimov has remarked:

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[53] Zimov et al., 216–217
[54] Zimov, "Wild Field Manifesto"

"There is a future of the park expanding regardless of my activity. It's an ecosystem. And it does not need me anymore."[55]

4.3 De-Extinction

Pleistocene Park's rewilding bears the mark of anti-modernism: in allowing the deep past to return gradually over time to a space unimpeded by human spaces with roads, structures, electricity, there is an implicit rejection of those efforts, a desire to limit them in a broader ecological system. Yet Pleistocene Park is more ambiguous than this initial picture might suggest. For the park has dueling impulses, one toward the premodern past—or at least a revival of its analogue—but the other toward the technological future. This is precisely the contradiction embedded in Zimov's desire for the "de-extinction" or resurrection of the woolly mammoth. The concept of de-extinction is relatively new, first appearing in science fiction, but then subsequently introduced to the public in a prominent way in 2013, at a TEDx de-extinction conference organized by Stewart Brand.[56] Fundamentally attached to an "eco-modernist" attitude, de-extinction raises substantial questions about our domination of nature, and about the status of "nature" to begin with.

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[55] Grant Slater "Mammoth," 22 minutes in.
[56] Shapiro xi. The conference presented some of the latest research projects centered around returning currently-extinct species to life, including projects on passenger pigeons, the Lazarus frog, and the woolly mammoth (elsewhere, others are attempting to revive non-animal lifeforms, including the American chestnut, which was decimated by a fungus, and coral, which will struggle with the warming waters of climate change).These talks are available on YouTube.

The process of resurrecting the woolly mammoth is extraordinarily complicated, but it begins with relatively recent advances in the biological sciences and their ability to intervene in the DNA of plants and animals. The consequences of the mammoth's particular habitat is that, unlike other extinct creatures, they are exceptionally well-preserved, and are not particularly rare.[57] As mammoths passed into extinction, they left traces of themselves all across Siberia, remaining frozen for thousands of years after dying. These mammoths did not die in some gigantic climatic catastrophe, as Agassiz thought, but rather of mundane causes: the remains we find tend to be from animals that died from falling in a mudflow or being trapped in a marsh or sink hole.[58] Mammoths were originally discovered in the 19th century precisely because they were preserved in this way, until the ground melted just enough to allow the frozen bodies to be revealed. For much of the 19th and 20th century, mammoth preservation was strictly useful for the purposes of anatomical evidence, for reconstructions of how mammoths perished, and for understanding what they ate, as food had sometimes been preserved in frozen mammoths. Today, their exceptional preservation has an even more useful goal in the biological sciences: since mammoths were frequently maintained so well, mammoth DNA has also been preserved in the ice—the first extraction of mammoth DNA occurred in 1977.[59]

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57 Lister and Bahn 46
58 Lister and Bahn 50
59 Lister and Bahn 57

It might initially seem possible that, since mammoth DNA has been preserved, it will be possible to simply "clone" a new mammoth, just as Dolly the Sheep was famously cloned in 1996. But as Beth Shapiro, a professor in ecology and evolutionary biology at UC Santa Cruz, outlines in her detailed book on mammoth resurrection, the preservation of mammoth DNA hardly means that an exact, authentic mammoth can be returned to life as it was thousands of years ago through cloning. It is, perhaps to our great disappointment, scientifically impossible for the simple reason that there are no living cells that can be collected for the purposes of cloning.[60] It is impossible to simply clone a mammoth in the way that a living animal might be cloned—preserved DNA alone cannot result in a viable cell.

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[60] Shapiro 11. It is in this sene that Shaprio advocates for us moving away from a species-oritented view of resurrection: ""This provides an opportunity to redefine de--extinction, shifting away from a species--centric view. Genetically pure mammoths, or genetically pure versions of any extinct species, are likely not possible. However, we do not need genetic purity to benefit from de-- extinction technology. If we select wisely which 1 percent of the genome to change, we may be able to resurrect those characteristics that distinguish a mammoth from an elephant. More importantly, we may be able to resurrect those characteristics that allow the elephant to live where the mammoth once lived. Once released into the wild, the hybrid elephant could stomp around, knocking down shrubs and consuming vast quantities of vegetation. It could disperse seeds and insects and distribute nutrients. This new hybrid animal could replicate the mammoth, without necessarily being a mammoth, with vast potential benefits to the arctic ecosystem.This provides an opportunity to redefine de--extinction, shifting away from a species-- centric view. Genetically pure mammoths, or genetically pure versions of any extinct species, are likely not possible. However, we do not need genetic purity to benefit from de-- extinction technology. If we select wisely which 1 percent of the genome to change, we may be able to resurrect those characteristics that distinguish a mammoth from an elephant. More importantly, we may be able to resurrect those characteristics that allow the elephant to live where the mammoth once lived. Once released into the wild, the hybrid elephant could stomp around, knocking down shrubs and consuming vast quantities of vegetation. It could disperse seeds and insects and distribute nutrients. This new hybrid animal could replicate the mammoth, without necessarily being a mammoth, with vast potential benefits to the arctic ecosystem." (130)

But there are other ways of potentially reviving the mammoth, including the process of selective breeding, which humans have been doing for thousands of years.[61] But, according to Shapiro, the more plausible method of resurrection, derived from the field of synthetic biology, will involve the process of "editing" the DNA of an Asian elephant and subsequently cloning the new creature. This is precisely what George Church, a geneticist at Harvard, is working on, and it is the prominent effort to bring the mammoth back. Here is how Shapiro explains the process, in perfectly straightforward language that obscures the difficulties she will emphasize later in the book:

> First, we find a well-preserved bone from which we can sequence the complete genome of an extinct species, such as a woolly mammoth. Then, we study that genome sequence, comparing it to the genomes of living evolutionary relatives. The mammoth's closest living relative is the Asian elephant, so that is where we will start. We identify differences between the elephant genome sequence and the mammoth genome sequence, and we design experiments to tweak the elephant genome, changing a few of the DNA bases at a time, until the genome looks a lot more mammoth-like than elephant-like. Then, we take a cell that contains one of these tweaked, mammoth-like genomes and allow that cell to develop into an embryo. Finally, we implant this embryo into a female elephant, and, about two years later, an elephant mom gives birth to a baby mammoth.[62]

This sounds simple enough, but there are a host of scientific and technological barriers to the success of this process. Even if a well-preserved specimen is discovered, the DNA is not likely to be complete, as it deteriorates over time just like any other material

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[61] See Shapiro, Chapter 5.
[62] Shapiro 11–12

substance. Moreover, in any given sample, there will inevitably be DNA from bacteria, fungi, insects, plants, mice, dogs, and humans, and anything else that might have come into contact with the remains as it defrosted.[63] Furthermore, even after the genome is mapped, elephant eggs would need to be modified, and they are not particularly easy to acquire. After that, an Asian elephant would need to devote two years of its life for the gestation period, which itself could involve a number of complications, especially since elephants do not necessarily survive well in captivity.[64] Mammoths would then face the difficulty, raised in captivity, of learning how to survive in the wild, and learning the behaviors of the heard. And finally, if the end-game of resurrection technology is the emergence of a self-sustaining herd that can live in the wild, the population itself becomes a challenge, as the gestation period of an elephant, the population itself would take an enormously long time to build up. Overall, then, this is a process that is likely to take a long time to come into being. There is good reason to believe that, despite the impressive progress of the science of genetic engineering, a herd of mammoths is quite far off.[65]

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[63] Shapiro 63

[64] See Shapiro, Chapter 9.

[65] Pilcher writes: "Suppose Church perfects all the methods that he needs and makes a viable hybrid 'mammoth' embryo in the timescale he imagines. It would then take a further two years for that embryo to turn into a calf, and another 15 years for it to reach sexual maturity. Even if all the technical hurdles involved in making a mammoth were overcome tomorrow, it would still take well over half a century to make a single viable herd, which would not be anywhere enough to do the job."

Nonetheless, it is worth considering the enormously strange questions the process of de-extinction or resurrection raises. Practical scientific questions, of course, immediately raise themselves: Where would they live? Could this revive dangerous diseases and pathogens from the past? Would resurrected species destroy ecosystems that are currently thriving? Would this divert funding away from conservation efforts for contemporary species that are in danger, like the Asian elephant itself? Would de-extinction serve as an excuse for people to no longer worry about the rapid forms of extinction currently taking place? At the level of ethics, the questions are even more unsettling. What would their quality of life be in a world that left them behind? Would it be fair to the animals, bringing them back into a world they no longer know, in which they no longer have a particular niche? Producing a woolly mammoth would require experimentation on a modern-day Asian elephant—what justifies the subjection of an animal to that potential danger? De-extinction toes the line between animal rights and ecology: the rights of some living animals would be sacrificed in order for a new ecological moment to be achieved.[66]

Particularly important for our purposes here are the questions that de-extinction raises that I have gathered under the notion of the Anthropocene at the beginning of this chapter. On the one hand, de-extinction raises concerns about the "domination" of nature. Here, the domination of nature takes on a very different color; where in

[66] See Riederer

environmentalist discourse we are more accustomed to thinking about the domination of nature in terms of large-scale alternations to landscapes and ecosystems, here the domination of nature takes place at the level of genetics, and inside the space of laboratory.[67] It is not about cutting down trees, redirecting rivers, remaking fields to suit the needs of agriculture, but rather about reformatting biology at the level of the genome. Ethics reenter this discussion the moment we attempt to decide whether this power is good or evil, which is to say the moment the ethical binary rears its head. Resurrecting extinct species, including the mammoth, would represent a considerable expansion of human power over life: for the religious, this could appear to usurp the powers of divinities, but for environmentalists, this might appear to be a form of Icarus-like hubris, a great overreach of our capabilities that will inevitably backfire. Some however view the expansion of human power as a fundamentally beneficial process, like Stewart Brand, quite clearly part of the same "ecomodernist" approaches to the environment as others who envision the Anthropocene to be a good thing.[68] For these eco-modernists the act of "playing God" is not particularly different in "kind" from what we normally do, only in scale: we have been acting like gods over the earth for a

[67] See for example John McPhee's *The Control of Nature*.
[68] Beth Shapiro herself encapsulates this modernist vision quite nicely: "This, I believe, is why people like me are so captivated by the idea of de-- extinction. Not because it is a means to turn back the clock and somehow right our ancestors' wrongs, but because de-- extinction uses awesome, exciting, cutting-- edge technology to take a giant step forward. De-- extinction is a process that allows us to actively create a future that is really better than today, not just one that is less bad than what we anticipate." (207)

long time, and it is best that we acknowledge that role, however unenviable it may be, and do it well.[69]

Meanwhile, de-extinction also raises questions about what we might be able to call "nature" in the first place. If we call "natural" that which precedes humans, or that which has been free of conscious human interference, itself already a problematic binary, then the mammoth we would have in Pleistocene Park is mostly certainly not natural. Just as the mammoth ecosystem cannot itself be brought back in precisely the way it was in the Pleistocene, neither can an "authentic" mammoth be brought back to life. Even if the process of resurrection is successful, we will not have truly brought back the past in the form of a genuine, authentic, "natural," mammoth: we are dealing, as Shapiro observes, more with the resurrection of individual "traits" than with the return of an entire species.[70] Reviving the woolly mammoth would essentially consist of altering the DNA of Asian elephants, adapting them to be mammoths by adding a dense

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[69] Again, here is a useful statement by Shapiro: "In the specific case of de-extinction, the accusation of playing God concerns human manipulation of nature. By engineering new organisms, by altering the structure of biological communities, and by altering the course of today's extinction trajectory, we are messing with things that we simply don't understand and therefore probably shouldn't be messing with. Importantly, de-extinction does not mark the beginning of human manipulation of nature. With the earliest attempts at domestication of gray wolves in Europe some 30,000 years ago, our species began manipulating the genetics of other organisms to our advantage. Most of the food we eat has been genetically engineered— albeit by breeding and not by genome editing— to suit our tastes and to meet the growing demand for more. Species introductions, whether purposeful or accidental, have been happening since we first built boats and learned how to navigate from one place to another. And the extinction trajectory on which we are heading is, arguably, itself human induced." (204)

[70] Shapiro 11

fur and layers of fat.[71] It is in essence a mammoth-elephant combination, rather than the "natural" woolly mammoth from the past.[72] What will be produced, in other words, might better be described as a cold-adapted elephant, one that has been genetically modified to have long thick hair and blood that more efficiently absorbs oxygen. The mammoth that would actually be created, then, is something more like a "hybrid" in the Latourian sense, a monster akin to the one built by Dr. Frankenstein.[73] It would be the product of scientific labor. Shapiro gets at the heart of the difficulty of categorizing hybrids when she asks: "[I]s a species that contains resurrected traits truly man-made? It might have an altered genome sequence, but the alterations evolved, naturally, within the genomes of now-extinct species. The traits themselves are natural, but the genetic combination of these traits and the genome of a living species is man-made."[74] Although Shapiro suggests that the "semantic limitation" of distinguishing between natural and unnatural is primarily a problem for environmental laws and regulation surrounding GMOs, it is also clearly a complication that gets even deeper into the heart of problem of human influence.[75]

However interesting these questions are for humanists and ethicists, these concerns do not necessarily bother Sergey and Nikita Zimov in their project. Indeed, the

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[71] See Riederer
[72] See Pilcher
[73] Shapiro uses this precise term (7). Latour's notion of the "hybrids" produced by modernity can be found in *We Have Never Been Modern*.
[74] Shapiro 186
[75] 186

Zimovs see no problem with "playing God" in this case. As Nikita recently remarked, echoing the eco-modernist way of thinking, humans have already played god when they eliminated the mammoths in the first place, so qualms about doing so today are historically suspect: it is not new, and not something we can avoid.[76] Moreover, as we have already seen, the project of rewilding is unconcerned with returning to something like a state of nature with "natural' creatures to populate the steppe; Pleistocene Park aims for the resurrection of the woolly mammoth's particular ecological functions of tree destruction and grazing.

4.4 Geoengineering and the Problem of Permafrost

In part, Pleistocene Park is an experiment to see whether the return of large megafauna will herald the gradual return of the grasslands, whether the resurrected mammoth, given sufficient numbers and time, will begin to reshape the steppe environment to its former glory, allowing for the expansion of grassland ecosystems across Siberia. The reserve in this sense is nothing more than a giant open-air laboratory, a concentrated effort to play with particular variables in order to see what will happen. And yet the park itself, despite its location in Siberia, and despite the fence erected to corral the animals, does not function in pure isolation from the world as an ideal experiment would, nor as an ideal site of conservation, a kind of island outside of the

[76] See Slater

history of human development. Zimov rather intends Pleistocene Park to have a substantial impact on the broader planet. Pleistocene Park draws on Zimov's deep knowledge of geological and ecological history in order to serve a dual purpose: both as an experiment to verify the ecological costs of human-caused extinctions, and to mitigate global warming. It is in this sense also a project of geoengineering, a practice attached to an eco-modernist worldview just like de-extinction.

Northern Siberia is an important site for climate change because of melting "permafrost," which is soil that has remained permanently frozen, sometimes for thousands of years. Permafrost is unlike anything most of us experience on a daily basis, accustomed as we are to encountering ice falling from the sky as snow or hail, blanketing the ground in uneven white, or coating the sidewalks. The same is true of our experience of soil, from the dry almost dustlike substance we touch on rainless ground to the brown runny mud after a storm. Permafrost is something between these two, the color of soil but the consistency of ice, essentially frozen mud.

Permafrost is a strangely banal but compelling visual phenomena; indeed, in Slater's documentary about Pleistocene Park it caught the camera's attention. On the edge of the Kolyma River, the permafrost is melting into nothing more than a giant pile of mud. Sergey Zimov walks along the edges, touching shards of dirty ice as they slowly turn to mud; he finds exposed bones from animals that might have lived thousands of years ago. As he walks around this enormous cliff of mud, swarmed by bugs, it is a wonder he is not trapped in the mud. Contrast this with the "normal" state of permafrost, which the documentary discovers in a basement or cellar like hole dug in the ground by the Zimovs. There, the brown walls of soil are covered with ice, a cave of permafrost. It is, needless to say, cold to the touch. Grass and roots from thousands of years ago stick out. In old times, we are told, this might have functioned as a freezer for Siberians who wished to store meat for long periods of time; as the soil always remained frozen, it would function just as a freezer would function in modern homes today. Now, it functions as a reminder, a contrast with the soil on the surface that is in an obvious state of melt.

But melting permafrost is not merely an indication that the climate is changing; just like melting glaciers, it is potentially part of an enormous feedback loop that could in fact increase global warming. When James Croll, as we saw in chapter one, first theorized the climate system as a result of intertwined feedback loops between the ocean, trade winds, and ice cover, he failed to account for the presence and importance of greenhouse gases, a fact that Svante Arrhenius addressed directly not long after. It is in their greenhouse contribution that permafrost soil is dangerous. Greenhouse gases—namely carbon dioxide and methane—are locked up in the permafrost; as it melts, due to global warming, the microbes that were frozen in the soil begin to digest their surroundings once again, thus beginning to release CO_2 into the atmosphere.[77] The more CO_2 released, the greater the warming; the greater the warming, the more permafrost will continue to melt and unthaw their vast microbe population. Life from the Pleistocene, not merely preserved in the bones left behind in the permafrost, is coming back alive to hasten the input of carbon into the atmosphere.

I have emphasized in the previous chapter on "New Arctic" writing the geologist's ever-important point that the past is always present, that it is constantly in the background, the ground on which we stand, the rocks we encounter. I have also emphasized the Latourian problem of recognizing the agency and animation of the Earth's nonhuman forces, from the large-scale wobbles of the entire planet in space to the localized growth and decline of glaciers. Here we encounter the unnerving unity of geohistory and agency in these microbial forms of life that precede us, and that can come back, as if from the dead to exercise their agency.[78] They are not zombies, nor is this like a ghost—we are not fundamentally dealing with a kind of "hauntology"—this is rather persistence, the quality of never having left in the first place, never having moved or changed. The microbes have always been there, frozen in time, essentially waiting for just this moment of becoming defrosted to begin consuming once again.

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[77] See Zimov et al. 194–198.

[78] This would not be the first time microbial life would have an impact on Earth's atmosphere.

Zimov's work in resurrecting the ice age ecosystem addresses itself to the agency of these microbes, recognizing the potential threat they pose to the global climate. He has proposed that the presence of large megafauna in the steppe grassland can prevent the permafrost from melting, keeping the microbes frozen in stasis in the cryosphere. Currently, Siberia experiences substantial snow cover in the winter; perhaps counterintuitively, this snow cover keeps the ground beneath it warm, like a blanket. But mammals in search of grass—especially the woolly mammoth—will trample over the snow and melt it, thus exposing the ground to the cold air temperatures, keeping it colder. If the ground remains cold in the winter, so Zimov's thinking goes, it will be substantially more resilient to melting in the summer, thus keeping the microbes frozen in the soil, and the atmospheric greenhouse gases stored away, at least for now.[79]

Such a project is fundamentally related to geoengineering, which may be defined as the intentional alteration of the Earth's global climate systems by human beings (I say intentional because we have already altered the Earth's climate systems without knowingly doing so; I specify human beings because the Earth's climate system is always changing, with or without us, as when volcanoes erupt; and I specifically say Earth's global climate system because we are not changing particular environments directly, like by deforestation, but rather the entire planet). Typically, these projects fall into two categories: Solar Radiation Management (SRM) and Carbon Dioxide Removal

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[79] Zimov et al. 198; Zimov 798

(CDR).[80] SRM would involve changing the amount of sunlight or radiation being trapped in the Earth's atmosphere, which could be accomplished by releasing sulfate aerosols into the atmosphere to absorb sunlight, essentially mimicking the effects of an enormous volcanic eruption (and called the Pinatubo effect after a real volcanic eruption in 1991. CDR plans, meanwhile, would take out CO2 from the atmosphere and store it in the ocean or underground. There are a host of ways this can be done, ranging from the simple process of planting more trees, to stimulating the growth of phytoplankton by dumping iron into the ocean, to techniques of "enhanced weathering" that change the chemistry of the ocean. One popular plan is referred to as BECCS, or Bioenergy with Carbon Capture and Storage, and it involves creating monocultural plantations to produce bioenergy and to capture and store the leftover carbon.[81]

These might seem like processes from the future, but they have a history.[82] In 1965, a report was given to Lyndon Johnson about planetary warming caused by CO2 emissions. The report proposed a geoengineering solution to the problem, rather than emissions reductions: dispersing reflexive particles over the ocean to reflect sunlight back. Although this never happened, other projects of a similar nature have occurred.[83]

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[80] See Schneider.
[81] See Schneider and Ribeiro.
[82] We might suggest that historically geoengineering is the product of what Bonneuil and Fressoz call "geopower," or the wielding of a long-standing development of knowledge about the Earth (88-91).
[83] I would draw your attention to the Vietnam War. Not only did U.S. soldiers use powerful bulldozers to knock down forests, they also engaged in a massive geoengineering project called Operation Popeye. The department of defense attempted cloud seeding processes in order to induce extra rainfall along the Ho Chi Minh trail between March 1967 and July 1972, and were relatively successful in extending the monsoon

Modern advocacy for geoengineering seems to have grown since 2007 when Paul Crutzen (who, not-coincidently, is also responsible for the current concept of the Anthropocene) wrote a paper proposing it as a solution to climate change, given the extremely slow rate of progress made up to that point.[84] In that sense geoengineering is still rather new, and its legal status seems to be ambiguous at best: the UN Convention on Biological Diversity (CBD) called for a moratorium on all geoengineering projects in 2008, but the IPCC assumes the use of some geoengineering techniques in its report to regulate the Earth's warming below 2C before 2100, and the most recent report considers other forms of CO2 removal as well.[85]

Geoengineering has unsurprisingly retained both detractors and proponents that fall in line with modern and antimodern attitudes toward the Anthropocene. David Keith, a physicist at Harvard, emphasizes that geoengineering, although it does not deal with the problem of emissions, is still a necessary component of a comprehensive plan to mitigate to climate change. He points out that even if we stop emissions completely right now, there is still an immense amount of CO2 in the atmosphere that will require us to do something. There is no any other way of dealing with that CO2 on a human scale;

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season (127-129). The Environmental Modification Convention, an international treaty signed in 1978, was a response to this kind of weather warfare performed by the U.S. It was agreed that environments would not be artificially modified for the purposes of warfare, as Silvia Ribeio notes, missions over the Ho Chi Minh Trail during the Vietnam War, in an effort to swamp Vietnamese supply lines" (Ribeiro).

[84] Klein 261

[85] See Ribeiro.

doing nothing, we will necessarily face dramatic consequences until the planet cycles through the carbon over hundreds of thousands of years.[86] From a wider economic perspective, geoengineering is essentially a "techno-fix" that fits comfortably into the notion of a market based solution: there is an incentive for companies to create this kind of technology because it will make them money. Companies already hold patents on some carbon capturing technology, and they can easily invent more. Companies could theoretically go from being polluters to being in charge of clearing pollution, continuing to make outstanding profits. The purpose of geoengineering, in the corporate mind, then is to allow us to continue the way we live now.

Meanwhile, there are a host of reasons to be skeptical. One major objection is that it is risky. SRM through sulfate distribution could result in suppressed rainfall in some regions and altered monsoon patterns in Asia. Carbon farm monocultures for BECCS would negatively impact natural ecosystems.[87] And these are only the side effects we know. The earth system is so complex that we simply do not know what would happen; in some cases, what might happen would be worse. Another objection is that of accountability and governance, because it is not clear who would make the decisions on

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[86] See Keith's TED talk here: https://www.youtube.com/watch?v=XkEys3PeseA

[87] Schneider has summarized these risks: "Computer simulations have predicted other possible impacts of geoengineering schemes on the natural world. Injecting aerosols in the stratosphere could suppress rainfall and potentially interfere with monsoon patterns. Carbon farm monocultures threaten to destroy natural ecosystems at a massive scale. Given that natural processes and systems are complex, non-linear, and in some measure chaotic and unpredictable, the overwhelming majority of effects that will ripple through our global ecosystems might only become apparent after geoengineering technologies are actually deployed."

whether to begin or continue particular projects. Would it be governments? Scientific organizations? Corporations? This is a particularly worrisome problem because significant geoengineering projects would likely impact people from around the globe, and yet the decisions would likely rest in the hands of a very small group of people from the global north. It is not hard to imagine corporations disregarding and fighting against legislation for regulation to the detriment of many people. For geoengineering to be done safely, it would need global governance; that we cannot even agree on emissions reductions speaks to the obvious impossibility in the current world order of creating something like this. The final, and perhaps most damning objection is that it does nothing to fix the underlying causes of climate change. If we spend time doing geoengineering, we do not spend time addressing carbon emissions; it is a "distraction" or "fantasy" that stops us form talking about real solutions. Although many scientists—David Keith among them—believe that geoengineering ought to be done in tandem with other kinds of decarbonization, it is likely that companies will make it impossible to do both geoengineering and decarbonization, as they will use geoengineering to convince the public that extreme measures of reduction are no longer necessary.

Zimov's project in Pleistocene Park is quite dissimilar from other forms of geoengineering that have become popular in scientific circles. Pleistocene Park has little interest in interfering with fossil fuels, or with managing the carbon already placed into the atmosphere through fossil fuels. It is concerned with the enormous amount of carbon that could be released into the atmosphere that only indirectly involves the presence of fossil fuels. In this sense, the temporality of Pleistocene Park is substantially different. Zimov is trying to prevent a future eruption of fossil fuels; where most geoengineering projects are focused on the recent past or immediate present. In a similar sense, Zimov's project does not aim to have a sudden or immediate impact on the planet's CO2; this project, as I have emphasized about rewilding, is meant to be a gradual solution to a potentially catastrophic problem. Pleistocene Park also carries with it very little danger compared to SRM or other large-scale projects. The failure of the experiment can only maintain the status quo, can only allow the expected to happen, where the failure of other geoengineering projects could result in climate chaos, entirely unanticipated in modeling. Finally, Pleistocene Park distinguishes itself from the mentality of the profit-driven technological fix, as other geoengineering projects tend to be, because will not require a continuous input of human capital and resources; it intends to work, as we have seen, all on its own as a self-replicating environment.

Yet Pleistocene Park nonetheless shares a deeper resemblance with these projects at the level of philosophical implications. It has been argued that geoengineering enacts the same mindset of the "domination of nature" that resulted in climate change; it is a continuation of the very politics and mentalities that have brought us to this situation—that of the Anthropocene—in the first place. Geoengineering is the epitome of embracing the human role in natural systems. It was our accidental geo-engineering that brought about the destabilization of planetary ecosystems, and it cannot be the solution to the problem.

Pleistocene Park's participation in the drive toward nature's control, as I have suggested throughout this chapter, is ambiguous: on the one hand, we have seen that rewilding pushes toward the relinquishment of human interference; on the other hand, the Zimovs are willing to embrace the science of genetic engineering. Geoengineering, even in the relatively low-impact method devised in Pleistocene Park, points in a similar direction as genetic engineering. Indeed, if we see this particular geoengineering scheme as the ultimate end of the park, then everything moves in the direction of dominance: their recognition of the agency of the microbes in the permafrost is not a move toward letting them be, but rather an effort to control them; the same may be said for the entire assembly of plants and animals, from the grass to the resurrected mammoth, which here become a mere instrument for the preservation of human civilization.

4.5 The Politics of Geohistory

Pleistocene Park's gathering of rewilding, de-extinction, and geoengineering stands as a unique reaction to the Anthropocene. Although the Zimovs view these practices jointly as a "gradual" and relatively slow response to global warming, at a philosophical level they stand in contrast to one another, drawing together two radically different responses to the Anthropocene that can be called modernist and anti-modern:

one in which the role of humans ought to be minimized in order to allow ecosystems to flourish, the other in which humans must take control of the environment in order to ensure our continued persistence in a relatively controlled and comfortable climate. Zimov's work is on the one hand is the epitome of the Anthropocene, disguised in the robes of the Pleistocene; yet on the other hand it seems to offer a way off the beaten track, in which ecosystems, rewilded, may now flourish without direct human intervention. Pleistocene Park's core contradiction is that it is both human and not; it embraces the human even as it rejects it.

Complicating our understanding of the status of human in this space is the equally challenging questions Zimov poses about the past role of humans in the environment. As we have seen, Zimov ascribes to a catastrophic theory of how humans played a significant role in the demise of the mammoth and its ecosystem, a fact that would seem to challenge the now common understanding of when we began to have a widespread influence over the planet. If it is true that hunting played a determinant role in the mammoth's extinction and the large-scale transformation of its ecosystem, then we can only conclude that the destructiveness of our species predates what we typically call modernity by thousands of years. Seen together, Zimov's historical theory expands our sense of human impacts on the world into the deep past, while his actual activities in Pleistocene Park signify a radically idiosyncratic and contradictory effort to address those very impacts. It is a challenge to the periodization of the Anthropocene, and a way of relating to the Anthropocene in the present, regardless of when it has started.

In conclusion, I want to draw out some of the consequences Pleistocene Park has for politics in the Anthropocene, and specifically the politics of climate change. It has been suggested that green politics has been compromised since the height of "green utopianism" was reached in the 1970s, when theories of environmental overshoot and collapse were accompanied by radical environmental visions. This initial wave of utopian impulses was subsequently contained by the normalization of the environmental crises with the concept of sustainable development; the exponential expansion of green problems with the discovery and widespread discussion of anthropogenic global warming and Anthropocene has also hobbled the radical imagination, as it began to appear to many that the battle for "nature" has already been lost.[88] Yet there is an enormous body of writing on the development of politics for the Anthropocene, and it ranges from the pragmatic and politically neutral to the more explicit efforts of the left to tie climate politics directly to long established problems of class struggle, empire, and racism.[89] Mainstream political efforts have largely focused on carbon reduction—but not elimination—on an international scale, as in the Paris Climate Accords of 2015. Other more radical proposals like the Green New Deal have emerged

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[88] Garforth 156

[89] See, for example, Bonneiul and Fressoz's *The Shock of the Anthropocene* and Naomi Klein's outstanding *This Changes Everything*.

from the political left, aiming to revolutionize parts of the US economy in an effort to mitigate global warming.

Seen among these other political moments—all of which remain focused strongly on the present and near future, and on what humans can do for other humans—Pleistocene Park introduces the value of what I have been calling the geohistorical imagination. Zimov's knowledge of deep history forms the core of Pleistocene Park. In imaging the struggle between plants and herbivores over millions of years, his writing is attuned to planetary timescales, and to the historicity of the natural world. In seeing the importance of thawing microbes to global ecosystems, and the equal importance of mammals in preventing them, Zimov recognizes the nonhuman agencies that motivate Earth's history. In recognizing the anthropogenic origins of the mammoth's extinction, he understands the longstanding impacts humans have had on geohistory. In resurrecting the mammoth steppe, Zimov recognizes the persistence of this ecosystem, and its ability to last far into the future.

Zimov's perspective is remarkable because geological history seems to have little bearing on how we speak about daily life, even if it is the case that our modern world is currently determined by fossil fuels formed millions of years ago. Moreover, it can, depending on how it is understood, eliminate the urgency of human politics entirely. In imagining the large-scale transformations that occur over millions of years, the geohistorical imagination brings us to a temporal realm in which change is absolutely inevitable on this planet. If normal environmental thought places a value on a landscape of rolling hills, or a forest's edge, or a mountain vista, the geohistorical imagination necessarily pushes back by demonstrating that these are all mere ephemeral products of geological unfolding. There is nothing permanent about a grassy field, a forest, a river, nor even a mountain, which will in the "abyss of time" be eroded away by the very same forces that made the landscape visible in the first place. To the planet, there is nothing intrinsically "valuable" about retaining any given earthly formation. They only have value to us.

The valueless "flat ontology" of geological history rarely informs our philosophical thinking, literary endeavors, or political actions.[90] This is not because such a perspective is misanthropic—geohistory does not think humans are important enough to hate, and so it is merely indifferent towards them—but rather because human existence bears little significance in this frame of time. In the most extreme sense, geological history allows for the dismissal of human concerns entirely. From this perspective, human extinction carries no significance; we would be replaced by some other form of life, just as humans replaced the dinosaurs. The various transformations occurring to the planet right now, for example, mean no more in geological time than

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[90] In philosophy, we can find all sorts of different wasy of phrasing this. We can speak of a "flat ontology" from new materialisms and object-oriented philosophies (Garcia), or we could says something about how tis perspective takes us "beyond good and evil," in terms of ethics. I prefer to think of it in Heidegger's terms: This is where we reach what he would call the "nothing," the space where human meaning becomes impossible to ascribe with any rational sense without reverting to a belief in god.

those of any other epoch; the Anthropocene, just as the Holocene and Pleistocene did, will fall into geological history, and many of its signs will be completely erased, leaving only particular traces for some future alien geologist.[91] However morally problematic the Anthropocene may be to us, and to the animals that inhabit the Earth, we cannot say from a geological perspective that it is ethically problematic, or ultimately meaningful in any sense, to the planet itself, which will surely recover from this period of time just as it has recovered from countless other catastrophes in the past. Geohistory is the space where the Earth does not care very much us or our well-being, and all narratives about the importance of human life, indeed the importance of life itself, becomes questionable.

How can such a flat, and even nihilistic position, be avoided in the face of geological history, without simply forgetting about it, turning it into mere background, unchanging and supportive nature? What is remarkable about Zimov's thinking is that it addresses the depth of geological history, but still finds value for the place of humans within it. Zimov does this through what we might think of as "containment operations" aimed at holding sublime geological time in the human mind.[92] Zimov relies on periodization and rifts; he sections off our own period time—the Pleistocene and the Holocene—from the earlier geological moments of history as if they were unconnected; focused on the end of the last glacial epoch, the time before the Pleistocene bears little

[91] This is why Jan Zalaciewicz can approach the Anthropocene from a purely stratigraphic perspective, looking for what types of human fossils will be left behind in the far future.
[92] I borrow this phrase from Jameson.

relevance to Zimov's project. In Pleistocene Park, the geohistorical imagination returns to certain forms of human thinking; it puts geohistory to use in a human scale. It shows us how the deep perspective of geological time—normally so void of politics, of human caring—can become a green political project in the Anthropocene. Thus Pleistocene Park gestures toward a deep historical awareness without ever embracing the kinds of quietism that such a geohistorical vision would allow for.

The particular form that politics takes in Pleistocene Park—intervening in environmental practices, including rewilding, de-extinction, and geoengineering—is one in which humans are a central object of concern, but are nonetheless seen in a web of other beings, ecosystems, and geohistorical events. The Zimovs are primarily interested in saving the environment for humans, but they recognize that this can only be done through rewilding ecosystems. Sergey Zimov has explained his concerns about contemporary human civilization, and he suspects that rewilding projects will be necessary for survival, not merely because of the mitigating effects of the permafrost, but also because it will create a sustainable ecosystem that will eventually support human existence. "I am convinced," he has said, "that if wild ecosystems were to disappear, man would not survive either. Because our civilization, that of cheap oil and cities, is doomed."[93] The Zimovs still have a commitment to human beings: our time scales, our needs, desires, and so on, but also to the being of nonhuman ecosystems.

Such a politics seems absolutely necessary in a moment of the Anthropocene for the way in which it addresses anthropocentrism. Anthropocentrism, as I have suggested in the introduction to "Our Ice Age," stands as one way of understanding the roots of the current environmental crisis. While many other political projects can address the other roots, Pleistocene Park has the power to bring light to the deep problem of human-centered thinking. Even though they dive into deep history and recognize nonhuman agency, the Zimovs are still confined by a form of anthropocentric care for human futures. Nikita Zimov expresses this best: "I have three kids—maybe I'll have one more—and what I do, I do for them. I don't do it just for the idea or for the planet itself. I don't care about the planet itself. I care about my kids way more. And I care about humans way more than I care about animals. And I deal with animals because I want animals to help humans."[94] He suggests something important here: the planet does not need saving, but we do. On an otherwise meaningless and indifferent planet that has no particular interest in our survival, humans have an obligation toward mutual aid, especially in times of great ecological upheaval. All political projects are human matters; even when we pursue the most ecological, the most anti-modern environmental work,

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[93] From: "Siberia: The Melting Permafrost – ARTE Documentary" Toward the end. Zimov has expressed a similar sentiment in his "Wild Field Manifesto."
[94] Slater 22:41

there will inevitably be a base of anthropocentrism, in which human life still matters. Politics in the Anthropocene therefore must be a matter of struggling against this necessary anthropocentrism, even if it cannot be ultimately avoided.[95]

Pleistocene Park is not a replacement for the many other kinds of political activities necessary today, from fossil fuel reduction to what has been called "deep adaptation," from protests directed at political institutions to indigenous resistance against pipeline construction.[96] But this crisis—uneven, sometimes slow, sometimes punctuated with great speed—is so challenging to solve that it is necessary to embrace a variety of strategies and political forms. The complexity of our response to the Anthropocene must reflect the complexity of the Anthropocene itself. Climate politics, normally so focused on the present, and on what humans can actively change among humans, may begin to succeed in new ways once it begins to scale up its imagination as Zimov has done in Pleistocene Park. Following his lead, what becomes thinkable are the ways geological history might inform our actions in human time. To recognize the long lasting impact of humans on the steppe environment, to be concerned by the danger that the permafrost poses, to enlist the aid of an ancient ecosystem and its many mammals,

[95] My thinking on this is strongly influenced by Slavoj Žižek's conception of ideology. Žižek has argued that we live by ideological fantasies; they cannot be merely dismissed or eliminated via stringent critique. See *The Sublime Object of Ideology*.

[96] It is extremely tempting to refer to Pleistocene Park's achievement as fundamentally utopian. Zimov's emplotment of recent geohistory involves a strong sense of tragedy, yet Pleistocene Park bears a uniquely hopeful imagination for the future in the face of this prehistoric tragedy. Utopia for Zimov is not found, as we might expect, in the absolute abandonment of the "nightmare of history," but rather with a more nuanced and deeper embrace of the past.

and to allow a once-stable ecosystem to return, is to establish a groundwork for an earthly, geohistorical politics. With Pleistocene Park, there is no longer any reason to think that politics needs to be confined to the imagination of the present.

Conclusion: Ice Ages and the Deep Future

Written years before the science of global warming became established, Arthur C. Clarke's short story "History Lesson" (1949) details the struggle of nomadic humans during an ice age, facing the slowly but inexorably advancing glaciers. The tribe hopes to escape south from the oncoming ice sheet that is "grinding continents to dust and freezing the very air before it."[97] Tragically, Shann, the leader of tribe, spots off in the southern distance the "glint of ice" he had seen to the north, and he knows his pack is doomed: "There was no way forward. Through all the years of flight, the glaciers from the south had been advancing to meet them. Soon they would be crushed beneath the moving wall of ice."[98] But when these southern glaciers finally reach the sons of Shann, years later, we are confronted with a twist: this was not, as we might have thought, a story of the prehistoric past, but rather one of the future. For the tribe, knowing it will perish, goes to bury its most sacred treasure, which it had long ago forgotten the purpose of: old print books, coins, a telephoto lens, a watch, a lamp, a microphone, an electric shaver, a radio part, and so on. These represent the "flotsam that had been left behind when the great tide of civilization ebbed for ever."[99] Thousands of years later, long after the last humans have perished, yet another unexpected twist takes place: amphibious aliens from Venus come to Earth, discovering a lifeless ice planet; a single

[97] Clarke 92
[98] Clarke 93
[99] Clarke 93

signal alerts them to the buried remains of western culture, which they carry back to their home planet. A group of alien historians attempt to understand the objects but find no way of interpreting what has been left behind.

I end with this rich but forgotten story because of the ways in which it draws together the most important themes of this dissertation, but also because of how it points us toward another way of phrasing the basic aims of this project. As a narrative, this short story's form interacts with those of the other texts we have encountered here. Despite the gradual pace with which the glaciers move down from the poles to crush the humans like a vice, Clarke's story is perhaps the most extreme version of human-centered catastrophism we have encountered in "Our Ice Age." Unlike Jensen's apocalyptic vision of the last ice age's effect on the human species, here the glaciers allow no room for human adaptation. As the world transforms into a so-called "Snowball Earth," humans meet their extinction, along with the rest of the terrestrial biosphere. It is perhaps this vision of human extinction that persists in contemporary climatic catastrophism more than anything else; the form of Clarke's pessimism seems as common today as it was during the height of fears about nuclear apocalypse. The figure of the last humans caught between two oncoming glaciers, with nowhere else to go, seems only different in content from the many potential crises we face in the future, from sea level rise and superstorms, to food shortages and novel diseases.

Moreover, like the other objects we have encountered throughout "Our Ice Age," Clarke's story relies heavily on the geohistorical imagination, a sense of the planet as an entity that changes radically over long stretches of time, rather than the environmental imagination of traditional nature writing. Like the geologists who first came to this way of thinking about the planet, Clarke attends to the agency of nonhumans, in particular the ice sheet that "grinds" the bedrock and "freezes" the air as it moves forward. It also retains a sense of how these agents seem to defy the kinds of temporality associated with the human body: these glaciers move slowly enough to push Clarke's brief story into the realm of intergenerational epic, capturing the interaction and entanglement of human and nonhuman time. In imagining geohistory, Clarke too seems to make a similar point about history—wishes to teach us a similar lesson about history—that many of the other objects in this dissertation sought to: that human history must be understood within the context of longer nonhuman scales. For Clarke, the human scale of the tribe is insignificant when compared to the deep historical scale of biological life, the planetary scale of climate, and indeed the interplanetary scale of astronomical time. Everything we currently have achieved as a species both socially and technologically becomes destabilized by climate change—humans forced to return to the kind of social organization they had before the advent of civilization—and is moreover erased in geological time. Drawing on these different scales, Clarke's history lesson is evidently that the human history we tell is small compared with these other three histories, but it is always bound with them and contained by them.

Put differently, we might say that what Clarke's "History Lesson," draws our attention to is simply the presence of the past. I mean this particularly in the sense in which our deep histories, both human and geological, are always with us, even when we do not actively see them. Clarke's point, like those of some of the other writers I have explored in this project, is to show how the deep biological past of nomadism seems to have some genetic perseverance through the domesticating effects of civilization. In a similar sense, the texts from each of the four chapters have also presented ways in which the past persists into the present in unexpected ways: for Agassiz, the glacial erratics stood as persistent evidence of the catastrophic glacial advance during the ice age, and the breaking through of the ice by the Alps; for Croll, the planet's astronomical cycles and gradual transformations over thousands of years continued from the moments recorded in the geological record to today. For Robinson's *Shaman*, the persistence of the past relates to the human capacities for science and art, as well as for our ability to adapt to climate change, both in the past and present. For Jensen, taking a darker turn, the past persists in evolutionary history: his myth of ice age evolutionary history came to justify European racial superiority. Turning toward the interglacial present, Glassley's *A Wilder Time* emphasizes the persistence of wilderness in the Arctic, however precarious in the New Arctic, while Watt-Cloutier writes about the ice's persistence as a precondition for the continued survival of Inuit culture. For Zimov in Pleistocene Park, it is precisely the past's persistence that is both troubling and potentially beneficial: the microbes that are coming back to life from the thawing permafrost may cause catastrophic global warming, but the revival of the ice age ecosystem—making use of persistent genetic material—may yet reverse that trend. In all of these cases, the presence of that which we assumed to be gone makes a critical difference in the way these writers understand the present.

But Clarke's story also might help us understand the presence of the past in a different way: in the sense of cyclicality, the ice age periodically reemerging to eliminate civilization, forcing us back to our nomadic way of life. Indeed, Clarke's sense of this possibility was initially inspired by Will Durant, who wrote ominously in *The Story of Civilization* (1942) that "civilization is an interlude between ice ages: at any time the current of glaciation may rise again, cover with ice and stone the works of man, and reduce life to some narrow segment of the earth."[100] But the persistence of the past may be interpreted to mean as well the disquieting ways in which speculative visions like Clarke's, projected from a very different time and place, come to be relevant for us nonetheless. Although we might want to understand Clarke's story as one answering a counterfactual question—what might have happened if global warming never took place? If humans had never ventured down the path of fossil fuels and carbon intensive

[100] Durant 1

practices?—it may also be understood as a vision of what Curt Stager calls our "deep future."

What is deeply unsettling about reading Clarke's story today, after humans have emitted so much CO2, is that its catastrophic scenario remains plausible. Indeed, a disturbing lesson from Earth systems science is that, as an "interglacial," our own warm time will still likely give way to another round of advancing ice sheets in the deep future. Although this idea seems implausible, counterfactual, and science fictional, it is far from a conspiracy theory.[101] As paleoclimatologist Curt Stager writes, "we have prevented the next ice age. The ebb and flow of natural climatic cycles suggests that we should be due for another glaciation in about 50,000 years. Or rather, we used to be. Thanks to the longevity of our greenhouse gas pollution, the next major freeze-up won't arrive until our lingering carbon vapors thin out enough, perhaps 130,000 years from now, and possibly much later."[102] Despite having placed so much carbon into the atmosphere, the astronomical cycles that Croll theorized, as well as the planet's icehouse state, still outmatch us. When we imagine our ice age, then, we must always imagine it

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[101] Many scientists believe we will enter another period of glaciation, but that we have delayed it. See, for example, Archer (149-157) and Stager (11). Weaver and Hillaire-Marcel concluded in 2004: "In light of the paleoclimate record and our understanding of the contemporary climate system, it is safe to say that global warming will not lead to the onset of a new ice age" (402). More recently, Ganopolski, Winkelmann, and Schellnhuber conclude that "moderate anthropogenic cumulative CO_2 emissions of 1,000 to 1,500 gigatonnes of carbon will postpone the next glacial inception by at least 100,000 years" (200).
[102] Stager 11

doubly: as a past that is still relevant biologically and climatologically, and as a future we may yet once again endure if we last long enough.

What are we to make of this fact? On the one hand, it seems clear that we should be disturbed by the scale on which we have intervened in climate cycles. As we consider the list of markers that make this moment identifiable as the Anthropocene—concrete, plastics, extinction, CO2—we may now also add our intervention into the ice-age astronomical cycles. To see ourselves as geological agents is to see ourselves in conjuncture with these enormous cycles. From that geohistorical perspective, this intervention is nothing short of a catastrophe, one to be mourned and concerned immensely with, especially if you have an aesthetic or cultural attachment to ice. And yet, it seems all but clear that this catastrophic vision remains all too confined to a human historical perspective. From a wider—indeed gradualist—perspective what seems more shocking still is that despite all we have done to warp the planet, the glacial cycles still persist. We have, from this planetary perspective, barely made an impact on the planet: our cities, roads, agriculture, have barely made an impact on the defining feature governing planetary climate in our time. Even at a moment when human power extends well beyond our temporal comprehension, we still act within deeper historical trends like glacial cycles. Taken together, we can only conclude that although climate change is happening today because of us, it would have happened without us, and will continue to happen in spite of us. This is what it means to come into contact with, as

Chakrabarty writes, "the rude shock of the planet's otherness."[103] In this sense, ice ages do not merely give us a more precise sense of our long entanglement with climate; they also point toward the complexity and length of geological history, and our overall geohistorical insignificance.

"Our Ice Age" has consistently questioned the ways in which the planetary perspective may be brought together and integrated with the political and social necessities of the present. The implications of a future ice age, and our geohistorical insignificance, for what we should do now seem ambiguous at best. Is it the case that delaying the next ice age with carbon emissions might perversely benefit humans as a whole? As Stager notes, there is a way in which global warming becomes a kind of political savior from this perspective, a temporary ill to stave off an even worse ice age: "On the scales of environmental justice," he asks, "how do several centuries of imminent and decidedly unwelcome change stack up against many future millennia that could be rescued from ice age devastation?"[104] Moreover, does the fact that Earth will reabsorb our actions, in the long run, mean that nothing we have done to the planet matters? Are the stakes of global warming much lower than previously thought? Does this change the moral dimensions of climate change?

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[103] "Climate and Capital" 23
[104] Stager 11

What seems clear to me is that, from a planetary perspective, it is true that global warming matters differently than for our human worlds. The planet, as a geological and biological entity, will survive us. And yet, from the perspective of human history, it is clear that global warming is doubtless one of the most significant threats to our continued existence as a species. These contradictory perspectives need to be held in the mind at once, neither one negating the other. Such a dialectical effort would seem to lead this: that whether dealing with ice ages or global warming, humans—in particular those in power within a global system of capitalism—have a deep obligation to act, and to see the geohistorical past as a new layer informing politics. This means that, in the present, we must recognize that climate change has always been a threat to our survival, and will—barring some fantastic and permanent geoengineering solution—be a threat, far into the deep future. Dealing with global warming, through both radical acts of mitigation and adaptation, is therefore not merely an ethical act in the present to help people; it is an act of preparation, a collective decision to survive climate change into the future. It would be a decision to ensure that, when the next ice age comes, glaciers slowly scraping away the concrete worlds we have built, we will be ready.

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Biography

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