CHAPTER
THREE

witnessing ecologies

IN THE COMMUNIQUÉ from the Fiftieth Pacific Islands Forum, held in Tuvalu in August 2019, leaders from the region "reaffirmed climate change as the single greatest threat to the livelihoods, security, and wellbeing of the peoples of the Pacific," but stopped short of calling for significant and immediate action. In the Kainaki II Declaration that accompanied the formal communiqué, countries are called to "reflect" on transitioning away from coal rather than banning its use, "meet or exceed" national emissions reductions rather than creating new and more ambitious ones, and continue "efforts towards" meeting international climate-funding promises rather than demanding urgent and ambitious commitments.[1] According to media reports, Australia successfully stymied efforts for a much bolder declaration, reducing Prime Minister Akilisi Pohiva of Tonga to tears and prompting leaders from Fiji, Vanuatu, and Tuvalu to make heated remarks about their more powerful neighbor. "We came together in a nation that risks disappearing to the seas, but unfortunately we settled for the communiqué," said Fiji's prime minister, Frank Bainimarama. "Watered-down climate language has real consequences—like water-logged homes, schools, communities, and ancestral burial grounds."[2] The ire of Bainimarama and others was directed primarily at then Australian Prime Minister Scott Morrison, a man who once triumphantly brandished a lump

of coal in Parliament, only reluctantly accepted the science of climate change, and stalled progress to limit emissions and develop renewable energies at every opportunity, achieving the ignominious distinction of Australia ranking dead last among 170 states analyzed in a 2021 UN report on climate action.[3] At the forum, it seemed Morrison wanted every dollar Australia spent in the Pacific to be recognized, but refused to commit to any action that might slow the rising seas threatening to swallow Tuvalu and other islands.

Much can be said of events such as this and the warped politics of climate change, the enduring inequalities that underpin the failure to act by wealthy nations, and the histories of colonialism, clientelism, and militarism that shape the present Pacific. Just as the Marshall Islands and other nations in the Pacific were crucial sites for nuclear testing throughout the Cold War, so too are they now the canaries in the mineshaft of climate change. Indeed, Elizabeth DeLoughrey points out that "climate science and nuclear weapons testing have an intimate relationship," as the tools and techniques for understanding the atmosphere developed for war were applied to establishing carbon baselines and monitoring their change.[4] Climate crisis is thus sutured to "catastrophic ruptures to social and ecological systems" that "have already been experienced through the violent processes of empire" and continue in the ongoing, unnamed imperialism of regional geopolitics.[5] Climate is itself increasingly a military problem, securitized by planners in ways that have little regard for the wellbeing of populations most subject to it.[6] When the Islander leaders of the Pacific juxtapose Australia's domestic energy pricing concerns with the erasure of life, culture, and community, it makes clear that trauma is not registered as an individual experience but as an ecological phenomenon. Pleas for an acceptance of shared responsibility in the face of drowning depends on shared witnessing, on opening onto impossible loss, grief, and ecological trauma.

Among the most widely known evocations of the drowning islands of the Pacific Ocean are the poems of Kathy Jetñil-Kijiner, a Marshallese spoken word performance artist and writer. Her poem "Tell Them" includes these lines:

> tell them about the water
> how we have seen it rising
> flooding across our cemeteries
> gushing over the sea walls
> and crashing against our homes
> tell them what it's like
> to see the entire ocean__level___with the land[7]

DeLoughrey observes that the poem "employs allegory to figure the island as a world in ecological crisis, depicts an active, nonhuman ocean agent, and articulates the imperative to both witness and testify to a dynamic, changing Earth."[8] Allegory, she argues, is one of the most powerful forms of cultural narration of climate crisis precisely because it bridges ruptures in knowledge, experience, and culture through "its ability to represent both historical and scalar relations" by animating "universalizing tropes such as planet, species, nature, and the human into narrative—and thereby into space and time."[9] While the poem can certainly be read in an allegorical mode, there is something else at work here beyond recognition that "the Marshallese are both humans and nonhumans."[10] The repeated refrain of the poem's middle stanzas—"tell them we are . . ."—intermingles human and non, "hollow hulls" and "wood shavings," "sweet harmonies" and "styrofoam cups of koolaid red."[11] Distinctions of status slip away between "skies uncluttered" and "dusty rubber slippers" as space, place, object, speech, and gesture become entangled with the "we" of the poem. Here is a complex ecology, one rendered *sensible*—able to be felt—through the rhythm and rhetoric of the poem but not *reducible* to language. "We are" might also be an assertion of ontology, of shared being-in and becoming-with the world that is slowly being drowned. "Tell Them" is an allegorical call for climate justice, but also an address to the nonhuman entanglements already rupturing in the refracting wakes of catastrophic pasts and futures. Its witnessing demands not only response-ability on the part of the state system, but also that the rich ecologies of the Marshall Islands be recognized as response-able and address-able. If this poem—and others like it—are calls to witness and acts of testimony, then their mode of witnessing is nonhuman, animated by the inextricable entanglements of being, land, living, community, ocean, and culture.

This chapter coheres around the proposition that one way that ecological trauma—complex, mutable, resilient, ephemeral, material, moving, unsettling—comes into focus is through aesthetic works that undertake the tentative, always incomplete project of nonhuman witnessing. In pursuing this proposition, I attend to artistic and literary works that examine ecological trauma through scale as a site of political contention and in the existential rupturing of nuclear weapons. Violent mediations and machinic affects animate the martial and capitalist operations, events, and technologies that concern this chapter, but here I shift my inquiry from what animates assemblages of catastrophic violence to pursue traumatic

aftermaths for more-than-human ecologies. Ecological trauma is not conceptually dependent on the terms that have occupied the first two chapters of this book, but, rather, as I show through this chapter, provides a way of thinking with and responding to crises and violence that far exceed the human sensorium and the prosthetic techniques we have built to enhance or supersede it.

The chapter begins with an exploration of ecologies in media and cultural theory, before pursuing scale as a relational problematic in the face of ecological violence. From there, I develop the concept of ecological trauma in earnest, defining it as a rupturing of relations that ripples through the ongoing composition of more-than-human ecologies. To explore how nonhuman witnessing offers a response, I then turn to the violence and trauma of nuclear testing on First Nations lands in Australia, and the fiercely resistant art practice of the Kokatha and Nukunu artist Yhonnie Scarce. Rather than pursue the witnessing of ecologies through scientific frameworks, I aim to trouble the dominance of such forms of knowledge, and particularly the aerial imaging through which the planet becomes media. While such technologies are critical to the formation of scientific knowledge about climate crisis and ecological violence more generally, the growing entrenchment of remote-sensing visualizations are what Lorraine Daston calls an epistemic image, "one made with the intent not only of depicting the object of scientific inquiry but also of replacing it."[12] This makes probing their limits a necessary task. Satellite programs such as Landsat certainly fall within the rubric of nonhuman witnessing, but what they register and make legible struggles to escape the epistemic and technical frames within which it takes place.

Less bound by such strictures, aesthetic interventions make nonhuman witnessing sensible and graspable in ways that bring the constraining frames, structures, politics, and violences of the technoscientific state to the fore. Continuing empire, mutating colonialism, nuclear testing, enduring irradiation, rising waters, mined out lands: catastrophic futures are already here and have been for a long time, but that hasn't stopped Man from charging headlong and ever deeper into oblivion. How, then, to unknot the forms of knowing and being that make up the human of Man, the figure who proudly waves coal in national parliaments and is unmoved by those who weep for what is and will be lost? How to reckon with the ecological entanglements wrought by industry and war? How to witness within and through ecologies of the human and more-than? How to open up a communicative commons that grants standing to human and nonhuman?

This chapter expands the focus of the book to think with more-than-human ecologies that encompass land, sky, and water, rather than remaining within the technocultural domains that have been its principal preoccupation. As with its predecessors, this chapter travels with the doubling movement of its title: the witnessing of ecologies and ecologies of witnessing. Understood as complex systems of interacting and interdependent parts, ecologies are constituted by relations between elements. Whether wrought in the split-second fission of a nuclear bomb or the drawn-out temporality of radioactive contamination, ecological violence strikes at the relational composition of ecologies themselves. Uprooting a verdant tree to clear the way for a new road is not ecologically violent simply because the tree itself is lost, but rather because its removal tears at the fabric of the ecology within which it is webbed. As Cubitt writes: "Ecologies are not networks connecting previously separate things: Every element of an ecology mediates every other. Life mediates nutrients and sunlight, storing, changing, growing, passing, mutating, returning."[13] Media theorist Matthew Fuller makes the point that the word *ecology* "is one of the most expressive language currently has to indicate the massive and dynamic interrelation of processes and objects, beings and things, patterns and matter."[14] But ecologies can also be brutal, particularly once we extend their conceptual reach into the violent. "Geopolitics, enacted through global war, is itself a form of life that pursues a *savage ecology*," Grove insists, "radically antagonistic to survival as a collective rather than discriminatory goal."[15] Ecologies are not inherently moral, but are rather inescapably political on a planet shaped by Man.

Conceiving of media as ecological and ecologies as medial provides a conceptual apparatus through which to examine, in the context of ecological violence and its attendant traumas, the communicative mode I am calling "nonhuman witnessing." As this chapter argues, nonhuman witnessing can become a reparative response to ecological trauma, the state of wounded survival that follows in the wake of ecological violence. But it also responds to a deeper historical rupture between human and nonhuman, a cleaving of Man from Nature that is rooted in Platonic and Aristotelian thought and thus inherent to the ascendance of Anthropos, even before its violent intensification as Wynter's Man, which I discussed in the introduction and will return to in the coda. "The more humans defined themselves over against nature," Cubitt observes, "the more they defined nature over against themselves, in this way formalizing and enforcing the split between the natural environment

and humanity, which in the process became a nonnatural, religious, or rational quality."[16] As Haraway and other feminist philosophers of technoscience have shown, the recomposition of nature and culture as entangled with each other is an urgent political task. Haraway coined the term "natureculture" to enact this intertwined coexistence, insisting that no concept of ecology could exclude the human, or vice versa. The stakes of this intervention are significant, not least for science, which must be understood as operating in agential entanglement with "nature" rather than observing it from a distance.[17] This chapter commits itself to this task by asking how thinking-feeling forms in response to ecological violence.

Aesthetic works figure more prominently in this chapter, as I read artists and writers who find the means for evoking and establishing communicative relations between human and nonhuman, even working to dissolve such distinctions. The works examined here pursue what Cubitt calls an "ecological aesthetics and politics" that makes possible "communication of and through difference."[18] Nonhuman witnessing of ecological trauma is not confined to the overt aesthetic production that occupies much of this chapter, yet there is always an aesthetics of nonhuman witnessing, in the sense that aesthetics is inseparable from sensing and its registration. Geological formations witness the passage of deep time, the arrival and departure of ice ages, the life and death of forests, and the passage of animal life. Nonhuman witnessing describes the fixing of fossils records: captured in mud or peat or sand, bodies shape the earthy matter that spills over and claims them, an ecological affectivity in the transformation of materialities as they fix into enduring form. Archaeology and geology seek out this witnessing, still in process on the planetary scale of time, only to reduce it to "evidence" that can be ordered into disciplines of knowledge rooted in whiteness, extraction, and colonialism.[19] Biochemistry, biophysics, the quantum mechanisms of the universe itself: all entail relational dynamics that register change as sensation, as elements in relations of mediation, becoming through encounter and in time. But while pursuing this radical empiricism of nonhuman witnessing to its most elemental would be a worthy if quixotic project, my concern here is with its concrescence into modes that register more coherently with the human sensorium.

With the first satellite images and, later, the *Earthrise* (1968) and *Blue Marble* (1972) photographs taken by astronauts, atmospheric sensing has held out the tantalizing promise of making nonhuman scales, perspective, and spectrums accessible and sensible. Despite Cold War rivalry and government investment in military spending driving the rise of technoscience, the

extraplanetary view swiftly produced a utopian politics. Most famously, Stewart Brand's *Whole Earth Catalog* played a key role in the emerging Californian cyberculture, which in turn spurred the rise of Silicon Valley and helped create the ideological and material conditions for contemporary algorithmic enclosure.[20] Militarism and military investment were never far from the surface, as the foundational role played by DARPA in the creation of the internet attests, but Brand saw the view from space as simultaneously triumphant and humbling, a testament to human achievement but also to the necessity of living together on this small blue dot in the expanse of space. Suffused with the overdetermined figure of Man described by Wynter, Brand's vision promoted a universalizing whiteness manifested most potently through the absence of race and class.[21] Imagining the fusion of cyberculture with business as the means for simultaneously acquiring both wealth and liberation would play no small part in the emergence in our own time of billionaires with space shuttles and dreams of colonizing Mars. But Silicon Valley ideology was not the only offshoot of the capacity to capture the planetary through sensing apparatuses.

One of the earliest applications of electronic digital computers after their emergence in World War II was weather forecasting, an effort led by the Manhattan Project mathematician John von Neumann. Even in those early days, von Neumann sought what he called "the infinite forecast," the capacity to simulate climatic circulations over a long enough period to grasp its fundamental principles.[22] But the origins of climatic computing can also be found in both nuclear fallout monitoring regimes and the Cold War effort to render the world computable by early warning nuclear strike systems. Model simulations required new spatial and atmospheric data, collected through a range of sensors fitted to planes, boards, floats, and satellites.[23] The latter proved valuable, with the TIROS, Nimbus, and Earth Radiation Budget Experiment satellites enabling the emergent planetary regime to engage in vertical mediation between the terrestrial and the stratospheric.[24] These geospatial satellites and the growing array of sensors sent into orbit with them produced a new capacity for earth imaging across the breadth of the electromagnetic spectrum. "Earth imaging," writes Russill, "now depends on light recorded from sites that are uninhabitable or inaccessible to humans, at wavelengths we cannot perceive directly, travelling at speeds and in quantities we cannot handle."[25]

No longer could human perception claim a privileged status when it came to making sense of environments: becoming knowable—to science but also to militaries, governments, NGOs, and even publics—meant being registered

by remote-sensing systems collecting data inaccessible to the human sensorium.[26] Tracking environmental change, whether from natural phenomena or industrial depredations or the violence of war, no longer operated on anything like a human scale. On the ground, knowledge maintained its currency within particular contexts, as the rise of humanitarian witnessing attests, but earth imaging ensured that human senses were "no longer the grounds for authoritative depictions of environmental change."[27] Remote sensing is thus a form of nonhuman witnessing—one that illustrates precisely the way the human is exceeded by emergent technics and by the complexity and scale of ecologies, and yet also returned to through address and the injunction to respond. Earth imaging not only made ecological volatility sensible, but it also conjoined war and environment through satellite-sensing apparatuses and the processes of violent mediation much like those discussed in chapter 1. This desire to exert control from the atmosphere extends to the desire to control atmosphere itself via what Furuhata calls "climatic media," which ranges from planetary geoengineering to the mundanity of greenhouses and air-conditioning.[28] Environments themselves become subject to the potential violence of mediated control. Violent mediation is thus as much a part of climate science and ecological violence as warfare, at work in many of the informational and communicative processes that facilitate extractive industries and those that enable climate monitoring and regeneration.

As earth imaging has become more accessible, its role within human rights and ecological monitoring has grown as a means of bringing state and corporate slow violence into the zone of the sensible and political. Dutch nongovernment organization Pax for Peace, for instance, employs remote sensing in its analysis of Syria to demonstrate the interrelations of war and environmental damage. Remote-sensing data allows Pax to identify damage over time and to find critical sites within the ecology, such as makeshift oil refining, and map their location and impacts. But Pax also uses on-the-ground sources, recognizing that earth imaging can elide crucial information and contextual complexity. As Weizman has pointed out and I discussed in the previous chapter, the resolution of publicly available earth imagery is often limited so that the human body fits within its boundaries, thus placing the body—the locus of human rights—below the "threshold of detectability."[29] But this level of resolution fits well with climate-monitoring regimes and their computational architectures, including initiatives such as the Microsoft Planetary Computer that promises to harness the compute power and machine learning capabilities of big tech to ecological research and action. As Delf Rothe puts it, "Visual technologies such as satellite remote sensing

play a crucial role in the ontological politics of environmental security" and have "considerably influenced the epistemological horizon of environmental security thinking."[30] Earth imaging as nonhuman witnessing is thus already bound up with the savage ecology of contemporary geopolitics. A crucial question is whether it can be otherwise.

Remote sensors are communication technologies, but their traffic is one way: they bring the nonhuman into the domain of the sensible but provide no means of address to the nonhuman in response. But as Jennifer Gabrys has documented, remote sensors also form part of a media ecology that seeks to make the earth itself programmable: "Sensing is then not just a process of generating information but also a way of informing experience."[31] Against large-scale efforts to make the planet computational for the purposes of climate monitoring and military targeting alike, Gabrys attends to what she calls "citizen sensing." These are collaborative, grassroots projects that employ a DIY ethos and enter into a processual, dynamic relationship between technics and environment and which, in the terms of this book, could be understood as an insistence on making nonhuman witnessing political. But returning to the work of Gabrys and others through the frame of nonhuman witnessing is not my purpose here. As this chapter unfolds, my interest is less on remote sensing and earth imaging as modalities of nonhuman witnessing and much more on how ecologies can be witnessed and how witnessing takes place ecologically.

In the manifestations with which this chapter dwells, nonhuman witnessing mediates between what Félix Guattari calls the three ecologies: the environment, social relations, and human subjectivity.[32] New modalities for such mediation are vital for Guattari: "Now more than ever, nature cannot be separated from culture; in order to comprehend the interactions between ecosystems, the mechanosphere and the social and individual Universes of reference, we must learn to think 'transversally.'"[33] As an "assemblage of enunciation" that conjoins machines, people, animals, environments, and objects, nonhuman witnessing generates transversal relations with the potential for strengthening into enduring bonds. Mediation animates these transversal relations, enabling communicative flows that don't just carry information but render aesthetics sensible by a multiplicity of agencies, humans among them. As Fuller points out, "The stakes [Guattari] assigns to media are rightly perceived as being profoundly political or ethico-aesthetic at all scales."[34] This question of scale recurs throughout this chapter: scales of time and space and their collapse, scales of perspective and intensity, scales of intimacy and violence.

With its roots in the Latin *scala*, meaning ladder or stairs, *scale* refers to defined relations of space, time, or quantity between one thing and another. A musical scale sets out the relations between one note and a series of others, while a cartographic scale defines the ratio of distances on a map to those on the earth. As Timothy Clark writes, scale "enables a calibrated and useful extrapolation between dimensions."[35] Scale, then, is one means of making instrumental and practical sense across difference, a means of managing relations between one thing and another. Scale helps anchor perception in worlds that extend beyond the perceptual reach of the human sensorium; it enables one to conceive of entities far bigger or smaller, say, than can be contained within the human visual field. This is one of the promises of remote sensing: not only to extend perception to atmospheric or underwater viewpoints, but also to enable sensing at spatial and temporal scales that exceed the human. As Fuller points out, "A 'scale' is something that operates at one level in what might be thought of as an infinite zoom, were a camera to be built that could be sensitized to elements as diverse as practices, institutions, atomical structures, weather patterns, linguistic formations, protocols, transport infrastructures, a glance."[36] High-resolution satellite imagery thus not only enables breadth of perception but also depth through the capacity to zoom imagery down to the half meter and even smaller. Scale is an epistemological tool, a means of organizing the world and its causal relations. It does not inhere in any given entity but is an imposed relationality between one thing and another. At the same time, "a scale provides a certain perspectival optic by which dimensions of relationality and other scales may be 'read.'"[37] This means scale can be intensely political because it constructs relations between entities and processes and, in doing so, can become bound up with questions of agency.

Defining our present geologic era as the Anthropocene, argues the postcolonial historian Dipesh Chakrabarty, shifts the scale at which human agency operates: "To call human beings geological agents is to scale up our imagination of the human . . . to attribute to us a force on the same scale as that released at other times when there has been a mass extinction of species."[38] But climate change is not only about happenings at the scale of the planet or even the capacity of the human to have effects at the planetary scale. Rather, Clark argues that it involves "an implosion of scales, implicating seemingly trivial or small actions with enormous stakes" even as disciplinary, ideological,

religious, and other boundaries collapse into one another or delimit knowledge in damaging ways.[39] Approaching the problem from a different angle, Derek Woods argues that scale itself should be the site of critique, suggesting that doing so makes clear that "the subject of the Anthropocene is not the human species but modern terraforming assemblages."[40] Consequently, as Alaimo argues, those most responsible for the climate crisis need to engage in "scale shifting that is intrepidly—even psychedelically—empathetic, rather than safely ensconced."[41] If there is an emergent "structure of feeling" around climate change, it must surely be a generalized anxiety bound up with urgency, disbelief, and futility—with scale is at its core.[42]

At stake in these and other such interventions is the capacity to overcome scale as a problem for knowing and communicating climate change. How, then, might scale itself become subject to politics? How might scale not simply be communicated but witnessed? That is, how might scale be registered as a site of necessary political and ethical engagement? How might scale, its effects and its collapse, be grasped as a matter of practical world-making and repairing?

WITNESSING SCALE

The nonhuman witnessing of scale opens onto embodied engagements with the strange disjunctures of climate change. These disjunctures include its unfolding into a future in which everyone currently alive is dead, and its weird geographies, its planetary scope and localized effects, its collapse of distinctions between apparently discrete systems and spaces. All this demands "rethinking perception as unfixed, nonlinear, embodied, and mobile," as Zylinska writes in relation to nonhuman photography.[43] Scales connect the human and nonhuman in complex, inextricable ways: they bind entities through relation, yet do so transversally, rather than through any explicitly causal interrelation. Scale is a site of nonhuman witnessing because it is a manifestation, even a technique, for the registration of relations that are not at all obvious, or that defy human experience, or that insist upon incommensurability. Witnessing scale, whether of time or space or anything else, means making political and contestable its structures, assumptions, effects, histories, and technicities. Technoscientific views from above are a critical convergence of all these things, not least because the view from above also coalesces war, data, and climate in multiple ways.

Thanks to the global touring of a major exhibition and its accompanying documentary, the Canadian photographer Edward Burtynsky, along with his longtime collaborators Jennifer Baichal and Nicholas de Pencier, has played a significant role in popularizing the term *Anthropocene* and produced some of the best-known interventions into the view from above. Shot using high-resolution digital cameras, Burtynsky's oeuvre documents decades spent traveling to places where the markers of human activity on the planetary surface are devastatingly evident. His photographs are arresting, even disturbingly beautiful, finding in open-cut mines, polluted deltas, and deforested landscapes an aesthetic of shadowed contours, strange colorations, geometric fractures, surreal surfaces. While some of his work operates at an immersive human scale, almost all his photographs since the late 2000s are aerial. Typically photographed from a light plane, the images splay out with just enough perspective so that salt pans in Gujarat, India, or lithium mines in the Atacama salt flats, Chile, seem to extend indefinitely beyond what the camera reveals. In "Salt Pan #18," asymmetrical polygons of land stagger away from the bottom of the image in long lines, while in "Clear Cut #3," the curling marks of clear-felled palm oil plantations in Malaysia curve off every edge of the image. A series from the Morenci Mine in Arizona, USA, renders the landscape alien: vivid oranges and purples, vivisected by curves and lines carved by immense vehicles that emerge slowly from the image, barely distinguishable on the monumental prints on gallery walls (figure 3.1). Point of view and framing together render the images difficult to position definitively: spatial scales feel monumental but resist enumeration, content escapes form even as the aerial view seems to offer the possibility of revelation.

Unsettling, even destabilizing, Burtynsky's photographs are generators of affective disembodiment, of being temporally shoved out of the human sensorium and placed in relation to the scale of the human as geologic agent. Human and nonhuman fold into each other, perturbing spatialities of scale by presenting the planetary terraforming of anthropogenic devastation at the limits of the human.[44] What we witness in these works is thus the affectivity of the geological and geometrical, the problematics of scale. These images attest not only to catastrophic human intervention in the natural world, but also to the tension between human capacity and aesthetics, between the technical and the beautiful. Here, nonhuman witnessing exceeds what resides in the visual field: relations of scale are themselves intensive, forceful, and embodied in the most radical sense of folding the human into the nonhuman spatialities of climate crisis and its causal agents of extractive industry.

FIGURE 3.1. "Morenci Mine #2," Clifton, Arizona, Edward Burtynsky, 2012. © Edward Burtynsky, courtesy Sundaram Tagore Galleries, Singapore / Nicholas Metivier Gallery, Toronto.

Against the scientific aesthetics of satellite imagery, which are typically framed by indexical legends and produced at specifically determined scales, Burtynsky's photography situates the view from above as more contingent, as embodied in the aesthetic relations engendered by the image. So, while his photographs buy into the capacity of the view from above to reveal, they resist entry into the epistemic category of the technoscientific view that drives knowledge production in war and science alike.

Part of what makes climate change such a fundamental political challenge is that it is simultaneously an ontological and epistemological problem. Moving up, down, and between scales, climate change confuses systems of governance and knowledge. Clark calls this the "derangement of scale," in which "received concepts of agency, rationality and responsibility are being strained or even begin to fall apart in a bewildering generalizing of the political that can make even filling a kettle as public an act as voting."[45] For all the derange-

ments of scale produced by the climate crisis, its defining scalar feature might well be the collapse of scales, their folding into one another such that scale itself proves at once illusory and determinate, ephemeral and material. This ambivalent relationship between the human and nonhuman eye, between creative practices of witnessing and scientific documentation of the world, is evident in a 2018 work by the Australian media artist Grayson Cooke.

Shown at major venues across the country, "Open Air" combines the paintings and processes of artist Emma Walker with satellite images of Australia from the Landsat "Digital Earth Australia" program, set to the 2013 album *Open* by the cult Australian band the Necks. The work plays with the visual registers of the aerial view, troubling the mediated materialities of land and art. Running just over an hour, it brings together motion-controlled aerial photography of Walker's abstract paintings with time-lapse images from the Landsat archive, which has been returning to image the same point on the planet every sixteen days for more than forty years (figure 3.2). In the video of Walker's paintings-in-progress, the camera scans surfaces slowly: intensely immediate, close to rough wood, cracked paint, flowing pigment, and heat applied to paint. At times, the Landsat images cut sharply from one to the other, at others they dissolve slowly, rich reds and blues sliding into one another, clouds and their shadows just barely separable. In some arresting sequences, the screen splits and mirrors, or satellite and photographic image overlay one another, collapsing together disparate scales, materialities, and topographies.

FIGURE 3.2. Still from "Open Air," Grayson Cooke collaboration with Emma Walker, 2018. Courtesy of the artist.

Launched by NASA in 1972 as the Earth Resources Technology Satellite and renamed in 1975, Landsat is the longest continuous program of satellite imaging of the planet, with its imagery used in everything from agriculture to conservation to surveillance. The two currently active satellites, Landsat 8 and Landsat 9, record blue, green, and red light from the visual spectrum, but can also sense in the infrared spectrum invisible to human eyes. Their data is freely available but produced by US government funding and so operates within the ambit of US strategic priorities, with a visible spectrum spatial resolution of 30m and closer to 100m for infrared. In "Open Air," Cooke's layering of multiple scales enables continuities between the orbital satellite and the macro video lens to bring into the terrain of the perceivable the climatic and geologic processes that might otherwise evade the human. Without narration or context, the Landsat images are more affective than representational: viewing them is not about decoding their content, but rather feeling through the strangeness of watching change from above.

Despite their high-definition clarity and our capacity to "read" them, these images are only secondarily representational: rather, they are testimonies to nonhuman mediations, to vital processes of change in form, space, and time. Scale collapses, eliding distinctions between pigment and pixel, painting and planet. Witnessing here is pure aesthetics: a registering of relations, an enfolding of materiality and mediation. As the instrumental soundtrack ebbs and flows, the artifice of the painting—the ways it is not land—become both more evident and less significant. Its mediation makes it mutable; processes (viscous dissolutions, searing wood fibers, bubbling and cracking coatings) supersede the thing itself. So too in the Landsat images, where their archival mattering as objects of scientific research falls away in the meditative movement between images. Scale is present but cannot hold—and what is witnessed in the dissolution is that collapse in the nonhuman processes of materialities fluxing in form. While Cooke works directly with the remote-sensing epistemic image, its indexical and informational functions are systematically eradicated, made materially aesthetic by the movement between satellite image and digital capture of paint, wood, dirt, and sand. As with the human experience of the Anthropocene and its climatic violence, claims to know are unanchored from their spatial references, made strange and intimately nonhuman.

If the spatial scales of climate captured by Cooke are dizzying, their temporal counterparts can be weird and estranging. Time is the site of one of its most confounding paradoxes: the urgent need for action now to confront something that exists as an affective fact of catastrophic futurity. But Man is

not used to thinking in time horizons that exceed Himself and yet demand radical and immediate transformation in the present. Derangements of the sensorium become estrangements of senescence. In a photograph documenting "Boiling Milk" (1999), a performance that took place one morning in 1999 near Krafla, Iceland, the small pan of milk in Ilana Halperin's gloved hands barely touches the surface of the sulphur spring (figure 3.3). Crouched by the side of the hundred-degree lake, her arm extended from a narrow spit of land, the artist seems almost a supplicant, her gesture one of ritual offering. Her bright red raincoat pulled tight to the curve of her back, face emerging from

FIGURE 3.3. "Boiling Milk," Krafla, Iceland, Ilana Halperin, 1999

the hood to focus intently on the task at hand, she stands out sharply against the background blues and greys of the water, mist and sky that dissolve into one another as she waits for the milk to boil. By bringing together the swift domestic act of boiling milk with the deep time of geothermal reactions, David Farrier writes that Halperin "summoned an extraordinary confluence of different scales," such that in "what appears to be a fleeting, even humble exchange between human and geologic temporal orders, a deeply Anthropocenic sensibility emerges."[46] Halperin describes her own work as examining "geologic intimacy," which Farrier sees as one form of the poetics of thick time. Yet there is something else at work here, too, a witnessing of temporal disjuncture, of nonhuman indifference to the scientific insistence on dating and measurement.

Consider the embodiment of the encounter: wrapped protectively and bent carefully at the knee, Halperin curls toward the hot water, only the skin of her face exposed to the heat and stink of sulphureous waters. It is not only the milk that feels the deep time of geothermal heat as its proteins coagulate and separate, but Halperin herself. She is witness to the encounter, but also entangled within it. In just a few short minutes, the composition of the milk changes from cool to hot, beginning to steam like the air of the lake itself. Located on the Mid-Atlantic Ridge, where the North American and Eurasian tectonic plates pull slowly apart, Krafla makes the slow drift of planetary geologic change accessible to the human sensorium. In "Boiling Milk," the transfer of energies takes place across radically incommensurate time scales, the millennial inching apart of the plates producing volcanic activity that heats the lake and in turn Halperin and her milk. Milk—perishable, biological, life sustaining—takes into itself the heat of infinitesimal geologic movement. In this transfer of energy, scales collide but do not collapse. The milk transforms, becoming other than it was through Halperin's ritual gesture. But this witnessing is not happenstance; it is deliberately enacted and carefully framed, mediated by the photograph and its title into an image testimony of the potential intimacy of time that far exceeds the human.[47] Reflecting on such temporalities, Zylinska points to the emerging significance of photography after the human, a phrase that refers not only to "the straightforward material disappearance or conceptual overcoming of the human at some point in the future . . . but also to the present imagining of that disappearance as a prominent visual trope in art photography and other cultural practices."[48] Tracing the way in which photography after the human confronts deep temporal and spatial scales, as well as problems such as extinction, is an essential political, ethical, and artistic question. In "Boiling Milk," the ungraspability of

deep time manifests in the dissolving background, the indistinct materialities of the environment itself. And yet the body of the artist is not diminished or made fragile but is attentive to its relations. Her body holds itself carefully, her attention is a mode of care for the moment itself, for this seemingly simple event of holding a pan of milk above heat from beneath the earth's crust. Viewing this image, one can witness not only temporal scale, but also an ethics of care toward what that scale does, how it can be a site of connection and bring shared intimacy between human and nonhuman.

But the witnessing of temporal scale can also be radically unearthly. In the final pages of Cixin Liu's epic *Three-Body Problem* trilogy, the impossible scale of the life of the universe itself enters into a strange relation with two of the novel's human protagonists, Cheng Xin and Guan Yifan. Suffice to say, the details of how this speculative fiction progresses from the midst of the Cultural Revolution to an interstellar future are beyond reckoning with here. But by the third book's end—SPOILER ALERT!—Cheng Xin and Yifan are in a small space shuttle orbiting a distant planet at the speed of light when they are caught by the rippling wave left behind by a light-speed engine that curves space to propel ships forward. Its rupturing of spacetime slows the speed of light itself to a crawl, such that—as the laws of relativity require—time passes incredibly slowly for the two of them relative to the universe outside. Forced to use hibernation technology to survive through the slow reboot of their shuttle's computers, sixteen days pass for the pair while the planet experiences more than eighteen million years. Using ground-penetrating remote sensors, they are able to find a message left for them through the eons and a doorway that leads into an artificial universe. It is a closed ecology of a single cubic kilometer, suspended outside of time and from its vantage the two will be able to watch our universe collapse into singularity and be reborn in a new Big Bang. But the loss of mass from thousands of such micro-universes risks reversing the crunch of the grand universe and instead expanding it into endless, deenergized lifelessness. Rather than contribute to such existential senescence, Cheng Xin and Guan Yifan give up their existence outside of time and the promise of the birth of a new universe to live the death of our own. They leave behind a computational record of human existence, and a small globe containing two fish, water, and a tiny artificial sun. To our universe, they return the mass and its incipient energy that has made their existence outside of time possible.

It is, even by the standards of science fiction, an almost preposterous projection, a conceit of human galactic endurance that belies our seeming incapacity to do anything but destroy the richness of life on this planet. And

yet it chases after something profound: a speculative pursuit of an infinite relation between the human and the nonhuman vastness of the universe. Against the total mass of an expanding and contracting universe, what is human life, memory, existence? As an exercise of thought, it proposes that the witnessing of humanity as a species depends inevitably and inextricably on the nonhuman. On the one hand, this is an obvious claim—what else might be the other of such witnessing, that to which address is made and response implored? But it is also a proposition that, for all its technowizardry and speculative gymnastics, returns the human unavoidably to the question of its relations to the milieu through which it moves and lives, whether at the scale of the universe, solar system, planet, ecology, community, or self. Witnessing the human at the limit point of the existence of the universe itself means insisting on an offering to the ultimate nonhuman, life rendered down to the necessarily flawed remainder yet insisting that some memory endure into the emergence of a new space-time.

Reflecting on the Abrahamic tradition of testimony, Peters writes that "testifying has the structure of repentance: retroactively caring about what we were once careless of."[49] Already, testimony serves this function of repentance in the Anthropocene: it marks and acknowledges the failures of government, publics, and individuals alike, as well as the small victories of collective action, of reparative meaning-making. Scale can be operative, as well as relational. Anna Tsing argues that scalability served a crucial role in the accumulation of capital and in the spread of extractive modes of production across the planet. Scalability describes "the ability to expand—and expand and expand—without rethinking basic elements."[50] Tsing points out the scalability of the plantation was essential to its proliferation as a model throughout the Americas, just as scalability remains a fundamental principle of contemporary business from social media platforms to fracking operations. As C. L. R. James and more contemporarily Chris Taylor, Caitlin Rosenthal, and Katherine McKittrick, among others, have argued, the plantation is the model for the factory and for neoliberal conceptions of scaling production up and down.[51] In approaching this weaponization of scale, Tsing calls for an attentiveness to nonscalability, "to the work of contingency and failure" and the workings of "scalability in action."[52] By attending to registrations of scale, nonhuman witnessing offers another means of thinking the nonscalable and the operations of scale between that which scales and that which does not. Nonhuman witnessing of scale, then, is not solely about how we grasp the ungraspable, but also how we intervene in the ways that scale is put to use. If ecological violence operates across spatial and temporal scales,

then so too is ecological trauma bound up with scale. Nonhuman witnessing of scale, then, brings us to one of the core problematics of ecologic crisis: its traumatic disjunctures, cascades, and contaminations.

ECOLOGICAL TRAUMA

Rising panic in the West over the "end of the world" often fails to recognize already existing experiences of ruined lifeworlds. Nor do enough planned or imagined responses to the climate emergency give heed to the ontologies, epistemologies, and practical knowledges of those people who lived far more sustainable lives before and despite settler colonialism. Ecological catastrophe has already been experienced by First Nations: the anthropogenic end of worlds is, all too terribly, nothing new. Through violence to knowledge, land, and ways of living, as Kyle Powis Whyte argues, "settler colonialism commits environmental injustice through the violent disruption of human relationships to the environment."[53] Felling forests to graze cattle and grow crops, introducing invasive species, diverting rivers and flooding valleys, flattening hills and bifurcating mountains with highways—the list of such disruptions is endless. Nor, of course, are such ecological traumas confined to the past. Environmental destruction, loss of traditional forms of community, and death itself all flow from resource extraction, weapons testing and war, plantation agriculture, and other forms of what Rob Nixon calls the "slow violence" of late capitalism, inflicted on the poor, oppressed, and dispossessed.[54]

Ecological trauma describes the injurious and ongoing effects at the level of experience of the rupturing of relations that compose ecologies as living and changing assemblages of more-than-human entities and processes. All traumas target relations, severing encounters or events from the flow of experience and lodging those fragments in bodies as they go on, affecting and affected by the world as it unfolds. But ecological trauma can be understood as trauma that results from the rupturing of the relations that compose an ecology, rather than those that enmesh a body within its world. Located at the relational-compositional level of the ecology itself, ecological trauma echoes collective cultural trauma, but is differentiated by its insistence on nonhuman entities and the situatedness of all ecologies and their relations. Like trauma more generally, ecological trauma is found not in the violence that enacts a rupturing of relations but in how that rupturing carries through into the future. Contaminating the unfolding multiplicities of experience that animate an ecology with the past, ecological trauma is also haunted by

futures forged by ecological violence. These are futures diffracted through trauma: the threat of collapse, stagnation, and death.

Ecological trauma encompasses but also exceeds what I and others have elsewhere called "climate trauma," the traumatic rupturing of relations that resides in the impossibility of the individual subject reckoning with the scale of the climate crisis in its totality.[55] Timothy Morton has argued that global warming must be understood as a hyperobject, "massively distributed in time and space relative to humans."[56] As a hyperobject, global warming can only ever be grasped through second-order abstractions such as graphs or in localized effects, such as the slow drowning of Pacific islands, but such representations can at best be synecdochic of the incomprehensible totality of the climate crisis. The problem is that the object-ness of the hyperobject takes precedence over its local manifestations, systemic origins, and meaningful strategies for its amelioration. The theoretical maneuver that transforms climate crisis into a hyperobject is itself a violent mediation, one that strips away agency, complexity, and relationality even as it evokes those very things within its theoretical tool kit.[57] Framing contemporary crisis within the hyperobject paradoxically reasserts the Anthropos, even as the human is disavowed by Morton's insistence on the separateness and inaccessibility of objects in general. While it is true that "climate change" constitutes an abstraction that necessarily contains more than can be grasped, reifying the planetary scale risks replicating the annihilation of experiences of ecological violence, loss, grief, and renewal that takes place in more intimate, varied, dispersed, and uneven ways. The ecological trauma of our age might be better grasped as both one and many; always ecological *traumas*, plural, even when it seems otherwise.

What I am proposing is a radical empiricist approach to ecological trauma that recognizes rupturing and violence as processual phenomena. Just as a radical empiricist approach to experience recognizes that the present is always lost between unfolding pasts, which carry with them lost futures, and the tug of potential futures, so too in more-than-human ecologies is the present always unavailable to its own experience. Future collapse bears down on wounded ecologies in the present, bringing itself into being through the continuance of violence in the form of trauma. Consider, for instance, the fires that have become the norm in California, Brazil, and Australia, and the way their looming ever-presence affects life even beyond the devastating damage to animals, habitats, and homes.[58] As Massumi writes: "This is the figure of today's threat: the suddenly irrupting, locally self-organizing, systemically self-amplifying threat of large-scale disruption."[59] There is, in a very real sense, an affective

injury in the now from that which has and yet has not arrived. Always in dynamic flux, even if that flux is entropic, the present of an ecology is always missed in much the same way as it is for humans.

This traumatic relation to ecological crisis is not simply about the apparent futility of action in this era of late capitalism but also the exponential complexity of the problem. Ecologies are not isolated systems; any boundaries placed upon them are always artificial and temporary. We humans distinguish one ecology from another to make them sensible and addressable but doing so is always a tactical measure: ecologies fold into one another, at once one and many. Against the reified hyperobject of catastrophic climate change, we might instead conceive of an endless complex planetary ecology, simultaneously composed of an infinite array of other ecologies. Ecological traumas have thus shaped and continue to shape lives, communities, cultures, and ecologies. Among those traumas is one that resides at the atomic organization of existence: nuclear war. Nuclear explosions occur within a fraction of a second but leave radiation that contaminates, mutates, and ends life into unfolding deep-time futures. Nuclear weapons and their catastrophic damage constitute a vital site for engagement with nonhuman witnessing as both an other-than-human registration of change and an aesthetic project of human and more-than-human commingling. It is to the testing of these paradigmatic technologies of world ending that I now wish to turn.

WITNESSING THE NUCLEAR

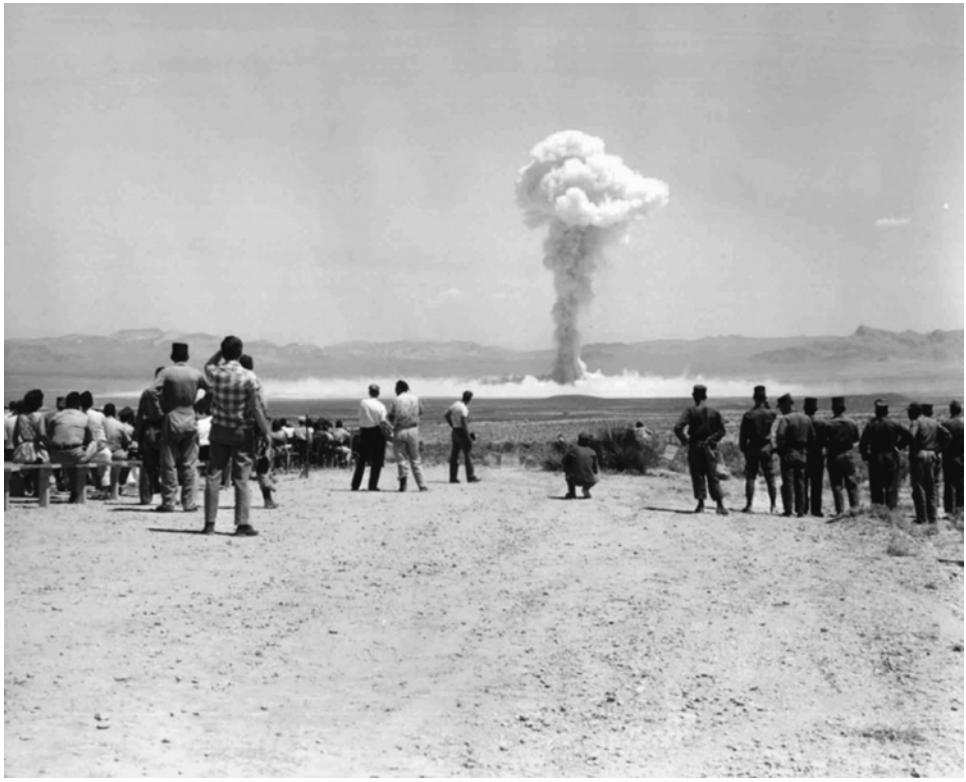
Yankunytjatjara elder Lester Yami called it a "black mist," a thick cloud enveloping Adnyamathanha country, part of a huge swathe of Aboriginal land in South Australia used for nuclear testing by Britain from 1953 to 1963.[60] He described his experience to the 1984 Royal Commission into the tests: "A big bang—a noise like an explosion and later something come in the air . . . [it] was coming from the south, black-like smoke. I was thinking it might be a dust storm, but it was quiet, just moving . . . through the trees and above that again, you know. It was just rolling and moving quietly."[61]

Personally authorized by Prime Minister Robert Menzies and conducted in secret, British nuclear testing in Australia took place on the Montebello Islands (in 1952 and 1956), at Emu Fields in South Australia where Lester Yami encountered the black mist (1953), and, most infamously, just to the south of Emu Fields at Maralinga (1956–1963).[62] Emu Fields was a particularly disastrous choice: difficult to access by vehicle and prone to violent dust

storms, it significantly increased the risk of wider nuclear contamination due to irradiated dust carried on the wind. But the worst damage was done at Maralinga, where the British tested seven atomic bombs and conducted a series of even more disastrous "minor tests."

In 1956, "Operation Buffalo" tested Red Beard and Blue Danube, plutonium warheads with a destructive equivalent to the weapon dropped on Hiroshima, with the smaller "Operation Antler" conducted the year after (figure 3.4).[63] These were followed until 1962 by a series of so-called minor tests, in which plutonium was scattered around various trial sites and blown up to analyze shock waves, safety measures, and radiation effects—with devastating consequences for Country.[64] Ineffectual clean-ups were attempted, with two desultory efforts by the British in the 1960s and more comprehensively by the Australian government in 2000, although costs were soon cut and their effectiveness has been contested.[65] In 2021, a study undertaken by scientists

FIGURE 3.4. British nuclear testing at Maralinga, archival image



at Monash University showed plutonium in the soil at Maralinga.[66] Because very little was done to protect local communities, many suffer from high rates of cancers and disease.[67]

Lester Yami described the immediate effects in visceral terms: "I cannot remember how long we were getting sick and sore eyes and watery eyes and diarrhea . . . vomiting and skin rashes . . . purtju, sore on the skin . . . I could not see with both eyes."[68] The entire ecology—people, water, vegetation, animals, dirt, dust, geology—were directly exposed to radioactive contaminants during the blasts and fallout, embedding radioactive elements within the ecosystem, passing them through bodies and life cycles.[69] Here, the recollections of Nyarri Morgan, a young man at the time of the tests, are instructive: "We thought it was the spirit of our gods rising up to speak with us . . . then we saw the spirit had made all the kangaroos fall down on the ground as a gift to us of easy hunting so we took those kangaroos and we ate them and people were sick and then the spirit left. . . . The smoke went into our noses, and other people still have that poison today."[70]

Maralinga was formally returned to its Traditional Owners in 2009, but Country and its ecologies, the rich relations that bind human and non, remain contaminated, wounded, and traumatized (figure 3.5). For First Nations in the settler state of Australia, such wounding of Country constitutes an existential violence. Trawlwulwuy scholar Lauren Tynan writes: "Country inhabits all relationality and is used widely across Australia to describe how all land is Aboriginal land, Aboriginal Country; Country is agentic and encompasses everything from ants, memories, humans, fire, tides and research."[71] Violence to Country needs to be understood as something far more injurious and rupturing than what might be denoted by damage to "environment" within Western epistemologies. As Tynan continues: "Country sits at the heart of coming to know and understand relationality as it is the web that connects humans to a system of Lore/Law and knowledge that can never be human-centric." Country is thus radically at odds with what Aileen Moreton-Robinson calls the "possessive logics" of white settler sovereignty, that claim land as property and thus render it always potentially subject to extraction and violence.[72]

While the British authorities made efforts to mitigate the effects on white farmers, the Aboriginal inhabitants of the region were almost entirely neglected.[73] Aboriginal culture, history, lifestyle, and ceremony were not considered important by civic and military authorities. "The nomadic nature of the desert people, their traditional lifestyle and seasonal journeys for hunting and ceremonial purposes was poorly understood," writes historian

FIGURE 3.5. Signage at the former nuclear test site at Maralinga

J. D. Mittman. "The country there was regarded as 'empty wasteland,' in line with the legal doctrine of *terra nullius*, a Latin phrase meaning 'empty land' or 'land belonging to no-one.'"[74] This legal doctrine of terra nullius articulated the land as lacking property relations. First Nations peoples might live on the land but had not undertaken improvements legible to the colonizers as demarcating possession. Through this doctrine, First Nations were dispossessed of the land so that white settlers could possess it, a move that not only stripped them of property under Crown law but also assigned them as belonging to the state of nature.[75] Just as terra nullius was retroactively applied to authorize the theft of land under settler colonialism in what became known as Australia, so too was it used to justify the new nuclear colonialism. For a British Empire in disarray, Maralinga was an acceptable sacrifice zone, an empty wasteland, populated by people still counted among the flora and fauna of the nation, that could be readily transformed into an extraterritorial zone of incision in which its inhabitants, having lived there for thousands of years, were suddenly rendered illegal.

This construction of a zone of absence and excision echoed that of the Soviet Union in Kazakhstan and Siberia, and the French and the United States in the Pacific. In this sense, Maralinga reproduced the nuclear colonialism emerging across the United States and the Pacific.[76] Unsurprisingly, the most targeted were and continue to be Indigenous peoples and lands. Operating in contexts of radical power asymmetries, nuclear colonialism depends on material and discursive maneuvers, generating economic dependencies on the one hand while constructing lands and people as permissible objects of

violence on the other.[77] In the Marshall Islands, the United States detonated thermonuclear weapons orders of magnitude more destructive than those at Hiroshima and Nagasaki, leading to the displacement of peoples from their traditional homes and to a horrific legacy of birth defects across the islands.

As the opening pages of this chapter made clear, those same islands are now among the most at-risk places on the planet for the rising sea levels of global warming, in yet another tragic knot in the entangled history of nuclear war and climate science. Perhaps unsurprisingly, drone histories occur here too, with the Operation Kamikaze remotely piloted drone munition tests conducted in the shadow of Castle Bravo, at fifteen megatons the largest test ever conducted by the United States. Nuclear colonial discourse imagined the Pacific as isolated islands and empty seas. But nuclear testing helped mobilize a renewed Oceanic political activism that insists on a relational political ontology, founded on the connectedness of sea and islands, peoples and fish.[78] Aboriginal land in Australia was similarly subject to expropriation and excision. Pitjantjatjara Anangu from Ooldea were forcibly removed from Country to a purpose-built settlement in Yalata more than 150km to the south. The test site was renamed Maralinga by the Australian authorities, the word for "thunder" in the Garik language, chosen for its fit to the nuclear violence that would take place there.[79] Maralinga was excised from the civilian legal order and made inaccessible to its Traditional Owners, a redoubled denial of sovereignty. Weapons testing began shortly after.

Detonated in the first test of Operation Buffalo at Maralinga, the bomb known as Red Beard used nuclear fission, a process that exploits the desire of unstable atoms to achieve an impossible equilibrium (figure 3.6). Under the intense force of neutron bombardment or chemical explosion, an atom of an unstable isotope—a mix of Uranium-235 and Plutonium-239 in the case of Red Beard—splits in search of stability. As it splits, energy is released but so too are smaller nuclei—fission products—that strike other unstable atoms, changing their atomic structure. Two or more neutrons, subatomic particles within the nucleus held in check by electromagnetic force, get ejected. Ejected neutrons disrupt other, already unstable isotopes. Uranium-235 becomes Uranium-236, an even more unstable isotope that splits again, releasing more energy and more fission products. More atoms are struck and split; more energy is released. This is the chain reaction that generates the catastrophic explosion of the atom bomb, an urgent hunt for stability that produces nothing but more splitting, more energy, more instability.[80] Nuclear bombs are designed to explode well above the ground, maximizing both the force and radius of the blast: this is what produces the spectacular

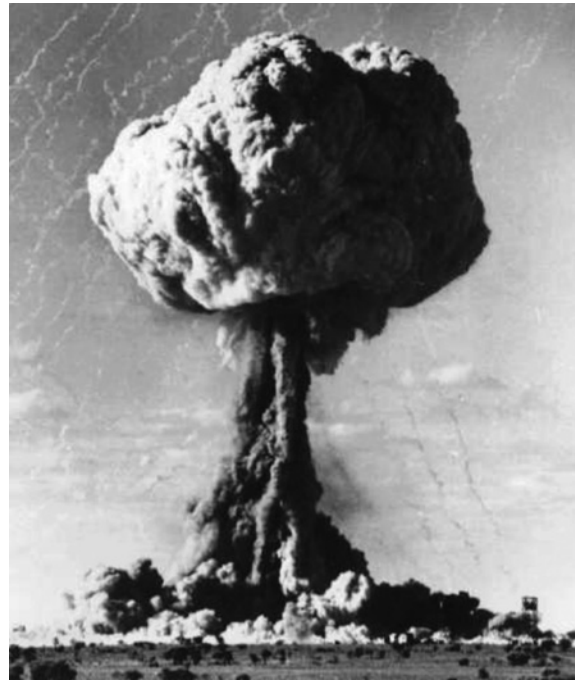


FIGURE 3.6. Explosion of a Red Beard warhead on September 27, 1956

mushroom cloud, which reached a height of almost twelve kilometers with the first test at Maralinga. Heat is so intense that it turns bodies to ash, melts metal and concrete, and, at Maralinga and Emu Fields, transformed the silicate and sand of stretches of desert into a crust of glass.[81]

Glass becomes an aesthetic medium for the nonhuman witnessing of nuclear violence in the hands of the artist Yhonnie Scarce: brittle yet tough, capturing light yet also diffracting and refracting it, rigid when cool yet shaped by the breath of the glassblower when molten. Belonging to the Kokatha and Nukunu peoples whose country forms part of the Maralinga excision zone and born in the military town of Woomera, Scarce's personal and familial history is bound to settler colonialism and to its entanglements with militarism. Her work is intensely political: an unflinching critique of past and present settler violence, but also a celebration of the resilience and endurance of Aboriginal people and of Country in the face of the colonial logic for elimination. Repeatedly returning to the interconnections between the classification and dispossession of First Nations land and scientific and military testing, Scarce's work is unified by an unrelenting aesthetic of austere grayscale, battered found objects, stark medical equipment, and spare

architectural structures and installations. While Scarce works with a range of media, glassblowing is at the core of her practice, a visceral and difficult art that demands much of breath and body. The subject of a major survey exhibition at the Australian Centre for Contemporary Art in Melbourne and at the Institute of Modern Art in Brisbane in 2021, Scarce's works are held at the National Gallery of Australia, the National Gallery of Victoria, Art Gallery of South Australia, and by other galleries and private collectors around the world. While her work always addresses colonialism and its violence, the subject matter ranges from family history to medical experimentation to the legacies of nuclear testing. In three of her major works—*Thunder Raining Poison* (2015), *Death Zephyr* (2017), and *Missile Park* (2021)—Scarce reveals the potential for a glassy aesthetics of nonhuman witnessing to nuclear violence.

Thunder Raining Poison (2015) and *Death Zephyr* (2017) are formally and thematically similar works (figures 3.7 and 3.8). Both are composed of thousands of blown glass yams suspended from the ceiling in arrays that reference the atmospheric forms produced by nuclear tests at Maralinga. There are critical differences between the two works: *Thunder Raining Poison* captures the instance of detonation, yams arranged in a teardrop formation and mostly made of clear glass, interspersed with black and blue; *Death Zephyr* examines the spread of contaminated particles in the aftermath of the blast, its mix of black and clear yams hang in a swirling current across the gallery space, a material enactment of Lester Yami's "black mist" over Country. Una Ray observes that "the yam and other 'bush tucker' plants such as the bush banana and bush plum, along with their associated Tjukurrpa (Dreaming) sites are important subjects for Aboriginal artists, particularly women who traditionally held the comprehensive knowledge of the regularly harvested and managed bush gardens across Australia."[82] Composing yams into forms of nuclear explosion and dispersal materializes the violation of life by such violence, its assault on the nonhuman that sustains the human. Not only is sand blasted into nonlife, these works suggest, but also the means to sustain life affectively and discursively signified in the alchemy of yams become inedible. Distended and distorted, the yams are reminders too of "eviscerated organs or exhumed physical evidence in the prosecution of war crimes," as art critic and Bundjalung and Kullilli man Daniel Browning puts it.[83] Both *Thunder Raining Poison* and *Death Zephyr* are reminders of the limits of the forensic practices of the state to understand the consequences of the tests conducted on Aboriginal land precisely because life is ecology: yams, sand, land, bush animals, people, are bound together by Country, a relationality

FIGURE 3.7. *Thunder Raining Poison*, Yhonnie Scarce 2015. Courtesy of Yhonnie Scarce and THIS IS NO FANTASY.

FIGURE 3.8. *Death Zephyr*, Yhonnie Scarce, 2017. Courtesy of Yhonnie Scarce and THIS IS NO FANTASY.

that is just as crucial to the ecology as the electromagnetic forces that hold neutrons in check are to stability at the atomic scale.

Unstable isotopes are radioactive: they contain an unbalanced combination of neutrons and protons in their nucleus, which typically means too many neutrons. By shedding extra energetic particles, these isotopes "decay" into other particles, becoming more stable and less radioactive but releasing nuclear radiation in the process. When a nuclear bomb is detonated, radioactive particles are dispersed by the explosive force, attaching themselves in turn to other particles. This is nuclear fallout: the irradiated particles of weapon debris and dust that are carried on the wind, as *Death Zephyr* reminds us, before they fall to earth. In their fall, they can attach and deform more particles and the cells that make up life, such that stones, plants, animals, and people become carriers of contamination, nonhuman and doomed witnesses to nuclear catastrophe.

Some of the most devastating effects at Maralinga were not the bombs themselves, but the "minor tests" involving the detonation of scattered plutonium and other radiation "safety" experiments. Depending on the half-lives of the isotopes involved, radioactive contamination might be present for minutes, days, or years.[84] Radioactive contamination can have enduring effects: making soil and water poisonous, producing cancers and miscarriages,

and deforming life at its most basic workings. Yet radioactive decay also constitutes a material witness to the unthinkable force of the nuclear explosion, a nonhuman registration of the impossible violence that it produces—and that produces it. Radioactive contamination and its decay are themselves both nonhuman witnesses, and what must be witnessed.

While foreign wars and colonial "exploration" are commemorated across Australia, the violence done to its original inhabitants remains politically contested and largely unmemorialized. Official memorials function as modes of commonplace witnessing, generating the shared meanings through which certain political knowledges and identities are reproduced and others are elided or erased.[85] *Missile Park*, commissioned to accompany the 2021 survey of Scarce's work, offers a countermemorial to the violence of nuclear testing and settler colonialism. Blasted raw and roughly painted black, three corrugated metal sheds echo the structures common to Maralinga and Woomera, but also to Australian settlement more generally (figure 3.9). One shed invites entry into a near-dark space, lit only by the gallery light that finds its way through the gaps of corrugation, in which a simple table holds twenty bush plums blown from black glass (figure 3.10). Gunditjmara and Torres Strait Islander artist and curator Lisa Waup calls these sheds "containers of trauma."[86] Here in the dark, in the hurried tin-shed architecture of the expansive project of Australian settlement, the bush plums attest to the memory of ecologies of life cleaved by violence. Ray describes the artist's work as "a composition between hand and breath, the alchemical, elemental process of glassblowing neatly fuses the maker to her material and her métier to meaning."[87] *Missile Park* coalesces these elementalities, finding in their ecological relations a host of evocative tensions. Bush plums of black glass capture breath, that most ephemeral and basic gesture of fleshy life, but they also hold in their material memory the pollution of air, the violent contamination of the bomb. They bear nonhuman witness to the scales of incommensurate temporalities of the nuclear: the split second of the explosion, the long half-life of plutonium, the irradiated endurance of Country. Here is ecological trauma, witnessed through an ecology of processes, objects, and milieus that only come to matter through their relational composition.

There is a dark irony in the witnessing capacities of glass, one that extends beyond Scarce's art and the silica seared into trinitite at Maralinga to the failed use of vitrification in the latest attempts to clean-up the radiation at the test sites.[88] Developed by the US company Bastelle, *in-situ vitrification*, or ISV, uses electricity to immobilize plutonium and other unstable isotopes in glass-like blocks that can keep them safe for hundreds of thousands of

FIGURE 3.9. *Missile Park* exhibition installation, Yhonnie Scarce, 2021. Courtesy of Yhonnie Scarce and THIS IS NO FANTASY.

FIGURE 3.10. *Missile Park* interior, Yhonnie Scarce, 2021. Courtesy of Yhonnie Scarce and THIS IS NO FANTASY.

years, at least in theory. In practice, ISV was difficult to implement and not always fit to task, the government department overseeing the process failed to establish clear criteria—and, surprising no one familiar with the history of the state's treatment of Indigenous peoples in Australia, once costs grew, vitrification was abandoned in favor of exhuming and burying the waste. Glass as a failed medium of remediation testifies to the unyielding nature of nuclear radiation, but also to the persistent coloniality of settler politics, to the legacies of who counts as human and who does not. As a byproduct of nuclear testing and as a failed mechanism for decontamination, vitrification is a process of mediation: silica into glass, by way of the intense applications of energy. Its violence is not inherent, but contextual. Through the breath of the glassblower, vitrified silica becomes intimate and lively: a rich ecology of country, life, fruit, vegetable and yet still an ecology deeply wounded by the violence of war and settlement. Glass yams and bush plums distill the ecological traumas of nuclear testing at Maralinga, the stuff of life rearranged into the mushroom cloud and its dispersal and memorialized in the tin sheds of the test sites.

What it means to witness such ecological trauma looks very different within the accepted bounds of historical witnessing, particularly in the official form it took in the Royal Commission into British Nuclear Tests in Australia, chaired by Jim McClelland. While the commission sought to account for the health impacts on Aboriginal people and heard the testimony of Lester Yami and others, its principal focus was the irradiation of Australian servicemen, the safety precautions implemented by the British, and the nature of the agreement between Australia and its imperial overlord. From a cultural standpoint, Yami's black mist is surely its enduring figure, one that finds a glassy counterpart in the art of Yhonnie Scarce. Nuclear activism and public pressure in the 1980s did much to make Maralinga and Emu Fields visible to the wider Australian public, and in 2009 almost all the lands of the excision were returned to their Traditional Owners. But the Royal Commission, the failed cleanups that followed, and the narrow inquiries from various departments and committees function as stark reminders of the impossibility of such organs of the settler state working against its fundamental investments in militarism and the denial of Indigenous sovereignty. Within such confines, the capacities of witnessing are bound not only by the necessity of speaking but also by legal norms and parliamentary terms of reference.

A more expansive witnessing must be sought elsewhere, in the poetry of Indigenous writers such as Oodgeroo Noonuccal, Lionel Fogarty, and Natalie Harkin, and even in the inventive research of scientists, who have exposed

the radioactivity embedded into particles of the land. In a poem written for the catalogue of the 2021 survey of Scarce's work, Harkin writes:

> mine and refine this float of molten
> landscape raw silica-sand and
> limestone sites slice and stirred
> and hot-shop forged we
> witness excavation of targets and
> melts a redaction of origins of
> lives of lands
> see what a breath can do[89]

An intimacy emerges in Harkin's words that bears a certain resemblance to that between Ilana Halperin and the deep time of volcanic heat in "Boiling Milk." Yet here the relation is one of breath, an intensive yet ephemeral bond between the geological, the nuclear, and the fragility and force of human life, the glassblower and her glass. As with all the aesthetic works examined in this chapter, Scarce's are of course instigated by human subjects and wrought by human hands. Yet they dance with the nonhuman in equally inseparable ways, from their insistent materiality to the nuclear violence they reference to the settler histories of dehumanization and the nonhuman classification of Aboriginal peoples. Glass suspended in air coalesces an instance of the most radical ecological violence possible: a violence torn from the fracturing of the atomic structure of matter itself, a violence that holds the potential not only to erase the human but also to destroy all but the most defiant, hidden, and persistent forms of life. And yet glass also captures the endurance of breath, the variability of life, and that most fundamental of mediations: photons of light passing through a medium. Life in all its relations, located in Country and food, in air and stone and water, is not simply indexed or represented in the art of Yhonnie Scarce: it is processually present, materialized as a witnessing ecology come to life out of the urgent need to witness ecological trauma and its continued imbrication with the settler state and its militarisms.

WOUNDING

In *The Logic of Sense*, Gilles Deleuze recognizes that futurity resides at the heart of the event and its relation to human expression. The event is "always and at the same time something which has just happened and something which is about to happen; never something which is happening."[90] This

simultaneous doubling and splitting of that which has just happened, or the actual, and that which may be about to, or the virtual, constitutes a kind of rupturing: a wound. While this wound is not corporeal in the same way as a cut or broken bone, it is nonetheless bound up with sensation, with the bodily experience of the event—and, crucially, with its separating into a distinct symbolic element in the realm of pure expression. Or, to put this in more distinct terms, the wound is the rupturing of virtual into actual, whether in experience, thought, or expression. Deleuze's choice of the wound as a metaphor is telling: it draws particular attention to the violence inherent in the limiting of potential that occurs in any given thing becoming actual. To call this a wounding suggests that all intersections of the virtual and the actual, all forms of creation—whether life-living or art-making, human or otherwise—are inextricable from injury, from a cleaving of one thing from another. Here, then, is the dynamic of violent mediation at the level of expression itself, of the coming into living of life: a transformative mediation from one state to another that cannot but cut off, leave behind, exclude, or ruin, even as it makes possible the new and the otherwise from which the good might flourish.

This relation between life and expression circulates in Deleuze's enigmatic final essay, "Immanence: A Life . . . ," in which he dwells on the two terms of the title and their relation to each other.[91] He shows how immanence neither refers to an object nor belongs to a subject but is immanent only to itself. The second term—*a life*—captures something at once instinctively understood and yet very difficult to pin down precisely. It is life as an indefinite thing—not this life or that, not my life or yours, but rather *a life*, indefinite and potential, indeterminate yet somehow also composed of singularities. At once the many and the one, to borrow from the pluralism of William James that so influenced Deleuze.[92] This multiplicity in the midst of singularity shares much with what Mario Blaser and Marisol de la Cadena call a "world of many worlds," a pluralism that is not only experiential but politically ontological.[93] Drawing from her deep anthropological engagement with Andean Indigenous communities and politics, de la Cadena insists on the political vibrancy and active agency of earth-beings, a necessarily truncated translation of mountains, lakes, rivers, and other existences that, for Andeans, "blurred the known distinction between humans and nature."[94] The pluralistic politics that flows from recognizing the standing of earth-beings is a question that I will return to in the coda of this book, but here I want to draw a relation between this pluralism and the processual emergence of actualities from within the sheer stuff of existence. Only in wounding does *a life* become the life of a subject or object, or even a milieu. "A life contains only virtual,"

writes Deleuze. "It is made up of virtualities, events, singularities."[95] Writing with Guattari, Deleuze describes the plane of immanence as "the plane of Nature, although nature has nothing to do with it, since on this plane there is no distinction between the natural and the artificial."[96] Such an approach echoes the relationality that Tynan describes as "premised on a truth that 'all things exist in relatedness' and whilst this is a naturally occurring principle of many Indigenous worldviews, it is a principle that is sustained and strengthened through practice."[97] Without eliding or erasing the differences in these epistemological standpoints, what emerges across them is a recognition of the mutuality and relationality that makes existence and experience possible.

It is within this sense of the mutuality of all existence that the complex and necessary nature of Deleuze's wound becomes clear. The wound is not simply to be suffered or endured; it is not an injury with moral overtones. It is incarnated in life as a state of things, as corporeal, temporal, and experiential, yet it leads into that indefinite, elusive plane of *a life* precisely because the wound is a "pure virtuality on the plane of immanence" even as it is actualized in particular bodies.[98] Put differently, the wound is a kind of passage, the means by which the plane of potential takes place, something felt as loss but also as always newly opened. Deleuze writes: "My wound existed before me: not a transcendence of the wound as higher actuality, but its immanence as a virtuality always within a milieu."[99] He might have chosen another word—cut or break, perhaps—yet this choice of wound (*une blessure* in French) matters. It is a reminder that embodiment is necessarily both a rupture from what might have been *and* the becoming-in-the-world of a host of lively potentials. Naming this a wounding calls attention to an ethic of care; it evokes both fragility and resilience. It suggests that how wounding happens, what form and movement it takes, matters both for *a life* and for life lived. This has consequences for conceptualizing and responding to ecological traumas: it suggests that wounded ecologies are also a wounding of the relation between experience and expression, between life and aesthetics, between existence and becoming. As a response to ecological traumas, the processual and unfinished nature of nonhuman witnessing seeks to make this constitutive wounding sensible—however fleetingly.

Wounding, unsurprisingly, also occupies a central figural position in the study of trauma in the humanities. As literary theorist Cathy Caruth insists in what has become a canonical formulation, trauma "is always the story of a wound that cries out, that addresses us in the attempt to tell us of a reality or truth that is not otherwise available."[100] This wound, like that of Deleuze, occupies a doubled position: marking both body and mind yet unknown

to either. Only in the belated arrival of a voice from within the wound—a return of the wounding in the form of trauma—does knowing become possible through paradoxically testifying to its own impossibility. As in Deleuze, the wound of trauma is not a metaphor but rather the living embodiment of a relation of rupture between experience and expression. Trauma studies shares with Deleuze this recognition that the rupturing of the wound occurs at the most basic forms of relation: its rupturing ruptures the planes of experience and expression. More, that this rupturing is at once destructive and creative—it closes off or eliminates potential even as it produces the actual.

Ecological trauma also possesses an affective dynamic, what Massumi describes as the participation of the actual in the virtual and the virtual in the actual.[101] In ecological trauma, as in all traumas, that enmeshment of virtual and actual is radically constrained by the foreclosure of potential and meaning. This foreclosure is characteristic of traumatic ruptures to experience: the disjunctive wound becomes a discordant, damaging feedback loop. Divorced from problems of scale and the necessity of human subjectivity, the wound in the virtualities of *a life* works at a remove from the problem of shifting between the personal and the collective that troubles so much work on trauma in the humanities. Nonhuman witnessing addresses trauma at this vital plane of existence because it resists the temptation to wait for trauma to arrive in the human. It attends to traumatic ruptures within life itself and their material entanglement of bodies of all kinds, from those of people to rocks, storms, and nonhumans animals.

ECOLOGIES OF WITNESSING

Nuclear testing, catastrophic climate change, the ecological traumas of militarism, capitalism, and colonialism: these are planetary phenomena that nevertheless have consequences that are at once intimately embodied and collectively targeted. Ecological catastrophe is martial as well as capitalistic. It is not an accident of history that required the Marshallese poet Kathy Jetñil-Kijiner to write of both rising waters and the deformations of life from nuclear contamination, of empty flesh sacs born in place of babies. Nor can the intensifying militarization of the oceans around China, a process in which Australia is a small but active player, be extricated from the failure of my country to act in response to the pleas and tears of Oceania's leaders.

Witnessing ecologies—both as a process of registering ecologies as sensible assemblages and as the composition of witnessing through the formation

of relations—are not an antidote to ecological trauma, but they are an opening toward the potential for repair. Nonhuman witnessing as an ecological relation generates transversal vectors between elements within ecologies: witnessing as ecological, produced in the dynamic relation of systems, but also the witnessing of ecologies, through the aesthetic registration of their relationality as process in time and space. Attending to the nonhuman witnessing of ecologies and ecological relations continually returns us to mediation at its most fundamental: the transfer and translation of energies from one medium to another, a process that can be harnessed by technoscientific instruments but also far outstrips them. Technoscience doesn't provide the only sensors and communicators of significance, even if we understand ecologies in a narrowly biological sense. Ecologies abound with sensing and sensors; animate and inanimate bodies alike take part in the dance of mediation, interrupting and modulating its flow. Some of these mediations are certainly violent in the sense that this book has articulated. But seemingly destructive forces within ecologies are not alien to life, as even a cursory knowledge of evolution, the seasons, or the role of fire in the flourishing of certain plants would attest. Ecological trauma, as a distinctive taking shape of that wounding to *a life* described by Deleuze, is not a "natural" phenomena, but one inextricable from the violence that humans do, and certain humans far more efficaciously, deliberately, and comprehensively than others. But while Man, the Anthropos, is surely responsible for the era that now bears his name, the forms and practices of knowledge-making that accompanied that transformation to what counts as life itself need to be wrested away.

Nonhuman witnessing, pursued in this chapter through the technoscientific apparatuses of remote sensing and in the aesthetic interventions of ecologically inflected art, makes possible the witnessing of ecologies and ecologies of witnessing that displace the human yet neither disavow responsibility nor refuse the address of wounded ecologies. In the next chapter, I pursue this collective and more-than-human concept of trauma alongside both the violent mediations and machinic affects of more technical systems with the aim of showing how nonhuman witnessing helps elucidate more quotidian experiences of violence, loss, and absence in digital cultures. This return to the human provides the ground for the coda that follows, where I take up the question of the politics of nonhuman witnessing more explicitly. Nonhuman witnessing is neither separate from nor prior to politics, but rather contains within it the latent potential for political relations that might otherwise fail to cohere, animate, or confront the human with the necessity of response.