Chemosocility in Multispecies Worlds

Endangered Frogs and Toxic Possibilities in Sydney

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Abstract Chemosocial communities have formed in Sydney, Australia, as a result of encounters with industrial pollution. If biosociality involves social relationships that emerge from biological conditions, then chemosociality involves altered, attenuated, or augmented relationships that emerge with chemical exposures. Some social groups have coalesced around place-based political action, while other chemosocial associations have proved to be ephemeral, evanescent, and conditional. Building on earlier work by multispecies ethnographers who have studied social relationships among humans and animals, this article follows chemicals into more-than-human realms. Fragile multispecies worlds have emerged in a complex landscape shaped by chemical weapons industries, municipal landfills, government remediation programs, real estate speculation, and a multitude of chemical and biological agents. Legacy dumping grounds in the Sydney Olympic Park have become habitat for the green and golden bell frog, an endangered species. While the normal world order of this frog has been lost with the spread of a deadly fungal disease, toxic chemicals have enabled for the continuation of its social life. Temporary spaces of immunity have emerged where life is protected and threats are negated by poisonous compounds that double as a cure.

Keywords chemoethnography; extinction studies; alterlife; multispecies ethnography; chemopower

Introduction

The Sydney Olympic Park, a polluted industrial zone that was remediated for the 2000 Summer Games, has become an unexpected site of reemergence for green and golden bell frogs (*Ranoid aurea*; formerly *Litoria aurea*), a threatened species that has experienced catastrophic declines.[1] While many amphibians have been harmed by toxic chemical exposures—such as pesticides from agricultural production, industrial runoff, and hormones in waterways—bell frogs have persisted here in polluted areas while vanishing from many protected conservation zones.[2] This article brings together

1. Pyke and White, "Review of the Biology."
2. Stuart et al., "Status and Trends"; Stockwell, "Impact and Mitigation," 26.

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insights of chemoethnography and multispecies studies to trace the interactions of biological and chemical species through shadowlands—the unrecognized places that provide material and ecological support to market economies and modern dreamworlds.[3] Reaching across conventional disciplinary divides I ask a series of questions: Which species are flourishing in polluted shadowlands? What conditions of social life have emerged in polluted landscapes and waterways amid the interactions of multiple chemical species? How should we care for endangered animals whose altered lifeways are now dependent on human-produced toxins?

Drawing inspiration from studies of human social worlds, one might characterize the world of green and golden bell frogs as an arena of shared discourse—where frogs sing to one another in choruses—and a space of social action where they have sex and "do things together."[4] In the Sydney Olympic Park these endangered frogs have a mode of life and sociality that has been altered by chemical by-products. This species is living with conditions of *alterlife* that have been "recomposed by the molecular productions of capitalism," to use a key idea from Michelle Murphy. "Alterlife names life already altered, which is also life open to alteration."[5]

Altered bodies, subjectivities, and affects often emerge with toxic exposures.[6] Among humans, nonnormative states of "cognition, proprioception, emotion, agitation, muscle strength, tunnel perception, joint pain, and nocturnality" have emerged from chemical encounters, according to Mel Y. Chen.[7] Even while chemical exposures enfeeble bodies and minds, they can also create ongoing possibilities for life.[8] Speculating about subjective experiences and embodied phenomenologies across the species interface, this article characterizes an alter-world for endangered frogs that has emerged in the artificial wetlands of the Sydney Olympic Park.[9] The conditions of social life that have emerged in this microcosm illustrate a phenomenon that has become ubiquitous in the era of late industrialism: chemosociality.

Chemosociality designates the altered, attenuated, or augmented relationships that emerge with chemical exposures. Encounters with toxins can produce intoxication, altered social experiences, and a shifting sense of normality for both humans and other animals.[10] Social worlds that develop from these shared exposures often involve creativity—at least in human realms—as people learn to live with non-normative personalities, idiosyncratic subjectivities, and quirky memories.[11] Like the cultural innovation

3. Plumwood, "Shadow Places."

4. Clarke and Star, *Social Worlds*, 113.

5. Murphy, "Alterlife and Decolonial Chemical Relations," 497.

6. Agard-Jones, "Bodies in the System."

7. Chen, *Animacies*, 196.

8. Roberts, "Reflections"; Derrida, *Dissemination*; Stengers, *Cosmopolitics I*, 29.

9. Buchanan, Bussolini, and Chrulew, "General Introduction."

10. Murphy, *Sick Building Syndrome*; Shapiro, "Attuning to the Chemosphere"; Pollock, "Queering Endocrine Disruption,"185.

11. Jain, *Malignant*, 219; Kafer, *Feminist, Queer, Crip*, 15.

that took place in colonial contact zones amid "conditions of coercion, radical inequality, and intractable conflict,"[12] social improvisation is a hallmark of communities that have formed as by-products of industrial chemistry.

Chemosociality is a kindred concept to biosociality. In the words of Adriana Petryna, biosociality engenders "novel social groupings bound by the hopes, fears, fates, and politics that have been made available to sufferers on the basis of biological knowledge."[13] While Paul Rabinow initially described new forms of biosocial identity that emerged with DNA testing technologies,[14] Deborah Bird Rose expanded the idea to include claims of political belonging and personhood that arise from illnesses such as HIV.[15] Some biosocial communities have been oriented toward activism aimed at securing treatment or compensation,[16] while other groups have emerged from genetic tests that reveal evidence of shared genealogical identities.[17] Chemosociality has taken on varied forms and political orientations amid fraught colonial, racial, gendered, and military histories.[18] Among humans, new virtual and place-based chemosocial communities have formed to campaign against industrial polluters and toxic dumps.[19] Shared chemical exposures in other contexts, like ephemeral clouds of exhaust emitted by a passing vehicle, can instead produce fleeting moments of recognition and solidarity that never resolve into political action.[20]

By introducing the idea of chemosociality in the context of biological communities and ecological assemblages, I insist that modern humans are not exceptional in our dependence on synthetic chemistry.[21] Multispecies ethnographers have long studied sociality in spaces where the provision of food changes relationships among animals,[22] where contagious fears leap across species boundaries,[23] and where humans patiently dwell together with animals in close proximity.[24] As ethnographers start to follow chemicals through complex landscapes—shaped by industrial production, modern war, urban planning, and real estate speculation—it is important to not just treat the environment as a backdrop to human agency, industry, and action. It is critical to consider emergent chemosocial assemblages in multispecies worlds.

12. Pratt, *Imperial Eyes*, 6.
13. Petryna, *Life Exposed*, 14.
14. Rabinow, *Making PCR*, 99.
15. Rose, *Wild Dog Dreaming,* 147.
16. Epstein, *Impure Science*; Petryna, *Life Exposed.*
17. Rose, *Politics of Life Itself*, 176; Nelson, *Social Life of DNA.*
18. Murphy, "Alterlife," 497.
19. Shapiro and Kirksey, "Chemo-Ethnography," 484.
20. Choy and Zee, "Condition."
21. Haraway, *When Species Meet*, 11.
22. Franklin, *Dolly Mixtures.*
23. Song, *Pigeon Trouble.*
24. Candea, "I Fell in Love with Carlos the Meerkat."

Toxic Sydney

When Australia won the bid to host the 2000 Olympics, the local committee began developing an unexpected site: the industrial precinct of Homebush in Sydney. The history of industry in this area began in the late eighteenth century, shortly after the colonial government divvied up land belonging to local Aboriginal groups, the Wanng-al clans, and gave it to white settlers. John Blaxland acquired 520 acres in 1806 where he established a tweed mill, a salt works, a flourmill, and a limekiln with white workmen as well as Chinese and women servants.[25] The first large-scale industrial enterprise in Homebush was a slaughterhouse. According to the Olympic Park website, by 1923 the Homebush Abattoir "was the biggest of its kind in the Commonwealth" with upward of 1,600 employees and a "killing capacity of 18,000 to 20,000 sheep, 1,500 cattle, 2,000 pigs and 1,300 calves per day."[26] Blood, manure, and other waste caused algal blooms and began attracting large sharks to Sydney Harbour. A building boom in Sydney led to the establishment of the State Brickworks in 1925, which began mining slate in Homebush, carving out a 23.5 acre open-pit mine. The brickworks further polluted waterways with silt. Gradually workers dug out a deep quarry, which became known as the brick pit. The landscape became dotted with oil refineries, paint factories, landfills, a gasworks, pesticide factories, and warehouses for storing naval munitions.

Chemosocial communities formed in other parts of Sydney in the 1970s when activists in Botany, a predominantly white neighborhood, began to campaign against Orica—a chemicals company that was stockpiling hexachlorobenzene and other toxic wastes.[27] When Sydney won the bid for the Olympic Games, city planners saw an opportunity to continue the work of these grassroots activists on a bigger scale. They chose Homebush for the Olympics because they wanted to clean up that area and found an opportunity for funding the remediation work, according to Gavin Birch, a geological scientist who served on the Olympic Environmental Committee. "The area was originally an intertidal wetland," Birch said, and in earlier eras it was seen as a swampy wasteland "so they filled it in with anything they could find—from garbage to building materials, to drums [of] very highly toxic organic pollutants."

In the run up to the Olympics, Gavin Birch produced knowledge in Sydney's shadowlands. Birch worked with his PhD students to take 4,513 core samples of soil in Homebush where they found elevated levels of toxic heavy metals—including chromium, copper, lead, and zinc.[28] "Some of the most toxic substances were actually located in 44 gallon drums," Birch said. "They just piled some of the most awful stuff into these drums and deposited them in wetlands." Union Carbide, which had been

25. Sydney Olympic Park, "Colonial History." www.sopa.nsw.gov.au/About-Us/History-and-Heritage/Colonial-History (accessed March 12, 2019).

26. Sydney Olympic Park, "Industrial History." www.sopa.nsw.gov.au/About-Us/History-and-Heritage/Industrial-History (accessed March 12, 2019).

27. Brown, "Ratbag of Botany"; James, "Taking Us for Village Idiots"; Hillier et al., "Our Battle."

28. Suh et al., "Spatial Distribution."

manufacturing DDT and Agent Orange for the Vietnam War on the nearby Rhodes Peninsula, dumped waste in Homebush Bay. After Union Carbide shuttered their plant in 1985, the legacy of chemical warfare lingered in the water.[29]

Some of the synthetic chemicals that were manufactured in Homebush generated what Deborah Bird Rose calls *double death*: a process that uncouples life and death, diminishing death's capacity to turn dying back toward the living.[30] At sites like Homebush Bay where highly toxic organic chemicals accumulated dangerous waste disrupted cycles of life and death. As toxins accumulated in bodies and ecosystems, relationships among a diversity of interdependent beings began to unravel.[31]

Some byproducts of industry, such as chromium and lead, were accidental toxins that inadvertently spread death through ecological communities. Other chemicals, such as Agent Orange and DDT, were deadly by design. Mosquitoes and other unwanted insects were targeted with large scale DDT spraying campaigns in Australia and many other parts of the world. Agent Orange was developed by the US Department of the Army. It was used in Vietnam as a broad spectrum poison to kill crops and destroy some 5.5 million acres of forest—depriving the Vietnamese people of food and eliminating vegetation concealing soldiers.[32] When Vietnamese refugees fled to Australia during the war, many settled in urban areas near Homebush Bay. During the 1980s and 1990s Homebush became a shadow place for white upper-class Australians whose geopolitical adventures and everyday lives were supported by pollution that disproportionately impacted Vietnamese migrants as well as Lebanese, Chinese, Indian, Pakistani, Afghan, and Cambodian communities.[33]

James Nguyen, a Vietnamese artist who moved to Australia when he was eight, lived near these toxic sites in a suburb called Villawood. In the early 1990s he remembers having family picnics and riding his bike along the Duck River, a tributary that runs into Homebush Bay. Multilingual signs told the public not to fish or swim in the waterways (fig. 1), but after school Nguyen would often play in the shadowlands—in a maze of concrete channels, underground tunnels, and storm drains at the headwaters of the Duck River. Along with his childhood friends—mostly other immigrants from Southeast Asia and the Middle East—he found a zone of toxic sovereignty and freedom, away from the watchful eyes of parents and the state.[34] Like Aboriginal children who swam, fished, and played in the nearby Georges River—despite similar warnings about pollution—these children found a space of freedom from dominant white culture.[35]

29. Birch and Taylor, *Contaminant*, 45.
30. Rose, *Wild Dog Dreaming.*
31. Carson, *Silent Spring*, 22; Rose, *Wild Dog Dreaming*, 87.
32. Fuller, "US Moves to Address Agent Orange."
33. Plumwood, "Shadow Places," 141.
34. Povinelli, *Geontologies*.
35. Goodall and Cadzow, *Rivers and Resilience*, 192–93.

Figure 1. Fishing and swimming is prohibited in many parts of the Sydney Harbour because of legacy pollution. Photograph courtesy of James Nguyen.

"It is ironic that the Vietnamese migrant community chose to settle in this particular part of Sydney," Nguyen said, "where chemical warfare continues to be a specter." Research shows that tidal flows in the Duck River have transported dioxins from Agent Orange and DDT production facilities into the waterway.[36] In 2018 Nguyen collaborated with his aunt, Nguyen Thi Kim Nhung, to make a floating charcoal wreath. They walked in open toed sandals—through mangrove sprouts at the former Union Carbide dump site—to place the wreath in the open waters of Homebush Bay. Nguyen said, "The performance was a symbolic gesture to reckon with the stories and memories of war in a new home where the chemical agents of war were manufactured." Nguyen thinks about his own possible chemical exposures in Sydney as strangely comforting since migration comes with the "guilt of leaving behind people who were exposed to war and its social and chemical legacies."[37]

The diverse chemosocial communities of Sydney have taken different forms—shaped by topology, hydrology, the built environment, the half-life of toxins, cultural locations, historical circumstances, and privileges associated with race and class. The furtive spaces of sovereignty and autonomy claimed by Asian and Aboriginal children differ markedly from the public political forums created by adult white activists who campaigned for cleanups in other parts of the city.[38] Chemosocial relations in the

36. James Nguyen, quoted in Birch and Taylor, *Contaminant*.
37. Author interview with James Nguyen, May 17, 2018, Sydney, Australia.
38. Brown, "Ratbag of Botany"; James, "Taking Us for Village Idiots"; Hillier et al., "Our Battle."

neighborhoods surrounding the shadowlands where these children played involved ephemeral moments of recognition—shared looks when strangers on the street inhaled pungent industrial odors or read occasional newspaper articles about cancer clusters.[39] "As recent migrants we were politically disenfranchised," said Nguyen. "We did not have the political or cultural capital to transform moments of recognition into publically visible action." Even still, some of Nguyen's childhood friends have since assumed important roles in society—as senior staff members of elected officials, as urban planners and architects—where they have quietly influenced government policy about industrial pollution.

Some industrial chemicals did not obey systems of privilege in Sydney.[40] As studies of the harbor sediments were conducted, toxins were found in the waterways of upscale neighborhoods: aldrin was accumulating in Double Bay, heavy metals in Mosman Bay, and DDT in Neutral Bay.[41] As imperceptible toxic exposures were rendered perceptible, political and economic forces aligned to deal with legacies of industrial pollution, colonialism, militarism, and capitalism. Increasingly concrete chemosocial formations emerged from neighborhoods that were connected by shared toxic waterways. People from relatively privileged social locations leveraged their access to public forums and policy makers.[42]

In the late 1990s, Sydney's political leaders used the Olympic Games as an opportunity to muster resources and develop new practices of responsibility toward the legacy of industrial pollution. Officials began experimenting with "alter-modes of collaboration and study that simultaneously aimed at world-building and dismantlement."[43] Sydney's Olympic Games opened up hopes in blasted landscapes, new potentials for future life, as toxic waste dumps of the recent past were dismantled and replaced with new infrastructures and architectures of care.[44]

Before construction began Janet Laurence, a renowned Australian environmental artist, was part of a charrette—with international architects, designers, curators, and environmental scientists—to imagine possible futures for the Sydney Olympic Park. "At the charrette we devised the idea of the 'Green Games' and started laying plans for a totally green autonomous village with some of the best solar panel and geothermal experts in the world," Laurence said. But a sudden shift in the political landscape interrupted the planning process. "We were developing a totally idealistic plan, but then the government changed and John Howard was elected as Australia's Prime Minister." Howard was from the conservative party and was generally opposed to environmental conservation as well as multiculturalism and nonwhite immigrants. Sydney's Green

39. Choy and Zee, "Condition"; Shapiro and Kirksey, "Chemo-Ethnography."
40. Murphy, "Uncertain Exposures."
41. Birch and Taylor, *Contaminant*, 39.
42. Brown, "Ratbag of Botany"; James, "Taking Us for Village Idiots"; Hillier et al., "Our Battle."
43. Murphy, "Alterlife," 497.
44. Kirksey, Brodine, and Shapiro, "Hope in Blasted Landscapes"; Shotwell, *Against Purity*.

Games proceeded, but in a political landscape that was much friendlier to real estate developers and the business community.[45]

Conflicting narratives emerged during the remediation process, according to Anne Loxley who curated the public art at the Sydney Olympic Park. "Swarms of people in hazchem suits would be working on things, and sometimes there would be this terrible smell," she remembers. Loxley, who is now Senior Curator at Sydney's Museum of Contemporary Art (MCA), wondered, "How safe is it here? What is happening?" Boosters of the remediation process claimed "this is going to be a brilliant new asset for Sydney and the State" and Loxley "wanted to believe that it was going to be great, it was going to be wonderful."[46] Reflecting back on the project, she said that the government was involved in the fabrication of hope in a historically disadvantaged area of Sydney, a place where politicians are now trying to court votes.

Even as some imagined futures became increasingly ephemeral, concrete hopes emerged in this postindustrial landscape as the hydrology and topography were reengineered with the goal of containing legacy pollution. The site contained over 160 hectares of contaminated waste that included power station ash, demolition rubble, asbestos, domestic garbage, dredging material from the river, and industrial hydrocarbons. Rather than export this waste to other places in Australia or abroad, rather than dispersing the slow violence of chemical agents across time and space, the Olympic Environmental Committee insisted on local accountability and responsibility.[47] Landfills were dug up and rebuilt with new containment technologies. Hazardous chemical wastes—such as DDT, dieldrin, chlordane, endrin, and DDD—were treated on-site. Treated toxins were consolidated inside capped and lined landfills built to minimize runoff into waterways.[48] Flows of contaminated water were rerouted into an infrastructure of pumps and treatment facilities. This shadow place became a public parkland dotted with remediated waste mounds—monuments to responsibility amid the toxic legacies of capitalism and modern war.[49]

The remediation project at the Sydney Olympic Park was undergirded by modernist optimism about the material world.[50] Hydrologists, geologists, and engineers assumed that their knowledge of chemical interactions, soil structure, and water flows could contain deadly agents and mitigate risks to socially acceptable levels. Boundaries and borders, however, are often porous and permeable.[51] Calculations about chemical

45. Author interview with Janet Laurence, August 29, 2018, Sydney, Australia.

46. Author interview with Anne Loxley, September 25, 2018, Sydney, Australia.

47. Nixon, *Slow Violence*, 2.

48. Sydney Olympic Park Authority, "Fact Sheet—Remediation." January 2014. www.sopa.nsw.gov.au/-/media/files/sopa/sopa/publications/fact-sheets/web_fs_remediation_2015.pdf.

49. Plumwood, "Shadow Places," 146.

50. Shapiro and Kirksey, "Chemo-Ethnography," 488.

51. Jackie Brookner, "Transdisciplinary and Porosity." www.multispecies-salon.org/transdisciplinarity-porosity/ (accessed March 12, 2019).

interactions often fail to account for the contingency of the world.[52] But, as this infrastructure failed to completely contain legacy pollution from the twentieth century, new opportunities for flourishing emerged for endangered frogs.

Bell Frogs in the Brick Pit

Today one of the iconic sites in the Sydney Olympic Park is the Brick Pit, a colossal hole created by the early twentieth-century brickworks. An elevated walkway now encircles this pit and frames encounters with a spectacular postindustrial landscape. The shadowlands have been turned into a tourist attraction. New memory practices have emerged with park signs, websites, and walking tours that reckon with the long history of legal and illegal dumping in Homebush Bay. An elderly white gentleman whom I met on a circular walkway encircling the Brick Pit told me about the pesticides, paints, oils, and resins made at nearby factories. "The stench was terrible," he said. "They thought that the tide would take it away."[53] He situated historic toxic exposures within an account of class inequality and local infrastructures, saying, "Workers in this industry didn't have access to major roadways or public transport, so they had to live close to where they worked."

The Brick Pit was an industrial wasteland that served as a garbage dump from 1977 to 1982, after brick production ceased. A layer of "municipal garbage and putrescible waste," some 45 feet deep, was removed from the pit in preparation for the Sydney Olympic Games.[54] Soil samples revealed concentrations of copper, lead, zinc, and chromium ranging beyond the threshold levels where adverse biological effects are expected to occur more frequently.[55] The presence of green and golden bell frogs in the Brick Pitt was initially puzzling for conservationists. Unexpectedly, during the remediation efforts, puddles became ephemeral social spaces and breeding habitats for this endangered animal.

Green and golden bell frogs were once one of the most common frogs in urban areas of Sydney with a wide distribution along the eastern coast of Australia. These frogs were once so abundant that they were fed to snakes in zoos and sacrificed for dissection in schools. This adaptable animal became an invasive species after being introduced to New Zealand, New Hebredes, and New Caledonia.[56] Worldwide declines in frog populations were first noticed in the 1970s—particularly in Australia and the Americas. Upward of 165 species of amphibians have been reported extinct. About 1,895 amphibian species, more than one-third of all described frogs, salamanders, and caecilians, are

52. Kirksey et al., "Hope in Blasted Landscapes."

53. This character is a composite to preserve anonymity and narrative flow. Recordings were made with permission and have been accurately transcribed.

54. Suh, Birch, and Hughes, "Hydrochemistry in Reclaimed Lands," 742.

55. Suh et al., "Spatial Distribution and Source," 60; Department of Environment and Conservation, "Assessment Levels," 25.

56. Tyler, "Introduction and Current Distribution."

formally designated as threatened or endangered.[57] Green and golden bell frogs experienced catastrophic declines throughout eastern Australia—disappearing from over 90 percent of their former range in the 1980s and 1990s.[58] The government formally classified this species as endangered in 1995.[59]

Many different hypotheses emerged to explain sudden decline of green and golden bell frogs and other amphibians—global warming, deforestation, habitat loss, pesticides—all putting humans at the center of the story.[60] Anthropocentric stories gave way to a more complex multispecies story when a new microscopic pathogen, a kind of fungus called chytrid, was described in 1999.[61] The same year that the emergent fugal disease was described a green and golden bell frog mortality event took place in the Sydney Olympic Park with seventeen frogs confirmed dead as a result of chytrid infection.[62]

One interpretive panel on the Brick Pit walkway notes that there are winners and losers in the urban environment: "Some native species are thriving by living off our urban lifestyles. Seagulls, ravens, magpies, red-back spiders, brown snakes and bulrushes are doing okay because of us. Green and golden bell frogs are winners in the Brick Pit. They appear in large numbers where earth has been disturbed and degraded. . . . But there's another side to the story. It's all very well that some opportunistic species thrive in cities, but for every one that does there are hundreds that don't. Losses still exceed gains." Even as an endangered frog species is persisting in this postindustrial landscape, other organisms are failing. Only some species are able to persist in conditions of alterlife, with life altered by chemical exposures and histories of colonialism, warfare, and capitalism.[63]

The patterns of bell frog deaths were counterintuitive in the Olympic Park and the broader Sydney region: they were dying off in protected conservation zones, and persisting in sites with legacy industrial pollution.[64] Rather than simply preserve the past—rather than just use sites like the Brick Pit and nearby mounds of industrial waste as cultural mnemonic devices—the Sydney Olympic Park began to manage ongoing processes of chemical decay, physical change, and biological emergence. In *Curated Decay* Caitlin DeSilvey notes that the emergence of new forms of growth is contingent on decomposition that channels death back into life through the action of enzymes and microorganisms.[65] Rather than simply celebrate emergent ecological dynamics

57. Amphibian Ark, "Frightening Statistics." www.amphibianark.org/the-crisis/frightening-statistics/ (accessed March 12, 2019).

58. Pyke and White, "Review of the Biology."

59. Australian Government, "Species Profile and Threats Database." www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1870 (accessed March 12, 2019).

60. Bateson, *Peripheral Visions*; Pyke and White, "Review of the Biology"; Shotwell, *Against Purity*.

61. Kirksey, *Emergent Ecologies.*

62. Penman et al., "Impact of a Chytrid-Related Mortality Event."

63. Murphy, "Alterlife," 497.

64. Threlfall, "Do Green and Golden Bell Frogs (*Litoria aurea*) Occupy Habitats with Fungicidal Properties?"; Stockwell, "Impact and Mitigation."

65. DeSilvey, *Curated Decay*, 11.

Figures 2 and 3. An elevated walkway at the Sydney Olympic Park allows visitors to view the habitat of the green and golden bell frog. High-rise apartment buildings are sprouting up in the landscape just beyond this postindustrial conservation zone. Photograph by Eben Kirksey.

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within a landscape shaped by chemical pollution, researchers began making situated judgements about the effects and actions of particular chemical agents and biological species.[66]

Chytrid fungi were determined to be the main threat to green and golden bell frogs in the Sydney Olympic Park, along with introduced mosquito fish (*Gambusia* sp.) and native birds such as kookaburras (*Dacelo* sp.) and white ibis (*Threskiornis*). Anecdotal reports from Latin America suggest that the spread of chytrids can be prevented by garden variety pollutants such as antibiotics, laundry detergent, and other soaps. These

66. Kirksey, *Emergent Ecologies*, 218–19.

low grade pollutants seem to have structured emergent ecosystems where some endangered frogs persist in Costa Rican coffee plantations and urban waterways.[67] Sydney Olympic Park is one of the first sites where biologists have started to intensively study a basic applied research question: Can toxic pollution cure frogs infected with pathogenic chytrid fungi?

Caragh G. Threlfall, then an undergraduate student at the University of Wollongong, began systematically investigating the impacts of pollution on green and golden bell frogs with her 2006 honors thesis. She found very high concentrations of copper and zinc in locations with sizable populations of green and golden bell frogs .[68] Working with laboratory cultures of the kind of chytrid that kills frogs (*B. dendrobatidis*), she found inconclusive results. Copper seemed to initially reduce the growth and reproduction of the fungus at a very low dose (0.5 ppm), but after 14 and 28 days the growth in the experimental treatments caught up to the untreated control cultures.[69] Subsequent studies with other kinds of chytrids found that heavy metals have the properties of Plato's pharmakon: these poisons have unstable attributes with effects that can shift from one extreme to the other depending on the dose, the circumstances, or the context.[70]

Copper and other chemical waste from industrial production have structured an alter-world in the Sydney Olympic Park where green and golden bell frogs persist. After an epidemic disease destroyed their normal world order, social life for these amphibians only became possible within toxic chemical ecologies.[71] Green and golden bell frogs formed chemosocial communities in polluted human environments. These once-robust animals have become fragile forms of alterlife.[72] One conservationist told me, "All of the old guys who used to work on the landscaping here, said: 'If you just dug a hole they would be breeding in it.' They were everywhere." As different construction projects came and went ecologists learned about this frog along the way.[73] While working in a dynamic human-built landscape, with a shifting base of knowledge, conservationists tried to stabilize this frog's world.

Life Support Technologies

At the Sydney Olympic Park I found conservation biologists and hydrogeologists who were trying to recreate habitat for endangered frogs, while managing a massive

67. Kirksey, *Emergent Ecologies*, 161.

68. Threlfall, "Do Green and Golden Bell Frogs (*Litoria aurea*) Occupy Habitats with Fungicidal Properties?," iv. ◀AU4

69. Threlfall, "Do Green and Golden Bell Frogs (*Litoria aurea*) Occupy Habitats with Fungicidal Properties?," 56; see also Threlfall et al., "Do Green and Golden Bell Frogs *Litoria Aurea* Occupy Habitats with Fungicidal Properties?"

70. Henderson et al., "Copper (II), Lead (II), and Zinc (II) Reduce Growth"; Derrida, *Dissemination*; Stengers, *Cosmopolitics I*, 29.

71. Chen, *Animacies*, 196.

72. Murphy, "Alterlife," 497.

73. Bateson, *Peripheral Visions*.

industrial pollution cleanup effort. The park is publicly funded and is run by a team of civil servants with diverse expertise. Rather than try to restore an imagined past, ecologists, engineers, urban planners, and architects have collaborated here to craft alterfutures.[74] The park staff developed new infrastructures that tried to purify water of chemical and biological contaminants.[75] The park staff tried to make the endangered frogs live (*faire vivre*) while applying a politics of death to predators and pathogens that presented an existential threat to this species. Classic strategies of biopower were applied to the domain of biology itself.[76]

Cutting-edge digital technologies and DNA sequencing protocol were pared with gardening equipment and everyday infrastructures to create and sustain microcosms for the green and golden bell frog at the Sydney Olympic Park. Over two hundred artificial ponds were created during the massive environmental remediation and restoration program ahead of the Olympics. The ponds were purpose-built for this endangered species. But, only a handful of the ponds actually became home to a robust population of green and golden bell frogs. Mesh frog fences were erected to keep animals off roadways. Underpasses were built to give them the option of passing underneath. Many frogs have been microchipped, with the same technology commonly used in dogs and cats, to track their movements and population dynamics. DNA testing was used to monitor the genetic diversity of frog populations and also the distribution of pathogenic chytrid fungi. But, the frogs largely stayed put—ignoring the massive infrastructure that was constructed around them.

If Foucault had visited the Sydney Olympic Park, perhaps he would have seen forms of life that have been seized and imprisoned by biopolitics—creatures that have been reduced to organic matter barely capable of reproduction.[77] Here animals were isolated from historical and ecological forces assailing them, separated from worldly happenings.[78] Bird nets, keeping out predators such as kookaburras and white ibis, stretch over some of the plastic-lined artificial ponds. Elaborate pumping mechanisms that periodically drain the frog ponds undergird the Sydney Olympic Park to kill fish and eels that eat frog eggs and tadpoles.

A glass pavilion on the rim of the Brick Pit uses microfiltration to remove particles from the water that are larger than 0.2 microns, which includes water parasites, viruses, bacteria, and most notably the deadly chytrid fungus. This filtered water is stored in the Brick Pit and then pumped through the artificial frog ponds in the park. But this elaborate and costly artificial infrastructure has been unable to eliminate cytrids. The fungus

74. Murphy, "Alterlife," 497.
75. Shotwell, *Against Purity*.
76. Rabinow and Rose, "Biopower Today"; Youatt, "Counting Species."
77. Foucault, "Right of Death."
78. Esposito and Hanafi, "Community, Immunity, Biopolitics," 85–86; Kirksey, *Emergent Ecologies*, 66.

Figure 4. A purpose-built pond for green and golden bell frogs on top of a remediated landfill. Netting keeps out birds and other predators, but the chytrid fungus is still able to get inside this infrastructure of care. The pond needs to be periodically topped up with water since it is leaking into the landfill below. Photograph by Eben Kirksey.

lives on frog skin and reproduces via tiny spores that use a flagella to swim through the water column, much like a human sperm. While chytrids are eliminated from the water supply with the microfiltration system, these tenacious parasites are entering the purified water farther downstream. The spores are able to live in small droplets of water and can move between bodies of water on the toes of birds, human shoes, or on the skin of some frog species that are asymptomatic disease carriers.

Despite ongoing efforts to make endangered frogs live, chytrid fungal infections continued to drive population declines in Sydney Olympic Park. Predators such as birds, fish, and eels continue to eat green and golden bell frogs as well as their eggs and tadpoles, despite best efforts to keep them at bay. Ecologists monitoring the long-term demography of frogs at the park report that they are still at "risk of extinction or rapid and dangerous decline."[79] Ongoing care work is sustaining life for frogs in the Sydney Olympic Park amid continuing processes of chemical decay, material change, and the emergence of new biological diseases.[80] The technology and infrastructure maintaining these populations is fragile and dependent on people for ongoing maintenance, repair,

79. Pickett et al., "Six-Year Demographic Study Reveals Threat," 251.
80. DeSilvey, *Curated Decay*, 20.

and care.[81] Artificial ponds leak as the landfills underneath them settle. Water slowly seeps out into the accumulated waste below.

When water filters through landfills, a liquid called leachate emerges. Another elaborate infrastructure under the Sydney Olympic Park was built to contain runoff and channel the flow of these toxic pollution toward processing facilities. Leachate flows are channeled away from open waterways and toward twenty-six pump pits that were installed during the earthworks preparation for the Olympic Games. Leachate is pumped from these pits into twelve kilometers of pipes that lead to three storage tanks and a central processing facility run by a private contractor called Cleanaway.[82]

Engineering practices and infrastructures designed to contain industrial pollution and waste are unable to completely contain risks. Writing of landfills in Canada, Myra Hird notes that "leachate moves between geological strata . . . between space and time. As it moves, leachate disperses known, unknown, and unknowable entities." She suggests that we address the potential future harm connected to chemical toxins leaking from landfills by bringing "buried and forgotten waste to the surface of our ethical landscape."[83]

Within the broader landscape of Sydney, the leachate treatment infrastructure at the Olympic Park is ethically exemplary—demonstrating an ongoing commitment to responsibility and care. Ian Wright, an outside expert on aquatic insects who has led political campaigns to stop coal companies from dumping heavy metals into waterways, visited the facility with me in February 2018. "Do you know one of the things that really interests me about this being treated?" Wright asked me rhetorically. "Most leachate in Sydney is not treated." While government regulators have tried to force landowners throughout the city to take responsibility for legacy pollution, Wright said that many corporate polluters have taken evasive measures. "Often they will walk away, go bankrupt and change name of the company," he said.

The ethical sensibilities of ecologists, urban planners, and waste management experts came together at the Sydney Olympic Park in the design of infrastructure that aimed to purify the water.[84] But, lively chemical and biological agents continued to move across porous boundaries. When vibrant populations of green and golden bell frogs began to flourish in the polluted runoff from some of the most toxic sites in the park, the staff did not know how to respond. As their biopolitical strategies for managing populations of endangered frogs showed signs of failing, as biopower ceased to be efficacious, park staff struggled to understand emergent forms of chemopower.[85] The staff struggled to care for a novel chemosocial world.

81. Puig de la Bellacasa, *Matters of Care*; Star, "Ethnography of Infrastructure."

82. Sydney Olympic Park Authority, "Fact Sheet—Remediation." January 2014. www.sopa.nsw.gov.au/-/media/files/sopa/sopa/publications/fact-sheets/web_fs_remediation_2015.pdf.

83. Hird, "Waste, Landfills," 108.

84. Shotwell, *Against Purity*.

85. Rabinow and Rose, "Biopower Today."

Euphoric Chemosocialities

Thousands of green and golden bell frog tadpoles emerged in a pond of toxic waste shortly after the Sydney Olympic Park Authority opened the new Blaxland Landfill Leachate Treatment facility in August 2013. This facility had not been designed with the well-being of frogs in mind, but instead was planned as a sustainable treatment facility for leachate with low energy use, no chemical use, and no sludge production.[86] After contractors noticed the frogs breeding in their open-air leachate-processing pond, employees of the Sydney Olympic Park collected the resulting tadpoles and transported them to other less-polluted ponds for release. But, even after these tadpoles were relocated, the population of green and golden bell frogs at the leachate treatment facility continued to persist.

If the normal world of the green and golden bell frog was lost with the spread of the pathogenic chytrid fungus, these frogs began finding emergent opportunities for existence and reproduction in sites with hazardous chemical waste.[87] While frogs in the purpose-built ponds elsewhere in the Sydney Olympic Park were barely persisting (in pools that had been carefully isolated from leachate contamination) the frogs in Blaxland were unexpectedly flourishing in an emergent ecosystem structured by legacies of pollution. Frogs began creating social spaces—places for calling in unison, for sex, and for spawning—while living with chemical dependencies.

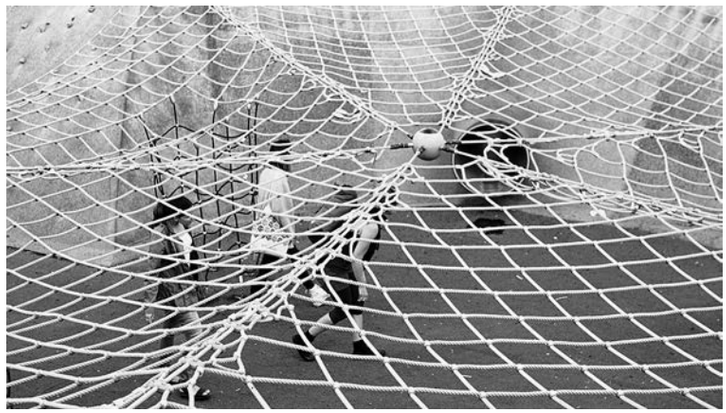
Since a mind boggling diversity of contaminants are processed at the Blaxland Landfill Leachate Treatment facility, it is difficult to discern which particular legacy pollutant has enabled the continued life of endangered frogs. The facility was built on a mound of consolidated waste—soil soaked with tar, or polycyclic aromatic hydrocarbons—from Petroleum and Chemical Corporation Australia Ltd. Nearby, in Wilson Park—a grassy field where people regularly play Australian-rules football—a sign renders visible a layered palimpsest of industrial waste. The Petroleum and Chemical Corporation Australia "produced town gas, chemical solvents, and road tar from the cracking of crude oil." The company contaminated "approximately 230,000 tons of soil and groundwater with tar and other hydrocarbon wastes from oil refining operations."

While the Blaxland Landfill Leachate Treatment facility sits atop highly toxic tarsoil, it actually processes liquid runoff from elsewhere: the Blaxland Common Landfill which is capped with clay underground. Above ground is a children's playground and skate park.[88] Underneath the playground lies waste from the Auburn and Hardies Landfills, which received Sydney's garbage from 1960 to 1984. The landfills contain asbestos

86. Water and Carbon Group, "Blaxland Landfill Leachate Treatment," waterandcarbon.com.au/project/blaxland-landfill-leachate-treatment (accessed March 12, 2019).

87. Murphy, "Alterlife," 497.

88. Sydney Olympic Park Authority, "Fact Sheet—Remediation." January 2014. www.sopa.nsw.gov.au/-/media/files/sopa/sopa/publications/fact-sheets/web_fs_remediation_2015.pdf.



Figures 5 and 6. (Top) Green and golden bell frogs spontaneously emerged in polluted water at the Blaxland Landfill Leachate Treatment facility. (Bottom)Water from nearby landfills is treated here in a series of bioremediation pools. Silverwater Correctional Complex is visible in the background, behind a row of trees and a razor wire fence. Blaxland Riverside Park, on the opposite side of the prison, has a skate park and a playground on top of a remediated landfill. Photographs by Elizabeth Lara and James Nguyen; published with permission from the Sydney Olympic Park Authority.

and demolition materials as well as industrial, commercial, and domestic waste.[89] Closely cropped grass, thick with clover, now covers expansive fields and mounds of slowly decaying garbage. A brochure for the site says: "The Blaxland Common Landfill site covers an area of approximately 20 hectares within the world-class parkland precinct of Sydney Olympic Park . . . Given the public visibility of the site, the solution's

89. The Water and Carbon Group, "SOPA Sustainable Leachate Treatment," vimeo.com/92696127 (accessed March 12, 2019).

aesthetic appeal was critical." This public park and playground is situated between the Newington Armory—where explosives were once stored—and the Silverwater Correctional Complex, which still houses a maximum security prison.[90]

One of the main chemical pollutants treated at Blaxland, ammonia, can be highly toxic to fish, amphibians, and other aquatic animals. Leachate treatment at Blaxland begins in a tank at the top of a small hill, a mound of soil that is contaminated with tar. This tank periodically discharges water from a stone pyramid structure through an aeration cascade—a series of eight teardrop-shaped bowls that channel a slow trickle of water down the slope. From there the leachate flows into raised beds, with gravel and aquatic plants. Sprinklers help water the system and expose the leachate to air. In the gravel beds the aim is to cultivate oxygen-consuming (aerobic) bacteria to catalyze a particular chemical reaction: transforming the ammonia (NH_3) into nitrate (NO_2–) and nitrite (NO_3–). Microbes that love Nitrogen, or nitrophiles, thrive within the emergent ecological community of this microenvironment. Bacteria such as *Nitrobacter* and *Nitrosomonas* can break down ammonia in the presence of oxygen.[91] These microbial communities too, might be understood as chemosocial formations. The metabolic processes of microbes, that are thriving in new chemical landscapes, have produced new entangled possibilities of life where one kind of microbe eats the waste of others.[92] Microbial metabolisms have also likely coproduced the conditions of social life for green and golden bell frogs.

Two long and wide trenches, called free surface wetland" on the Blaxland facility's website, host a separate microbial community that further metabolizes the landfill runoff. The trenches have shallow standing water, only about 10 cm deep. The leachate enters these trenches through white PVC pipes with bright green algal growth around the steady trickle of water. A diversity of marsh plants grows in the trenches. Microbial communities in the roots of these plants are critical to this bioremediation system. The stagnant waters of the lower leachate pools are anaerobic (with no or low oxygen), in contrast to the aerated beds on the hill. Here bacteria transform the nitrate (NO_2–) and nitrite (NO_3–) into nitrogen gas. This dense plant growth also serves as ideal habitat for amphibians, since it provides cover from predators such as white ibis and laughing kookaburras. It is here, in stagnant water amid aquatic plants, where green and golden bell frogs have been congregating and breeding.

This site claims to be "one of the most innovative leachate treatment solutions in Australia" and the values of hypervisibility, transparency, and sustainability were built into the design.[93] The government agency running the park, the Sydney Olympic Park

90. Muir, "Design of a Movement Corridor."

91. The Water and Carbon Group, "SOPA Sustainable Leachate Treatment," vimeo.com/92696127 (accessed March 12, 2019).

92. Hird, *Origins of Sociable Life*; de Lorenzo, "From the Selfish Gene to Selfish Metabolism"; Landecker, "Antibiotic Resistance and the Biology of History."

93. The Water and Carbon Group, "Low Energy Leachate Treatment System: Sydney Olympic Park." 2013. waterandcarbon.com.au/wp-content/uploads/2017/01/WCG-Case-Study-SOPA.pdf.

Authority (or SOPA), has tried to turn the facility into an example of best practices aimed at ensuring environmental protection and public safety.[94] At other toxic sites Michelle Murphy notes that sensing technologies have been deployed to produce "historically specific terrains of invisibility" or "regimes of imperceptibility,"[95] since toxicological experts know how to tinker with humidity levels, animal models, and device types to support preordained conclusions that are friendly to industrial agendas. While SOPA declined to comment on the methods used to sense pollution at Blaxland, some pollutant monitoring data from this facility are freely available on the Internet. Ammonia is only one among many toxic chemicals that appear in these data. Cobalt, nickel, dioxins, and copper have all been detected in liquid waste at the Blaxland.[96]

While chemical sensing technologies can reinforce the modernist dream of the imminent calculability and knowability of the material world,[97] the data from Blaxland reveal a cloud of epistemological uncertainty with concentrations of various toxic agents fluctuating widely over time. It is difficult to know with assurance which chemicals at Blaxland have the properties of the pharmakon for green and golden bell frogs.[98] One thing is clear: green and golden bell frogs continue to find conditions for life at this leachate processing facility. "Blaxland is booming," said one ecologist during a formal presentation in October 2017 to a group of frog enthusiasts, the Frog and Tadpole Society (FATS). "We have had massive breeding events."

The mass mating of frogs has made amphibians the symbol of unrestrained sexuality in the popular imagination of Europe. Figures of giant batrachian orgies appeared in the writing of George Orwell and in more recent fiction that mixes together scenes of human-frog sex, spawning, and death.[99] Normal modes of sociality and sexuality among green and golden bell frogs, before the chytrid fungus disrupted their world, were actually more subtle and antagonistic than these popular images. In 1979 a PhD student described males calling throughout summer days, and intensely at night, while perched on low mats of emergent vegetation. "Conspecific callers are not tolerated at distances of less than about a meter without vocal challenge".[100] Males attracted females with a call that has been likened "to droning or growling followed by several short grunts."[101] As females approached the calling suitors, the males circled around behind and gripped them in a characteristic embrace called amplexus—holding on, sometimes for days at a

94. Sydney Olympic Park, "Site Remediation." www.sopa.nsw.gov.au/About-Us/History-and-Heritage/Site-Remediation (accessed March 12, 2019).

95. Murphy, *Sick Building Syndrome*, 267, 274.

96. Sydney Olympic Park Authority, "Publication Data Blaxland Sustainable Leach Treatment Wetlands," www.sopa.nsw.gov.au/-/media/files/sopa/sopa/publications/environmental-monitoring-data/publication-data--blaxland-sustainable-leachate-treatment-wetlands.xlsx (accessed March 12, 2019).

97. Shapiro and Kirksey, "Chemo-Ethnography."

98. Stengers, *Cosmopolitics I*.

99. Sleigh, *Frog*, 141–42.

100. Humphries, "Dynamics of a Breeding Frog Community," 58.

101. Pyke and White, "Review of the Biology," 573.

time, until the females laid eggs. Male frogs also frequently grasped one another in "homosexual amplexus" in these historic sites that were largely free from industrial pollution.[102]

Queer frogs have emerged elsewhere as a result of exposures to endocrine disrupting toxins. Media hype about sex-changing chemicals in public waterways prompted Eva Hayward to write an essay that asks, "Can we address the impacts of toxic substances on vulnerable people and animals without appealing to society's basest fears about sexual disruption? Can we foster environmental responsibility without invoking anxiety that our most intimate reproductive environments have been infiltrated by an industrial world? Is there a way to re-evaluate ecological resilience—such as the sex-changing response—and meet the future organisms that we are becoming?"[103] Hayward suggests that we might develop better practices for *living with* toxic pollution in places where new forms of life are emerging, while imagining ways to reconfigure political and economic systems that produce waste affecting everyone, including animals.

At the Blaxland Sustainable Leachate Treatment Facility toxic exposures have not apparently produced queer transformations for green and golden bell frogs. Instead, potentially hazardous chemicals have produced a situation where heterosexual reproduction and presumably also homosexual amplexus takes place as normal. The choruses of green and golden bell frogs that appeared at the Blaxland seem to be like those observed by Humphries in 1979. A strange sense of normality prevails as endangered animals call, grapple, and hold one another in amorous embraces. But this place is haunted by uncanny specters of chemical toxins with indeterminate properties.[104] Mel Chen has described a "toxic sensorium," a set of affective states and phenomenological experiences, that emerges for people diagnosed with heavy-metal poisoning.[105] Mood swings, irritability, depression, fatigue, excitation, difficulty focusing, feeling out of control are part of the *intoxication* experienced and theorized by Chen.[106] Speculating across the species interface, it seems plausible that green and golden bell frogs may live with a toxic sensorium in Blaxland. Chemosocial bonds may be emerging for some animals with *intoxicating* chemicals that might be both dangerous and pleasurable. Anne Pollock argues that animals exposed to toxins might sometimes enjoy getting "fucked up" like humans on recreational drugs.[107]

Chemosociality among Blaxland's frogs may or may not be euphoric, in the sense of subjective experiences of excitement, exhilaration, and animation. But, perhaps Blaxland is a site of euphoria for green and golden bell frogs, in the terms of Roberto Esposito and Zakiya Hanafi's biopolitics, where this endangered form of life "is able to

102. Humphries, "Dynamics of a Breeding Frog Community," 58.
103. Hayward, "Ciliated Sense."
104. Stengers, *Cosmopolitics I,* 29; Hird, "Waste, Landfills."
105. Chen, *Animacies*, 196–97.
106. Chen, *Animacies*, 207.
107. Pollock, "Queering Endocrine Disruption," 185.

reproduce itself without interruption" beyond the historical and ecological conditions impinging on its existence.[108] In the technical terms of Sara Ahmed, perhaps these frogs are full of hap, if not happy, since they are living with the contingency of what happens.[109] In contrast to the designated frog habitat elsewhere in the Sydney Olympic Park, the pools at the leachate treatment facility were not enclosed with netting during my tour. White ibis, known predators of green and golden bell frog, were lingering around the pools of waste. A laughing kookaburra, sitting nearby on a plastic pipe, was staring intently at the marsh plants, head feathers flat against its head, ready to dive into the polluted water. In contrast to the purpose-built frog ponds elsewhere in Sydney Olympic Park, where threats to frogs were being carefully managed, here endangered forms of life were flourishing amid chemicals with unstable properties and lively dynamics in multispecies worlds.

While green and golden bell frogs were finding opportunities for life in this waste treatment facility ecologists remained concerned about the long-term consequences of toxic exposures. One researcher told me that frogs from the leachate ponds have a distinct color: lime green. Green and golden bell frogs have been systematically removed from the Blaxland site and enfolded in the infrastructures of care throughout the Sydney Olympic Park. While toxins have produced a chemosocial flourishing, an emergent multispecies world, ecologists speculate that it will be short lived. Conservationists in Sydney Olympic Park are trying to create and sustain conditions for less-toxic interdependent worlds.[110] As park managers take responsibility for "the molecular productions of capitalism in our own pasts and the pasts of our ancestors, as well as into the future,"[111] others are investing in visions of a postindustrial utopia.[112] But, the purity practices of these ecologists—their attempts to separate endangered nature from the toxic products of industrial culture—seem to be failing. Amid ongoing population declines of green and golden bell frogs, the ecologists may be forced to replace strategies of biopower with chemopower.

Bubbles of Hope

The Sydney Olympic Park is being styled as a "new golden mini city" that will have "45-storey residential towers, and a thriving shopping/cafe precinct" by 2030. With a $10 billion investment planned, a combination of public and private funds, officials hope to attract 23,500 residents and offer 34,000 jobs.[113] When I visited in February 2018 I stayed in one of the freshly constructed high-rise towers, and found ongoing construction all around. My twenty-third floor AirBnB apartment commanded a view of the Brick Pitt

108. Esposito and Hanafi, "Community, Immunity, Biopolitics," 85.
109. Ahmed, *Promise of Happiness*, 45.
110. Shotwell, *Against Purity*, 93.
111. Murphy, "Alterlife," 497.
112. Harvey, *Spaces of Hope*, 85.
113. Tabakoff, "Olympic Park."

and Homebush Bay where a luxury shopping mall and IKEA sat atop the former Union Carbide plant. Fleeting conversations with other high-rise residents revealed that most were cosmopolitan professionals from Asia and the Middle East.

Public signs about legacy pollution dot the landscape of the Sydney Olympic Park, but toxic specters were largely absent from the imagery and discourse prevailing in the high-rise apartment building where I stayed. In the elevator I struck up conversations with a medical student from Hong Kong, an architect from Shenzhen, and a retired couple from Beijing. When asked about the chemical pollution under the playground and near their apartment buildings, most shared modernist dreams about the ability of experts to calculate and contain risks.[114] Proximity to noxious chemicals was not generating chemosocial solidarities, or expectations of a transcendent future with a final solution, but instead hopes for an unchanging present—where risks were mitigated in intimate spaces of domesticity and public spaces of recreation and play.[115] In hallway conversations I found that endangered frogs were also beyond the purview of residents' social worlds.

Many white Australians, who vividly remember twentieth-century controversies about toxic waste disposal in the area, continued to visit the Sydney Olympic Park for work, recreation, and public events such as sporting competitions and concerts. But, few whites were buying real estate despite serious incentives in a high-priced market. Contaminated landscapes were being remade by oblique powers that reinscribed racialized exposures. In a city where memory and privilege continue to be unequally distributed across racial lines some people were finding modest hopes—for their own first apartments or homes—in places that others remembered as a wasteland.[116] The 2011 Australian government census reveals that an overwhelming majority of Sydney Olympic Park residents (78 percent) were born outside Australia. Demographic data reveal a population that is highly educated with employment rates and income levels that are higher than the Australian average. A large proportion of Olympic Park residents, 20 percent, were born in mainland China. A diversity of other nations is also represented in the neighborhood: South Korea, India, Hong Kong, and Iran.[117]

Within conservative political parties gaining power during my research, some Australians were experiencing a growing "fear of racialized immigration into the vulnerable national body at a time when its economic sovereignty was in question."[118] Amid xenophobic political campaigns targeting Asians and unskilled migrants, Malcom Turnbull's conservative coalition government announced major changes to immigration laws in April 2017, eliminating a broad class of temporary business and work visas.

114. Shapiro and Kirksey, "Chemo-Ethnography," 488.

115. Zee, "Holding Patterns."

116. Murphy, "Uncertain Exposures."

117. Australian Bureau of Statistics, "2016 Census QuickStats: Sydney Olympic Park." quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/SSC13716 (accessed March 12, 2019).

118. Chen, *Animacies*, 171.

Chinese buyers, who spent $32 billion in Australian real estate investments in 2015–16, began pulling their capital out of potentially toxic assets in Sydney's market.[119]

In parallel a developer called Mirvac announced an initiative in 2017 to build 690 new properties in the Olympic Park. Marketing campaigns targeted first-time buyers who had the opportunity to purchase apartments for $575,000 to $749,000 with just a 5 percent deposit.[120] But by early 2018 market analysists labeled the Sydney Olympic Park as a no-go zone for property investors because of the risk of major price falls.[121] The market could not support all of the new properties that were being built. When residents of the upscale Opal Tower apartment building heard loud cracking noises on Christmas eve in 2018, around 3,000 residents were evacuated from the high-rise where I stayed and other buildings nearby, as authorities feared a collapse was imminent.[122] The Opal Tower did not collapse, but the incident marked a clear break from earlier intoxicating dreams about the new golden mini city in the park. In the aftermath of this near disaster, property values fell and lawsuits mounted.[123] Ambivalent hopes about living with chemical and financial toxicity began to emerge for the residents.[124]

David Harvey has described spaces of hope that have emerged at the intersection of anarchic market forces. Ways of life are being continually destroyed by ecological, spatial, and cultural upheavals that open up opportunities for new investments of capital. In the face of these destructive forces, Harvey describes "a political or even utopian longing that desires a simpler, less volatile, more manageable, and secure life."[125] Green and golden bell frogs are persisting amid upheavals—ongoing changes to the landscape—that have been wrought by successive waves of capital investment, despoilment, and remediation in Sydney. While these endangered animals do not likely harbor utopian longings and political desires, they nonetheless inhabit spaces of hope constructed by their caregivers and sustained by ongoing investments in protective infrastructures. If the conservationists who care for these frogs lose funding then future generations of this population might be restricted to abandoned leachate pools.

As the real estate bubble of Sydney deflates, the government-funded care work at the Sydney Olympic Park could cease. Amid unruly market dynamics, the less-toxic interdependent worlds that have been created for frogs and people could disappear.[126] As molecular products of capitalism slowly reverberate through time and space, testing our collective capacity to care, fragile forms of alterlife may persist in the shadows.[127] In

119. Stewart, "Chinese Interest."
120. Corderoy, "Sydney Olympic Park."
121. Devine, "Parramatta and Olympic Park Area Declared No Go Zones for Investors."
122. Noyes, "Sydney Olympic Park."
123. Tan, "Maurice Blackburn Walks Away."
124. Chen, *Animacies*, 220–21.
125. Harvey, *Spaces of Hope*, 85.
126. Shotwell, *Against Purity*, 93.
127. Nixon, *Slow Violence*; Murphy, "Alterlife."

blasted landscapes where corporations have a legacy of abdicating responsibility, hopes for precarious ways of life circulate in temporary spaces of immunity where life is protected and threats are negated.[128] Green and golden bell frogs have found a fragile chemosocial bubble—a space where poisons offer the ambivalent cure of the pharmakon.[129]

Chemosocial solidarity is building across divides of class, race, and even species. Recognition of shared experiences of vulnerability is growing as conditions for flourishing become increasingly evanescent. Episodes of life in ephemeral ponds, or in toxic effluent that is deemed unsuitable for a proper existence, reflect the dynamics of temporality and futurity in other milieus. The short-term spaces of survival that have emerged in leachate pools may involve "the present fullness of a becoming whose arc may extend no further," to borrow the language of Eve Kosofsky Sedgwick .[130] As life on earth becomes inescapably entangled with industrial chemicals, novel symbiotic associations and social formations will continue to arise. Caring for these emergent worlds demands improvisation and tact amid shifting contingencies. Embracing the present fullness of altered life and sociality means expecting the unexpected—sustaining lively relationships with responsibility and accountability while remaining open to an unknown future to come.

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128. Sloterdijk, *Bubbles*, 12; Esposito and Hanafi, "Community, Immunity, Biopolitics," 86.

129. Derrida, *Dissemination*; Stengers, *Cosmopolitics I*, 29.

130. Sedgwick and Frank, *Touching Feeling*, 149; see also Ensor, "Queer Fallout," 156.

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◀AU2 ◀AU3

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AU1: Linnaean taxonomy dictates that a species name is always in italics, with genus capitalized and species lower case: like *Homo sapiens* or *Litoria aurea*.
AU2: Reference appears to be out of alphabetical order. Please check
AU3: Good catch!
AU4: Linnaean taxonomy dictates that a species name is always in italics, with genus capitalized and species lower case: like *Homo sapiens* or *Litoria aurea*.
AU5: Figs. 2–6 are not cited in the text. Please check and provide.