Exploring Interstitiality with Mangroves

Semiotic Materialism and the Environmental Humanities

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Introduction

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Introduction

A ragged band of mangroves hugs the shore along the lower reaches of the Cooks River in Sydney. If I walk along the river path looking out to the estuarine edge of the mangroves, I see a dark row of trees and protruding roots extending into the water or mud, depending upon the tide, around one to five metres from the riverbank. Along this river, mangroves have been the cause of some community division. In some places they are spreading into areas of rare saltmarsh vegetation and are being removed.[1] In other sites, local conservation groups are monitoring and tending to them, and sometimes they are mysteriously and illegally poisoned.[2] It is hard to get a sense of their status here in the city suburbs. They are not regarded with historic pride like the grand Moreton Bay figs, or with relief like the old Eucalypts shading the children's playground. Parents are more likely to tell children to stay away from the mangroves because of the putrid smell and filthy plastic bags and bottles collecting in their roots. Yet many care about them and are attracted to their strange otherness, the way they hold a world of life and change within their roots and branches.

Estuarine intertidal zones are highly dynamic places, where ocean, river, land, and sky converge, each bringing different materials, organisms, temporalities, and spatialities into play together. Mangroves are specialists in these liminal, challenging spaces, not only surviving there, but building worlds of extraordinary diversity. This work stays with the mangroves, with their edges that don't settle, with the tensions of their locations, with the many ways of knowing them, and with their marginality and dynamism. Where better to explore a non-anthropocentric approach to thinking interstitiality? One insight from having mangroves as companions is the realisation that the spaces between are not empty or static; taking a different perspective, or a different situation, may find them teeming.

Interstitiality, mangroves, and more-than-human approaches to enquiry

One of the major challenges for the environmental humanities is to explore what it means to understand and create in response to an apparent collapsing

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of categories and assumptions. The previously hardened divisions of geology and biology,[3] purity and pollution,[4] natural and artificial,[5] alive and not alive,[6] domesticated and wild,[7] culture and nature,[8] have softened and paradigms that assume human uniqueness and the virtue of human mastery and progress are being challenged.[9] Boundaries that once seemed solid, edges that held firm, are giving way to less well-defined, more ambiguous spaces and uncertain futures. This uncertainty has been described in numerous ways, including as increasing risk that affects our capacity to plan,[10] as physical and psychic pain,[11] and as challenges for thought and politics.[12] Along with the old categories, many theoretical and methodological tools (use value, ecosystems services, sustainability, and resilience, for example) are also being questioned as too tightly bound to assumptions of human uniqueness or system stability.[13] The diverse field of enquiry referred to as the environmental humanities is characterised by an emergent analytic ethics that seeks to overcome the deeply etched grooves of anthropocentric paradigms. Environmental humanities scholars are exploring creative modes of enquiry that do not assume the primacy of human interests and human perspectives, assumptions which are associated with ecological insensitivity leading to environmental destruction.[14] By exploring questions of betweenness within the semiotic materiality of mangroves, this work approaches those vexed dualisms and categories in a way that elides anthropocentrism and aims to contribute theoretically and methodologically towards supporting a research shift away from anthropocentrism and assumptions of human exceptionalism. It does this in two ways: by building conceptual capacity for thinking in-between categories and by adopting a more-than-human perspective.

In-between, liminal, and marginal spaces or states have been identified as key sites where assumptions and hegemonies are both formed and destabilised[15] or where associations, interactions, and connections provide the potential for the emergence of the new.[16] Within interstices, edges and differences are problematic and in-process. Interstices are not empty spaces between established things but are already thick with complex happenings that are likely to be interesting and where comfortable assumptions are not secure. In some contexts, the instability and uncertainty of the interstitial feels strange, monstrous, or impossible – themes this work will be investigating. According to Tim Ingold, while "between" "articulates a divided world", "in-between" is not defined by termini. It has its own status as "interstitial differentiation",[17] which Ingold instantiates with flow midstream and breath that continually inhales and exhales. Ingold suggests we are immersed in the in-between, which is the site of "answering and being answered to",[18] and because of that, the site, ultimately, of responsibility. Likewise, Brian Massumi calls directly for attention to the in-between in its own right, arguing that so long as being between is only considered as the marginal derivative of positive thingness, thinking continues to turn towards foundationalism, and fails to meet the challenges of complexity and inter-affective relationality. "The tendency is to describe the in-between as a

blending or parody of the always-already positioned", he explains.[19] Where this occurs, concepts that claim to consider interstitiality, such as marginality or mixture "retain a necessary reference to the pure, the central, and the strait-laced and straightfaced, without which they vaporize into logical indeterminacy".[20]

This research takes up this challenge, selecting theory that has focused on the in-between, and taking it to the mangroves to develop a non-anthropocentric understanding of the uncertain, ambiguous spaces of becoming, relationality, and difference.[21] The work explores concepts from within literature sympathetic to post-anthropocentric material semiotics that have sought to make interstitiality thinkable. I seek out concepts that remain close-up, peering into the details of the performances of interstitially.[22] Through this body of theoretical work, interstices take many guises: sometimes as a generative disturbance or a site of friction or irritation of materiality, other times as a contestation, a time or space of becoming, an entanglement of relations, a bifurcation or fragmentation, or a decision or indecision. Descriptors for the interstitial are equally varied.[23] Some of the writers whose thinking is drawn upon through this study employ dense vocabularies of neologisms to find ways to discuss interstitiality.[24] While there are differences between the approaches considered within this research, the various concepts I will be exploring are all similarly engaged with finding ways of allowing processes of generativity, dissolution, indeterminacy, and tension to be accessible to discussion while respecting their in-betweenness. By bringing these various accounts into conversations with mangrove ecology, I hope to develop a more-than-human exploration of interstitiality with some coherency, complexity, and breadth of significance.

The book progresses from an ontological focus in Part 1, to a focus on relationality in Part 2, to issues of power and politics in Part 3. Each section is organised around one broad concept, these being reflexivity in becoming, relationality, and difference. These provide me with three ways of enquiring into betweenness, three sets of questions and three extensive bodies of theoretical work. My inquiry considers the roles each of these three plays in establishing and maintaining the premises, attitudes, and practices of human exceptionalism. When I consider difference, my underlying intention is to provide insight into difference as it operates between humans and non-humans in those situations where human exceptionalism is problematic and to explore alternative ways of differencing. When I investigate relationality, it is with the recognition that human exceptionalism is maintained through particular ways of understanding and valuing relations, and when I explore reflexivity, it is to understand better how the reflexive moves that fold semiotic materiality into meaningfulness support human exceptionalism and how they might be folded otherwise.

A semiotic material ontology frames my thinking and arguments. In the broad sense in which I understand it,[25] semiotic materialism includes a legacy of writing that attends to its own textual practice, that is self-consciously

performative in exemplifying the theory it explores in practice. The text reflects the legacy of writers such as Gilles Deleuze (in Part 1), Donna Haraway (in Part 2), and Jacques Derrida (in Part 3), in regarding itself as performing a material semiotic practice as it explores semiotic material concepts. Important to this project in this regard is its situatedness within a particular semiotic materiality, that of the mangroves of Sydney's southern rivers. It was indeed the mangroves that guided my reading towards thinkers who embrace a semiotic materiality. As I sought thinkers whose work spoke to my experience of tidal rhythms and mangal relations, this was the body of theory that responded.

This book thinks with mangroves, whose preoccupation it is to occupy, complicate, and experiment in-betweenness. My research interlocutors throughout this study are the mangrove communities of the Cooks and Georges Rivers in southern Sydney. These mangroves are specialists in negotiating the space between land and water, salt and fresh, coast and river, change and continuity, regularity and disturbance, as well as negotiating with changing sea levels, tides, floods, and the chemical and material composition of their environments. In mangrove ways, they enact the between, stretching out through interconnections. Humans whose bodies and actions affect and are affected by the mangroves are part of that community, as are the migratory birds who stop there to roost or feed, and the sharks who follow the smaller fish into the safety of mangrove roots. Along the way, this study may follow a thread away from the riverbanks, into human wall building, immunology, or lunar traditions.

Introducing mangroves

Mangroves, a term used to describe both the trees and the forest type, including all the plants and animals as well as the non-living conditions required for their survival, thrive in a band along parts of the intertidal waterline of coasts and estuaries in tropical and subtropical regions.[26] Mangrove (or mangal) plants are taxonomically diverse, comprising some 54–75 species globally.[27] All mangrove tree species have evolutionary adaptations to enable them to survive in anaerobic, saline conditions and unstable waterlogged soil.[28] Most characteristic are the specialised roots. Pneumatophores, for example, are roots that protrude from the mud like small spiky fingers and absorb air during low tides through holes called lenticels. Other specialised mangrove roots act as stilts, forming stabilising networks of scaffolding for the tree trunks. To manage the high salinity, some species exclude salt through filtering processes, while others deal with it by excreting it through their leaves.[29] With these and many other specialised adaptions, mangrove trees are able to grow densely when conditions are suitable, forming a thick dark canopy.

Despite their limited range, squeezed within the tidal zone, mangroves are of enormous importance in many ways. Massive and complex root systems

and dense branches accommodate a vast range of organisms, and runoff from the land, tidal wash from the sea and the continual fall of mangrove leaves bring regular supplies of nutrients and other resources into this porous and capacious environment. This combination of regular incoming resources and diverse niches mean mangroves afford many opportunities for animals seeking refuge, food, shelter, mates, or nursery spaces for young.[30] Animals from sea, land, and sky converge here, along with many mangal specialists.

Mangroves were, and in many areas still are, highly valued by Indigenous coastal groups in Australia for their abundance of resources.[31] The Wangal, Cadigal, and Kameygal people of the Cooks River and the Gweagal, Cabrogal, and Bediagal[32] groups along the Georges River cut shields from *Avicennia marina* (commonly known as the grey mangrove) bark, fished with spears, and harvested shellfish, particularly oysters, mussels, and cockles from mud banks and sandbanks in large quantities, and along the Georges, mangrove worms or cah-bro were an abundant and favoured food.[33] Australian mangroves are also culturally and historically important within Indigenous contexts. Knowledge about how to look after the mangal and harvest its foods and other resources remains highly valued, particularly in northern Australia, and the mangrove-edged estuaries of the Cooks and particularly the Georges Rivers were important sites of Indigenous survival following the British invasion.[34]

In recent decades, climate change has drawn increasing attention to the significance of mangroves in coastal protection from storm damage and sea-level rise. Coasts protected by mangroves suffer less damage during storms than those where mangroves have been removed, sometimes far less where the mangroves are thick and healthy.[35] Furthermore, mangrove mud accumulates large amounts of organic matter, which degrades relatively slowly within the anaerobic environment, making mangroves one of the world's most effective environments for storing carbon.[36] These features make mangroves particularly "good to think with" in terms of considering the limits of expertise in approaching climate change, according to Sarah E. Vaughn.[37] As responders to and mediators of climate change, mangroves are moving into another kind of between, one that makes them particularly significant right now.

Cooks and Georges River mangroves

The mangroves of the Cooks and Georges Rivers survive within Sydney's urban environment and have had lengthy and troubled urban histories. Both these rivers run through the southern suburbs of the city and flow out into Botany Bay, to the south of Port Jackson and Sydney harbour.[38] They are ancient, predating the inundation of Botany Bay at the end of the last ice age. Before that inundation, they flowed together to a coast far to the east of its current location.[39] Indigenous occupation along the rivers extends back before that inundation.[40]

The Cooks River[41] is notorious as Australia's most altered and polluted river.[42] Noted by Captain James Cook in 1770 as a bountiful environment providing ample resources for the Indigenous inhabitants and fit to be Australia's first British settlement, the estuarine lower reaches of the low lying, slow-flowing river were fringed with mudflats, saltmarsh, banksia scrub, and extensive mangroves and supported a great diversity of animal species.[43] Cook's opinion was not shared by the officers of the first fleet, landing in 1788 and seeking a suitable site. They discovered a shallow intermittent flow which they judged would be unlikely to provide reliable fresh water for the colony. The city, therefore, grew with its face towards Port Jackson and the Parramatta River. The Cooks and its extensive and productive floodplains, mudflats, mangroves, and saltmarsh became the city's hard-working, "back door".[44] Sydney's rapid development quickly destroyed almost all the Cooks River mangroves. A dam built across the river in 1839–40 blocked tidal flows and killed all the mangroves upstream. Downstream from the dam, the broad areas of mangrove swamps were extensively utilised as a source of potash for soap-making to the point of depletion[45] and were devastated during the extraction of shells from Aboriginal middens for lime production and failed attempts at oyster farming.[46] They then increased their spread in response to the increased supply of nutrients from the city's sewage, some of which was diverted towards Botany Bay. Subsequently, the mangroves became regarded as dangerous sites of criminality and noxious miasma.[47] Eventually, in the 1940s, they were drained and reshaped into Sydney airport extensions and industrial areas. In recent decades, the old industrial areas and working-class suburbs surrounding the river have been gentrifying, river pollution is diminishing, and mangroves have been returning to the river. Community attitudes towards them, though mixed, are shifting towards greater acceptance and even limited encouragement.

The broader and longer Georges River[48] flows into the southern part of Botany Bay. It is approximately 80 kilometres long with a catchment of over 930 square kilometres which includes relatively undeveloped areas of bushland in the upper reaches. Through its middle reaches the Georges meanders through low-lying country which would once have been swampy floodplains but is now sprawling suburbs and significant areas of medium and heavy industry. The river widens into a broad estuary edged in most places by steep-sided sandstone banks which are broken by numerous inlets. It is within these inlets that many of the mangrove communities of the river are to be found. These lower reaches of the river are also surrounded by the southern suburbs of Sydney.

The Georges River mangroves have varied histories, depending upon the land use around each inlet. In several inlets, historical use as rubbish dumps was regarded as actually improving the value of these much denigrated and even feared habitats.[49] These rubbish dumps were later filled and repurposed as sports grounds or open areas. In some other inlets, surrounded by

industrial areas or national parks, the mangroves have remained less disturbed. Through the early twentieth century, the Georges was particularly important as a site of Indigenous continuity and resistance.[50] The rugged terrain, with steep-sided escarpments and many inlets, provided areas where "colonial control could not secure",[51] where Indigenous groups could survive and maintain some self-determination. One well-known camping area that continued to be occupied by Indigenous people into at least the mid-twentieth century was at Salt Pan Creek, where mangroves remained near the creek's river entrance. Indigenous groups survived and adapted at this camp alongside Sydney's mangroves.

The mangal of practice: material semiosis as filter-feeding

The search for non-anthropocentric research methodologies

One of my aims with this book is that it might constitute an example of research that disrupts and seeks alternatives to anthropocentrism. Locating mangroves at the centre is an integral part of that aim. Much work in the environmental humanities concerns the development of approaches to thinking, writing, and researching that avoid a solely human perspective. There are numerous approaches to this challenge. One of these involves expanding the limits of agency, communication and thought to include non-humans. A host of recent research is revealing the ways that, for example, plants and fungi communicate with each other, and how what we think of as decision, choice or agency cannot justifiably be limited to humans. Another approach is to expand models of participatory research to involve non-humans within the research processes, from design through to dissemination.[52] Beyond environmental humanities, methodologies contributing towards this challenge include multispecies ethology and ethnography, which have shifted their research fields towards considering humans as entangled within multispecies relations.[53] Within my work, I am asking how concepts that address interstitiality adapt and change as they are filtered through mangroves. What happens to these concepts when they wash through mangroves, how do mangroves change them? How can the mangroves with their muddiness and sponginess and shifting rhythms speak back to theory?

An alternative word that describes all things mangrove is "mangal", which can be used as an adjective or a noun, as can the word "mangrove". Serendipitously, it is the homophone of "mangle", the term for the device used prior to the manufacture of washing machines to wring water out of washing and also the verb for doing that squeezing. Andrew Pickering chose the mangle to help him describe the process through which "material and human agencies are mutually and emergently productive of one another" within scientific practice.[54] He called this process "the mangle of practice", to emphasise the performative and posthuman qualities of the process through

which the products of science and human intellectual activity emerge unpredictably from practices that involve human intentionality always mangled together with the agencies of the material world. Pickering's mangle of practice overtly assumes a separation of human intentionality from non-human materiality, which become mangled together within practices that occur within specific contexts: the laboratory, the engineering workshop, or academic enquiry. While useful for thinking about the construction of knowledge within these contexts, it arguably does not sufficiently acknowledge the extent to which human intentionality and material agencies are already thoroughly mangled before they get into these spaces and therefore seems to be applicable in contexts that assume an anthropocentric position. Perhaps some of the trouble lies with Pickering's choice of mangle. He focussed on a form of mangle that has the effect of emphasising human practices, the kind that is worked by a human and defined by its functionality towards human purposes. He applies a mangle-machine-metaphor to practices, assuming they are principally performed within the semiotic parameters of a human-centred context of meaningfulness, and never escapes the loop of anthropocentrism. Mangling does not escape the forceful imposition by humans of human-orientations upon what is brought violently together. In this work, I ask: "what might it mean to think with a mangrove understanding of the mangal?"

My hope for this project is that it can perform a "mangal of practice" that does not require an exclusively human-centred epistemological universe from which questions step off, or into which the response is presented for judgement. Here the questions asked, the work done through the practices of walking, flowing, listening, differentiating, processing salt, reading, photosynthesising, thinking, flocculating, writing, infecting, revising, or filter-feeding, are mangaled within a semiotics that is always ecological and material. The linguistic form of this book is the written English language, the hands that typed the words are mine; mangaling does not deny difference, emergence or semiotic meaningfulness, including meanings that are accessible within particular relations such as those of a human cultural practice. Like Pickering's mangle, mangaling describes practices of becoming, transformation and differentiation; both are about the performances of becoming meaningful. Unlike mangling, mangaling does not suppose these descriptions, practices and meanings necessarily involve an element of human exclusivity and exceptionalism, or that humans must perform a violent squeezing of the human and the material together. The process is more like filter-feeding. A lot of filtering-feeding goes on through a mangrove. Mangal mud is a vast filter itself, and many filter-feeders reside there, gathering their bodies and their durations from tidal current and drifting sediment, and through their filter-feeding, forming the geobiome of the mud. Rather than the violent forcing together of Pickering's technological mangle, this project filter-feeds theory and mangroves together. My filtering apparatus is transformed

through the process. This story of material semiotics as filter-feeding will be expanded through the first chapter, "The proposals of tides and the responses of oysters".

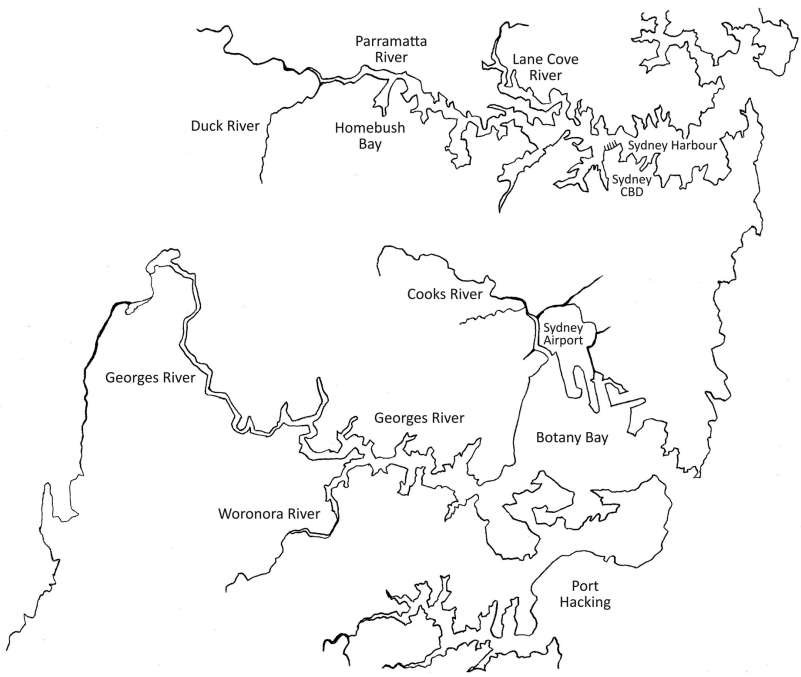
The book is organised into three major parts, each part addressing one of the three broad conceptual areas of the work: ontological reflexivity, relationality, and difference. Each is explored through a narrative feature of the Cooks River or Georges River mangroves, and each develops an argument intended to help align theory with the needs of non-anthropocentric, more-than-human futures.

Part 1, "Strange reflexivities: folding in communicative tidal materialities", considers tides and filter-feeding to explore reflexivity as it is involved in becoming. Its questions are ontological, and it dwells within tidal rhythms and the filter-feeding processes of the mangroves. Oyster bodies have responded to tidal rhythms over evolutionary time and in everyday interactions to work with the flow of the water current and the suspended particles. Selecting, excluding, digesting, and excreting, oysters nourish and build fleshy bodies and hard-shell reefs, filter water, and produce the geobiome of the rich mangrove mud. The three chapters develop a discussion, worked through mangrove materialities, comparing ontologies that propose a semiotic materiality that is meaningful because it comprises a nested hierarchy of layers of increasing semiotic abstraction and those that propose a folded or involuted semiotic materiality. It asks whether the thick gap of semiotic material meaning-making is located within a reflexive shift that establishes levels of abstraction, or whether reflexive processes are dispersed, unstable, and indecipherable as layers. I argue that hierarchically layered semiotic material ontologies have tended to perpetuate the legacy of anthropocentrism and that folding and involution offer ways of thinking the reflexivity involved in meaning-making more suited to the needs of post-anthropocentric theory.

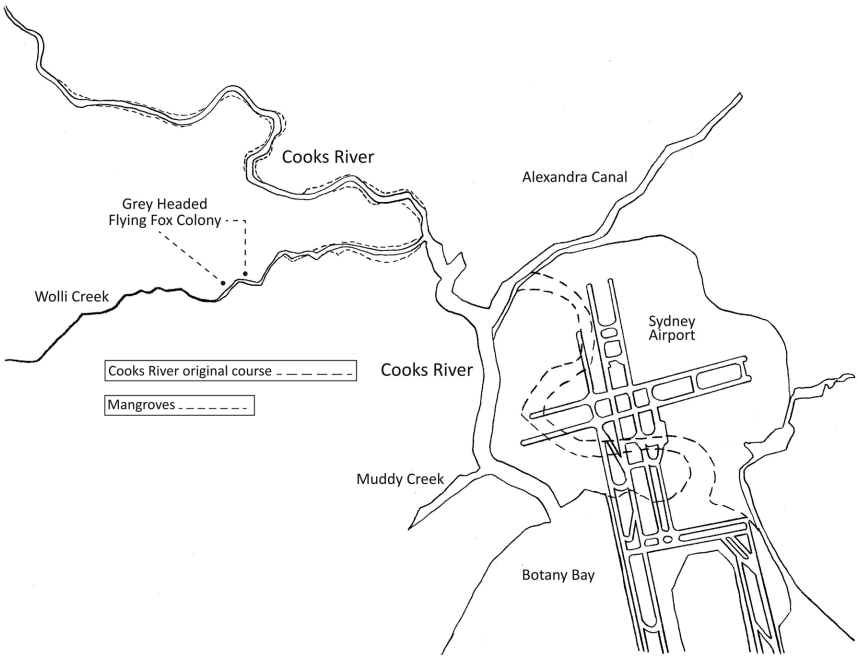
Part 2, "Monstrous relations: exploring a hermeneutic account of relationality", investigates a distinct way of thinking relationality. These three chapters follow the unfolding relations extending between a wallaby, an *Aedes vigilax* mosquito, Ross River Virus, and my body. Our relations have an epic quality – they are rich with life and death risks, sickness, desire, hunger, exploitation, and the nourishment of new generations. Our bodily exchanges are, as Beisel, Kelly, and Tousinant proclaim, "momentous"[55] – and while there are many attunements between us, these often seem to occur agonistically. Most of this discussion focuses upon our encounters one summer around the mangrove edged bays of the Georges River. My researcher's body is reflexively enfolded, called into questions of troubled co-becomings. My visits to the river become layered with an awareness of my body as food for future generations, as a complex experimental field of immunity and accommodation, and as a part of an ancient field of lively experimentation that leaps between, extends across, and shapes

all our different bodies.[56] The key proposal of this section is that in a semiotic material ontology, relations are narratives, and therefore narrative strategies are powerful when employed selectively within relationships. I argue that conceptualising relations as narratives within a semiotic materiality is both theoretically coherent and practically useful for guiding humans in the challenges of living better among others. Such a conceptualisation enables a diverse range of hermeneutic-relational methodologies to be considered for their efficacy in critiquing, supporting, or disrupting existing relations and working new or revised relations, in response to these challenges. In Australia, as in many other places where First Nations people maintain deep connections to land through practices that respect the agency and communicative capacity of other-than-humans, our paths towards more ecologically attuned practices should follow First Nations guidance. Many of the narrative strategies considered here, therefore, have their origins in First Nations practices.

Part 3, "Impossible differences: a muddy journey across more-than-human walls and hospitalities", focuses upon difference in relation to



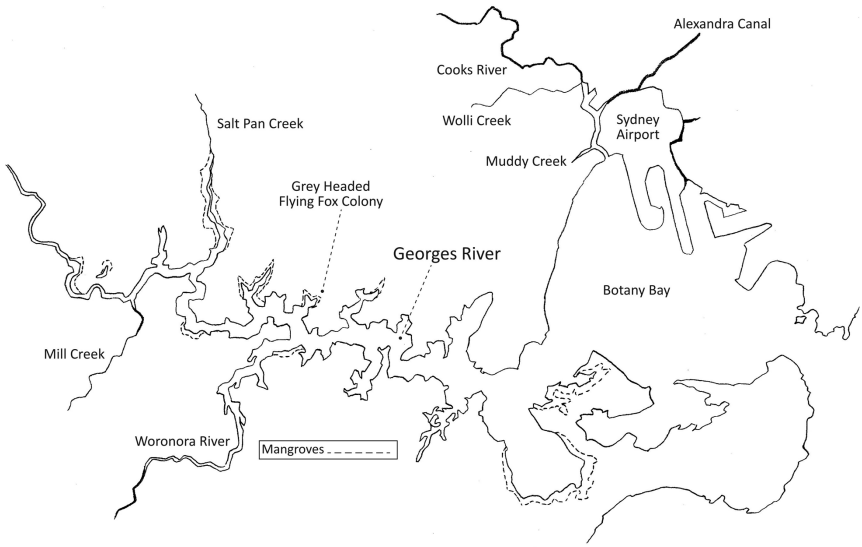
Map 0.1 Map of the New South Wales coast from Port Jackson to Port Hacking, showing the relative positions of the Parramatta River, Cooks River, Georges River, and Hacking River.



Map 0.2 Map of the Cooks River showing the areas of mangroves, the location of the flying-fox colony, and the course of the river prior to the construction of Sydney Airport.

questions of power, territory, and sovereignty. The history of the relationship between the dam walls and embankments of the Cooks River and the river's mangroves provides the mangal materiality for this investigation. The key proposals here are that it is important to understand the attractiveness of securing a powerful position, and that a thick, folded, relational semiotic materiality (as developed through the first two parts of the book, and instantiated by a mangrove) offers an alternative and useful way of reconceptualising security and its artefacts as porous, accommodating, and supportive of a reconceptualisation of vulnerability as a shared resource.

Ecological complexity continues, changes, and diversifies because this world is communicative in multitudes of intersecting ways. Anthropocentrism precludes almost all that communicative capacity from participating in the conversations shaping our common futures. This work contributes towards one of the great tasks of the environmental humanities; how to decentre human perspectives and interests and find ways to continually accommodate the communicative expressions, agencies, and interests of non-humans within decision-making that affects all our entangled futures.



Map 0.3 Map of the lower reaches of the Georges River showing the areas of mangroves, and the location of the flying-fox colony.

Notes

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21 I have chosen to use the terms "in-between" and "interstitial" rather than "liminal" here because in many (though not all) contexts liminality describes a transitional state or site encountered within a process of moving between others which are more stable. The interstitial as I am discussing it does not necessarily suggest such stable beginning and end points, or regular process of movement between.

22 Significant for me in taking this approach is Maurice Merleau-Ponty's call for "plunging-into the world instead of surveying it", in *The Visible and the Invisible*, ed. Claude Lefort, trans. Alphonso Lingis (Evanston: Northwest University Press, 1968), 38–39.
23 Just a few of the many descriptors that will be encountered through this book include "gaps" in Tsing, *Friction*, "*différances*" in Jaques Derrida, *Margins of Philosophy*, trans. Alan Bass (Brighton: The Harvester Press, 1982), "chiasm" and "intertwining" in Merleau-Ponty, *Visible*, and "intra-action" in Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham and London: Duke University Press, 2007).
24 I am thinking in particular of Deleuze, Haraway, Derrida, Michel Serres, and Merleau-Ponty, whose terminologies for discussing in-betweens will be discussed through this book.
25 I will introduce this ontological approach more fully in Chapter 1.
26 In the Sydney region, this does not include the intertidal zones above the regular high tide mark. Saltmarsh is the plant community occupying these less frequently inundated zones in south-eastern Australia.
27 Alfredo Quarto, *The Mangrove Forest: Background Paper* (Gland: Ramsar Convention on Wetlands, 1997), www.ramsar.org/news/the-mangrove-forest-background-paper
28 Beth. A. Polidoro et al., "The Loss of Species: Mangrove Extinction Risk and Geographic Areas of Global Concern," *PLoS One* 5, no. 4 (2010), https://dx.doi.org/10.1371/journal.pone.0010095
29 Quarto, *Mangrove Forest*.
30 Norman Duke and Klaus Schmitt, "Mangroves: Unusual Forests at the Seas Edge," in *Tropical Forestry Handbook*, ed. Laslo Pancel and Michael Köhl (Berlin: Springer-Verlag, 2015); Kandasamy Kathiresan and Brian Lynn Bingham, "Biology of Mangroves and Mangrove Ecosystems," *Advances in Marine Biology* 40 (2001): 81–251.
31 Mark Huxham et al., "Mangroves and People: Local Ecosystem Services in a Changing Climate," in *Mangrove Ecosystems: A Global Biogeographic Perspective: Structure, Function, and Services*, ed. Victor H. Rivera-Monroy et al. (Cham: Springer International Publishing, 2017).
32 These names have been recorded with a variety of spellings, I have followed those listed by Val Attenbrow, "Clan Names Chart," *The Australian Museum*, 2018, accessed 1 May 2022, https://australian.museum/learn/cultures/atsi-collection/sydney/clan-names-chart/
33 Val Attenbrow, "Food from the Sea: Shellfish and Crustaceans," *The Australian Museum*, 2018, accessed 22 July 2020, https://australian.museum/learn/animals/crustaceans/food-from-the-sea-shellfish-crustaceans/; Paul Irish, *Aboriginal History Along the Cooks River* (Sydney: Cooks River Alliance, 2017), 11, 14.
34 Heather Goodall and Allison Cadzow, *Rivers and Resilience: Aboriginal People on Sydney's Georges River* (Sydney: University of New South Wales Press, 2009).
35 Daniel M. Alongi, "Mangrove Forests: Resilience, Protection from Tsunamis, and Responses to Global Climate Change," *Estuarine, Coastal and Shelf Science* 76, no. 1 (2008), https://dx.doi.org/10.1016/j.ecss.2007.08.024; Farid Dahdouh-Guebas et al., "How Effective Were Mangroves as a Defence against the Recent Tsunami?", *Current Biology* 15, no. 12 (2005), https://dx.doi.org/10.1016/j.cub.2005.06.008; Kandasamy Kathiresan and Narayanasamy Rajendran,

"Coastal Mangrove Forests Mitigated Tsunami," *Estuarine, Coastal and Shelf Science* 65, no. 3 (2005), https://dx.doi.org/10.1016/j.ecss.2005.06.022

36 Cheryl L. Doughty et al., "Mangrove Range Expansion Rapidly Increases Coastal Wetland Carbon Storage," *Estuaries and Coasts* 39, no. 2 (2016), https://dx.doi.org/10.1007/s12237-015-9993-8; Daniel Murdiyarso et al., *Carbon Storage in Mangrove and Peatland Ecosystems: A Preliminary Account from Plots in Indonesia* (Bogor: Center for International Forestry Research, 2009); Robert R. Twilley et al., "Productivity and Carbon Dynamics in Mangrove Wetlands," in *Mangrove Ecosystems: A Global Biogeographic Perspective: Structure, Function, and Services*, ed. Victor H. Rivera-Monroy et al. (Cham: Springer International Publishing, 2017).

37 Sarah E. Vaughn, "Disappearing Mangroves: The Epistemic Politics of Climate Adaptation in Guyana," *Cultural Anthropology* 32, no. 2 (2017): 261, https://dx.doi.org/https://doi.org/10.14506/ca32.2.07

38 Map 0.1 shows the locations of these two rivers relative to Sydney harbour and Botany Bay. Map 0.2 shows the locations of mangroves along the Cooks River. Map 0.3 shows the locations of mangroves along the lower reaches of the Georges River.

39 Ian Tyrrell, *River Dreams: The People and Landscape of the Cooks River* (Sydney: University of New South Wales Press, 2018), chapter 1, Kindle; Irish, *Aboriginal History*, 7–8.

40 Irish, *Aboriginal History*; Goodall and Cadzow, *Rivers and Resilience*.

41 According to Tyrrell, *River Dreams*, chapter 1, note 12, and Irish, *Aboriginal History*. note 18, the names used for the Cooks River by Wangal, Cadigal, and Gameygal people before 1788 have not been adequately recorded. Tyrrell reluctantly refers to the name *Goolay'yari*, meaning pelican landing, which has been adopted by councils and community groups for want of a better alternative, but Irish advises against this. I will therefore refer to this river as the Cooks River but note the use of this name is very heavily laden with the violence of invasion and colonial imposition.

42 Tyrrell, *River Dreams*, Introduction, paragraph 15.

43 Ibid.

44 Ibid., chapter 1, paragraph 28.

45 Ibid., chapter 4, paragraph 11.

46 Ibid., chapter 4, paragraph 7.

47 Ibid., chapter 3, paragraph 7; ibid., chapter 4, paragraph 2.

48 Bedigal and Dharawal names for the Georges River are no longer known, according to Goodall and Cadzow, *Rivers*, 29. These historians therefore do not refer to the river by any name other than the Georges River. Many popular sources claim that the historical indigenous name is Tucoerah.

49 Heather Goodall, Allison Cadzow, and Denis Byrne, "Mangroves, Garbage, Fishing: Bringing Everyday Ecology to Sydney's Industrial Georges River", *Transforming Cultures eJournal* 5, no. 1 (2010): 64, http://epress.lib.uts.edu.au/journals/TfC

50 Goodall and Cadzow, *Rivers and Resilience*.

51 Ibid., 29.

52 For examples and discussions of both these approaches, see Michelle Bastian, "Towards a More-Than-Human Participatory Research," in *Participatory Research in More-Than-Human Worlds*, ed. M. Bastian et al. (London: Routledge,

2017). For an example of Indigenous-led research that demonstrates methodologies beyond a human-centric focus, see Sarah Wright et al., "Telling Stories in, through and with Country: Engaging with Indigenous and More-Than-Human Methodologies at Bawaka, NE Australia", *Journal of Cultural Geography* 29, no. 1 (2012), https://dx.doi.org/10.1080/08873631.2012.646890

53 An overview of the emergence of these methodologies is provided in Eben S. Kirksey and Stefan Helmreich, "The Emergence of Multispecies Ethnography," *Cultural Anthropology* 25, no. 4 (2010), https://dx.doi.org/10.1111/j.1548-1360.2010.01069.x

54 Andrew Pickering, *The Mangle of Practice: Time, Agency, and Science* (Chicago: University of Chicago Press, 1995), 24.

55 Uli Beisel, Ann H. Kelly, and Noémi Tousignant, "Knowing Insects: Hosts, Vectors and Companions of Science," *Science as Culture* 22, no. 1 (2013): 8, https://dx.doi.org/10.1080/09505431.2013.776367

56 The framing of our entangled relationships as an experimental field is explored in Natalie Marr et al., "Sharing the Field: Reflections of More-Than-Human Field/work Encounters," *GeoHumanities* (2022), https//doi.org/10.1080/2373566X.2021.2016467

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