Introduction: what is Digital Ecologies?

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In an era of mass extinction, climate emergency, and biodiversity collapse, what role might digital media play in securing liveable futures across species lines? To what extent are digital media ameliorating or exacerbating environmental crises? And what theoretical, empirical, and methodological frameworks are needed to make sense of digitally mediated ecologies? In order to confront these questions, this collection draws together scholars from across more-than-human and digital geographies, the digital and environmental humanities, social anthropology, and media theory, among other fields. Collectively, these authors trace relationships between digital media and environmental politics that are often fraught, sometimes hopeful, and always complex.

Interrogating the mediation of more-than-human worlds is increasingly urgent. As rare and endangered species find digital prominence online, many of them are fading out of corporeal existence. Yet online afterlives of extinct animals continue to circulate in digitised form.[1] In 2021, for instance, the National Film and Sound Archive of Australia released a colourised YouTube video of a thylacine, an extinct marsupial, to commemorate National Threatened Species Day. Numerous contemporary 'thylacine sighting' videos continue to circulate on the same platform.[2] Virtual reality technologies now facilitate encounters with extinct species, such as Jakob Kudsk Steensen's video installation *RE-ANIMATED* (2018–19), which brings the Hawaiian Kaua'i 'ō'ō bird back from the dead for the public to consume. Environmental activism, moreover, is frequently organised and coordinated via social media. Widespread protests by Just Stop Oil and Extinction Rebellion in the UK and beyond are obvious examples of activism that is tailored to being liked, shared, and debated online. Within academia, researchers now deploy digital technologies to study, manage, and conserve species, landscapes, and ecologies: from the everyday logging of birding lists via smartphone apps to advanced satellite tags being used to track turtle dove flightpaths,[3] and artificial intelligence being utilised in identifying plant species.

At the same time, digital media open up new regimes of environmental governance and surveillance. CCTV and camera traps are increasingly deployed to police wildlife in ways that risk reconfiguring colonial violence.[4] Meanwhile, the manufacture, maintenance, and disposal of digital technologies have vast material footprints, contributing towards and intensifying ecological crises.[5] Digital technologies are thus evermore entangled with more-than-human life, often with ambivalent results. Rather than detached, neutral, and objective intermediaries between bodies, digital technologies are situated, political, and affective mediators with manifold implications for the ecologies in which they are intentionally or unintentionally embedded.

Ideas for this collection of interdisciplinary interventions – each with their own objectives, perspectives, and contributions – emerged during the COVID-19 lockdowns in the early 2020s. As a group of scholars working across the social sciences and humanities who were interested in the complex nexus of human social relations with other species and technologies, but were unable to venture far from our homes, we began to search for alternative insights into, and encounters with, the more-than-human worlds we simultaneously study and co-constitute.[6] Many substituted the gaze of binoculars for that of the webcam to observe the daily lives of non-human animals.[7] Conversations about nature took place in alternative spaces and reached new publics online, meaning the very nature of nature itself seemed to change.[8] Organisations and scientists utilised an emergent arsenal of digital devices to mobilise publics (themselves with more spare time) to monitor the natural world at an unprecedented scale through a plethora of citizen science initiatives.[9] Although the global pandemic was heterogeneously experienced and characterised across cultural, historical, and geographical contexts, it resulted in the widespread intensification and normalisation of both digital media and digital mediation in everyday life.

Yet digitisation, and its varied social and political implications for more-than-human worlds, is a socio-technological process far pre-dating contemporary (post-) pandemic scholarship and practice. Technologies necessarily mediate countless human understandings of and engagements with ecology,[10] for example the vast assemblages of devices and implements which facilitate travel, understanding, or communication. The ontological foundations of what different people or cultures might call 'nature' or 'natural' are inseparable from the epistemological implications of the contrasting – and often contradicting – practices and processes used to understand it. Natural histories are technologically mediated, and contemporary ecological situations are known or made knowable by technological histories, to the extent where 'natural' or 'technological' do not make sense without each other, and the narration of ecology is fundamentally shaped by 'technonatural histories'.[11]

However, to emphasise the enmeshment of nature and culture is a non-innocent critical gesture. In empirical terms, as Ryan Bishop and AbdouMaliq Simone foreground in relation to Bernard Stiegler's late scholarship, the large-scale technical systems that are necessary for detecting, visualising, and mobilising around climate change simultaneously contribute to it.[12] This framing of digital media as pharmakon, concurrently culprit and cure for socio-ecological crises, could equally be applicable to the framework of technonatural histories itself. As we discuss in more depth shortly, the act of replacing a nature/technics distinction with an emphasis on the co-constitutive relations between these realms, or recognition of hybridity, has been embraced by hopeful posthumanist and new materialist theories in order to highlight interdependencies and resist anthropocentrism.[13] Yet some of the most prominent technological and conceptual lineages that this body of theory draws upon (notably cybernetics) are grounded in cold war legacies of militarisation and control.[14] As N. Katherine Hayles points out in *How We Became Posthuman*, early cybernetic theory – emerging from conferences sponsored by the Josiah Macy foundation – was intended to 'extend liberal humanism, not subvert it'.[15] In practical terms, moreover, Adam Wickberg highlights that these developments had particular significance for environmental politics, because:

> Early computers like ENIAC – the Electronic Numerical Integrator and Computer – were first developed to calculate complex wartime ballistics tables between 1943 and 1945 and were then received by civil society as a revolutionary means to increase efficiency in engineering, modelling and predicting weather, and would also be part of revolutionizing the understanding of the environment.[16]

Against this backdrop, the prospect of dissolving meaningful separations between mediating technologies and more-than-human worlds is an ambivalent prospect. It is thus important, we suggest, to find ways of understanding processes of mediation without uncritically celebrating them, and to resist treating the description of these relations as an ethico-political end in itself. Instead, this book functions as an ethical entry point, generative of critical lines of inquiry into the futures of ecological politics.

It is among these frictions and tensions we position *Digital Ecologies*. We take the mediation of more-than-human worlds as a starting point, looking to provoke more questions than answers. As such, the intervention we make with this book is not diagnostic or deterministic; it cannot and should not claim any authority over this shifting technological and ecological landscape. Our goal, instead, is to foster dialogue in the emergent space of mediated more-than-human relations and create opportunity for further epistemic multiplicity while at the same time insisting on the need

to centralise ethico-political questions about what these developments mean for more-than-human worlds.

This introductory chapter offers readers a roadmap to *Digital Ecologies* as an intervention. First, we chart the contemporary situations within which these interventions are made, asking what digital ecologies can provide both intellectually and politically in the technonatural present. We position digital ecologies, within the nexus of society–environment–technology, as an epistemological approach to question how and where the mediation of more-than-human worlds occurs, for whom, and with what political consequences?[17] Second, we detail the conceptual framing of this work by establishing a common vernacular through attending to and defining some key concepts such as 'digitisation', 'mediation', 'ecologies', and 'more-than-human'. Third, we explore the empirical articulations of this book, across three interrelated sections of 'digital encounters', 'digital governance', and 'digital assemblages', in addition to introducing the theoretical reflections offered by leading scholars in the social sciences, environmental humanities, and media theory. Lastly, in dialogue with our final trio of chapters, we suggest future directions for critical scholarship in the field.

Situations: the technonatural present

Complex global ecological issues such as climate dysfunction, biodiversity breakdown, and mass extinction now affect all aspects of life. Even activities, practices, and scholarship that were perhaps once thought of as separate from this overarching environment – for example, identity, creativity, or politics – are all dynamically related to the contemporary ecological catastrophe.[18] Notoriously difficult to grasp or imagine across spatio-temporal scales of great magnitude, these ecological frictions are known, communicated, and acted upon through scientific and technological practices associated with the proliferating use of digital media.[19] Agnieszka Leszczynski calls the ongoing intensification of socio-spatial digital mediation the 'technological present': characterised by significant changes in everyday life through the use of media – technical objects such as hardware or software – and forms of mediation.[20] But the complex nexus of technology, society, and environment is further complicated and reimagined in what we call the 'technonatural present'. We understand the technonatural present as rife with digital expressions of 'entanglement', a term deployed by scholars across the environmental humanities and cognate disciplines to decentre human exceptionalism and emphasise the agencies of other-than-human bodies, affects, and practices.[21]

Media theorist Sy Taffel, for instance, has made strides in thinking through digital mediation and the environment through the concept of digital entanglement.[22] In particular, Taffel's work is adept at thinking materialities and encounters – or infrastructure and experience – simultaneously. Drawing from Félix Guattari's influential work that conceptualises the inseparable ecologies of mind, society, and environment, Taffel deploys a relational approach to demonstrate how Guattari's 'three ecologies' are entangled through the mediation of more-than-human worlds. As Taffel underlines, moreover, digital entanglements should not just neutrally be described; instead, they are deeply political – while digital technologies are rooted in systems of exploitative and extractive capitalism through their very materiality, they are not necessarily bound to them. Following this observation, while much scholarship attending to more-than-human agencies tends to celebrate entanglement as something inherently good or progressive, our question here is to ask what comes after digital entanglement?[23] What futures are rendered imaginable or impossible in the technological present, as some technonatural entanglements are materialised while others are foreclosed?

To examine the technonatural present, a relational approach is therefore favourable. On the one hand, this involves acknowledgement that digital mediation has become ubiquitous across diverse societal practices. On the other hand, it involves recognition that digital mediation is itself ecological, underpinned by vast material infrastructures. The technonatural present can thus be characterised as an assemblage of relations that includes human and non-human bodies, environments, and technologies.[24] Digital ecologies, we propose, is one approach to examining the implications of this entanglement across species, spaces, and practices. As an epistemological approach, it asks how situated and politicised accounts of the technonatural present may stimulate alternative future constellations. In the media and public imaginary, speculative futures concerning the digital mediation of more-than-human worlds are commonly situated within a binary narrative of either techno-utopian futures or techno-apocalyptic despair. The former finds unwarranted hope in speculations of 'digital solutionism',[25] hoping for technofixes to the ecological catastrophe that often accommodate some form of 'business as usual'. The latter has long-standing prominence in environmentalist literatures articulated through popular ideas like 'nature deficit disorder',[26] arguing that screens and technologies inherently sever human connections with more-than-human worlds. As such, 'reconnection with nature' 'has become the mantra for addressing humanity's severance from the natural world',[27] which, as Robert Fletcher aptly highlights, is a gross simplification.[28]

Breaking down this narrative binary of techno-utopian hope versus techno-dystopian despair is a key task for digital ecologies scholarship. Such a progressive environmental politics, we argue, can be found in the *glitches* of the technonatural present.[29] Such glitches involve grounded and empirical stories that elucidate digital entanglement otherwise. In software studies, glitches in computation have long been conceived as moments of disruption that enable 'insight beyond the customary, omnipresent and alien computer aesthetics', a moment that 'reminds us of our cultural experience at the same time as developing it by suggesting new aesthetic forms'.[30] Work in digital geographies, likewise, contends that glitches function as 'generative fissures within the spaces and practices' of digital mediation.[31] Building on Legacy Russell's *Glitch Feminism*,[32] this epistemological approach to glitches 'acknowledges the simultaneous ability for error and erratum in digitally mediated formations' whereby 'each rupture offers an opportunity to correct for a different and better outcome'.[33] Glitches provide opportunities to look beyond necessary, but insufficient, criticism of digitisation in the technonatural present and to speculate on digitisation otherwise through affirmative scholarship.

Taffel's work hints at this glitchiness, whereby technologies can be repurposed and experimented with towards more just socio-environmental ends. One example of such glitch-hacking is artist-researcher Matthew Halpenny's work, which attends to the extractive qualities and materialities of digital mediation through attention to temporality. Halpenny's creation *Slow Serif* makes digital materiality palpable by provoking viewers to consider alternative temporalities of digitality.[34] Harnessing electricity from fuel cells powered by moss photosynthesis, Halpenny's research-creation powers artificial intelligence to write a novella on slowness. The electricity generated through the fuel cells can manage to generate one word per day, which makes palpable the relatively enormous amount of energy required for instantaneous and rapid transmission of text, images, and sound that have become customary for fossil fuel powered societies.

Within this framing, then, *Digital Ecologies* employs both critical and affirmative approaches to the mediation of more-than-human worlds, and searches for progressive means of questioning technologies otherwise. In the interstices of sweeping speculation about technologies and their polarised implications for ecologies, *Digital Ecologies* follows minor stories rooted in the everyday. Such work, following Leszczynski,[35] counters the majoritarian view of digitisation as a 'techno-apocalyptic phenomenon' to move towards 'more open – and ultimately more hopeful' futures in scholarship, thought, and praxis. *Digital Ecologies* is situated within the cracks of these narratives, looking for generative openings in thought and practice that awkwardly dwell with friction and modestly provoke inquiry.

Provocations: conceptual framing

To facilitate critically urgent scholarship on the mediation of more-than-human worlds, we need a shared conceptual vocabulary capable of working across disciplinary and practical perspectives. Many terms used throughout this book draw from important theoretical advances made by the 'more-than-human' and 'digital' turns that recently swept across the social sciences and humanities. These 'turns' are heterogeneous and complex, and multiple books could be dedicated to understanding the intricacies of each. In the interests of brevity, though, we will focus here on the contributions central to our conceptual framing of *Digital Ecologies*, defining some of the key concepts that inform the book, such as 'digitisation', 'mediation', 'ecologies', and 'more-than-human'. Strands of media theory have long defined, debated, and nuanced some of the key terms operationalised in this collection.[36] But rather than delving into their specific intellectual histories, here we are concerned with outlining working definitions intended for interdisciplinary audiences. As such, our understandings of these key terms are informed by digital geographies; media theory; science and technology studies (and how insights of this work have been reshaped by the environmental humanities); and transdisciplinary more-than-human theory.

Digital worlds are proliferating and are evermore the subject of academic inquiry, so much so that James Ash, Rob Kitchin, and Agnieszka Leszczynski have traced the emergence of a 'digital turn' in scholarship around the late 2010s, particularly in the context of geography.[37] Despite the digital receiving heightened attention as a matter of concern, the continued definitional ambiguity of 'the digital' is well documented. Daniel Miller and Heather Horst define the digital as 'all that which can be ultimately reduced to binary code, but which produces a further proliferation of particularity and difference'.[38] Digitisation converts the messy worlds of organic information into 'digits': the zeros and ones constituting binary code. Acknowledging digitisation as productive of multiplicity, Ash et al. warn against singular 'monolithic' depictions of 'the digital', instead invoking 'digital' in multiple ways to conceptualise the interconnected things produced through digital modes and mechanisms.[39] In relation to the non-human world, these multiple processes of digitisation work, in turn, to produce a multiplicity of natures.[40] As some of this book's editors and authors have argued elsewhere, 'digitisation thus shapes human–nature relations in multiple ways, enabling and foreclosing connections across more-than-human assemblages, events, and processes'.[41]

This conception of digitisation highlights its political and ethical stakes. Elsewhere, editors and authors in this book have noted that two 'ontological shifts' are inaugurated by the use of digital technologies in

mediating more-than-human worlds.[42] First, 'digitisation enables new ways of encountering nonhumans that were (and are) encountered without digital mediation'.[43] Second, 'entirely novel encounters are facilitated by digitisation, involving aspects of nature inaccessible to encounter without the use of digital technologies'.[44] What is at stake in these two modes of mediation, however, are very different. Indeed, two very different kinds of ontological politics – or the enactment of particular worlds – take place in each. The former involves changing understandings of already existing human–nature relations, whereby new affects can be generated that may co-exist with non-digitised encounters. Such encounters can be harnessed for a variety of purposes from entertainment to education, and we might view this mode as a kind of proliferation of the ways one might relate to nature. At stake here is whether these encounters may displace 'actual' human–nature encounters or enhance in-person encounters. As such, they carry the risk of rendering ecologies spectacular.[45] The latter, however, involves bringing previously inaccessible aspects of the non-human world into the realm of encounter and, thus, governance. Encounters with the deep sea or with certain microbial worlds, for example, are (arguably) *only* possible through digital mediation.[46] The type of digital mediation thus matters as there is a risk of singularly representing such worlds or excluding others – intentionally or unintentionally – from view. Both *how* more-than-human worlds are digitised as well as *what* is being digitised invoke very different ontological and ethical questions, which a digital ecologies framework is attentive to. Thinking across these two distinct modes of digital mediation, we come to understand how digital entanglement gives rise to different modalities of biopower, which, in turn, casts digitisation as an opportunity for 'activists, researchers, designers, artists, and others seeking to refashion how environmental governance takes place and [to] subvert technocratic hegemony'.[47]

Our second key term, 'media', is perhaps still more complex than 'digital' or 'digitisation'. Even in fields that take media as their object of inquiry – such as media studies itself – it can be challenging to pin down what the term 'media' actually means. As Nick Couldry points out, the difficulty is that: 'media themselves are always at least doubly articulated, as both transmission technology and representational content'.[48] These challenges are compounded when moving to other academic fields. Different disciplines offer alternative frameworks and approaches for studying media, producing diverse conceptualisations that mutate and evolve in pluralistic ways.[49] Perhaps the most well-known early theory of mediated communication is Claude Shannon and Warren Weaver's 'mathematical theory of communication' from 1948. This model breaks mediation down into discrete elements (information source, transmitter, signal/received signal, receiver, and

destination), in order to identify how 'noise' generated by semantic, technical, and efficacy problems could disrupt the smooth communication of messages from A to B. This rendering of mediation as a neutral process of transporting messages – only disrupted by external forces – seems far removed from widespread understandings of mediation in sociology or science and technology studies (STS) as any process that makes a difference in the composition of social life.[50]

Yet between Shannon and Weaver and contemporary, broader, conceptions of mediation, there is a rich tradition of media theory that has expanded what mediation means by thinking across different intellectual traditions. In their pithy overview and definition of digital media activism, for instance, Emiliano Treré and Anne Kaun find cultural theorist Raymond Williams' definition of media especially useful due to its emphasis on transformation.[51] For Williams, media should be analysed in terms of three forms of mediation, or transformation: amplification, duration, and alternative symbolic production. This engagement with Williams is productive, then, in combining a broad sociological conception of mediation as a process that makes a difference with a theorisation of *specific* modes of transformation associated with media technologies. In the context of digital ecologies research, this conception of media – and mediation – is productive in centralising questions about how, and in what specific ways, matter and meaning are being transformed at the interface of digital media technologies and more-than-human worlds.

Take livestreamed animal webcams as an example: to examine the digital mediation of peregrine falcons it is important to ask how the newfound visibility of nesting birds might amplify the plight of vulnerable urban species or what forms of ethical response-ability are generated as species are made accessible to wide audiences. It might also be important to ask about the ethical implications of this imagery in terms of its capacity to generate data: what does the production and storage of these data mean for the human and non-human animals enrolled in these mediated encounters? Finally, it seems vital to ask what new meanings are generated by the novel circulation of affectively charged representations? In sum, what role do these technologies play in transforming material relations and cultural narratives?[52] This approach necessitates careful reflection on the relationship between the content of media and its materiality. What is the ethical relation, for instance, between installing and maintaining a camera in a hard-to-reach, intimate site and the affective livestreamed imagery of vulnerable chicks this camera produces? These concerns speak to wider questions in media theory regarding the production of what Sean Cubitt calls 'ecomedia', or texts that are designed to raise environmental consciousness. For Cubitt, the ethics of ecomedia is only partially located in the content of these texts and

it is equally important to understand how this content intersects with the material production of media.[53]

The risk of framing media technologies in terms of the forms of complex socio-material transformation they inaugurate is that this emphasis can give rise to a deterministic understanding of media as forces that shape society – or in the context of this book, transform more-than-human worlds – in accordance with particular technological properties. From this deterministic perspective, for instance, the uptake of sensor technologies in industrialised farming could be interpreted as transforming agriculture in line with productivist logics; or the rise of tracking apps to monitor domesticated animals could be conceived as precipitating new forms of trans-species surveillance. Yet, as lively and valuable scholarship on these topics elucidates,[54] it is important to resist overly neat conclusions about technologies causing or determining social change, as this presumption neglects how media have themselves been shaped by wider socio-cultural assemblages.

To circumvent determinism, Treré and Kaun avoid making neat, linear claims about the types of social transformation that are created by particular forms of mediation. Instead, they reframe mediation in ecological terms, drawing on a tradition of scholarship that conceives of media as 'complex environments' constituted by 'newer and older media formats, physical and digital spaces, internal and external forms of communication, as well as alternative and corporate social media platforms'.[55] In the context of digital ecologies scholarship, therefore, specific media technologies might be entangled with particular forms of technonatural transformation, but should not be understood in isolation and instead conceived as one element of a complex environment. Also central to media ecological thought is the premise that the affordances of media are not static and unchanging, but emerge through practice and their (evolving) relationship with other media.[56] Although media ecological scholarship has a long history, as illustrated by several of the chapters in this book this approach has particularly flourished in the theoretical realm of software studies and ethnographic scholarship on social movement media use. Both these bodies of work have, in turn, drawn inspiration from a range of other disciplines (particularly continental philosophy, critical theory, and STS) to conceptualise media.[57] As Taffel foregrounds, while this approach might carry its risks – not least due to the appropriation of ecological language by corporate forces – an ecological approach retains political and ethical value.[58]

The insights offered by media ecological theory are thus productive for digital ecologies scholarship, in attending to the specific and situated transformations fostered by media environments while resisting deterministic narratives about the nature of these transformations. As Jody Berland underlines in *Virtual Menageries*,[59] developments in media theory mean

that three elements need to be interrogated in order to grasp the ethical implications of mediation for more-than-human worlds. It is vital, Berland argues, to understand both the 'ecology of species' and the 'ecology of media', but it is equally essential to grasp the relations between these ecologies and how they entwine and co-constitute one another. As traced across many of the chapters in this book, these arguments are also applicable to other non-human beings in addition to animals: from seeds and forests to ecosystems themselves.

Debates in media theory are complex and risk, at times, generating too many moving parts (especially when summarising decades of debate into such a condensed form, as we have done here). In sum, though, several key aspects of the above conceptions of mediation are especially informative for this book. First, our approach is informed by the broad conceptual understanding of mediation as a process that makes a difference in the composition of social life, as refined through a focus on the more specific ways that media technologies transform material relations and semiotic meanings. Second, as touched on previously, we adopt an ecological understanding of the affordances of media rather than a deterministic conception of how media shape social relations. Rather than possessing static properties, we understand the affordances of media as emerging through co-constitutive relationships with other elements in complex assemblages. This approach to mediation means that entities beyond the apps, television screens, newspapers, platforms, and phones that are conventionally understood as 'media' can become mediators. In other words, through their relationship with other entities, sometimes surprising entities emerge as important material-semiotic actors – such as the animal mediators described by Berland. This approach, third, means that we take an expansive understanding of what constitutes media, resonating with John Durham Peters' conception of 'elemental media',[60] wherein entities – from clouds to water – can, in Stefan Helmreich's terms, be understood 'not just as an ambient surround, but as a medium through which living and knowing happen'.[61] As Melody Jue points out, understanding the specific ways that elements act as mediators is generative for rethinking some of the central tenets of mediation.[62]

While our *conceptions* of digital media(tion) are informed by digital geographies and media theory, our *ethical orientation* in analysing mediation is informed by approaches originating in science and technology studies (STS) that have flourished in the context of the environmental humanities. As hinted at by many of the recurring conceptual touchstones throughout these opening pages – and throughout this book as a whole – theoretical work from STS informs both our own engagements with digital ecologies and arguments made in many of the other chapters. There are several key

traditions within STS (though some have historically seen more uptake beyond this field than others),[63] but our reference points are grounded in feminist science studies in light of its influence in the environmental humanities and more-than-human geographies.[64] This branch of STS is useful as it combines the recognition of non-human agency and dissolution of boundaries between humans, technologies and non-human animals with an insistence on centring ethico-political questions about the implications of these relationships. As Susan Leigh Star argues in her influential essay, 'Power, Technology and the Phenomenology of Conventions', this tradition starts with the premise that 'it is more politically just to begin with a question, *cui bono?* [who benefits] than to begin with a celebration of the fact of human/nonhuman mingling'.[65]

For Star, what is missed in celebratory narratives of entanglement is recognition that socio-technical infrastructures organise worlds in ways that are difficult to reverse and become normalised as a fact of social life. It is thus important to ask how these infrastructures come into being and to interrogate the work they do in order to foreground who benefits from them (and crucially who is harmed). Put differently, when analysing digital infrastructures, it is vital to address questions of power and inequality. To do this, Star contends, it is important to ask who does the 'invisible work' of negotiating exclusionary infrastructural arrangements because this focus not only highlights inequity but disrupts infrastructural naturalisation by highlighting that: 'There is nothing necessary or inevitable about science or technology, all constructions are historically contingent, no matter how stabilized'.[66] As Star goes on to emphasise in her landmark book on the politics of classification with Geoffrey Bowker, *Sorting Things Out*: 'Each standard and each category valorizes some point of view and silences another. This is not inherently a bad thing – indeed it is inescapable. But it is an ethical choice, and as such it is dangerous – not bad, but dangerous'.[67] What is underlined by Star and Bowker, then, is the importance of understanding how categories and standards mediated by spreadsheets, filing cabinets, and computer desktops might seem mundane – and, as such, are difficult to even notice – they nonetheless organise worlds in profound ways.

As evoked by the title of *Sorting Things Out*'s first chapter, 'To classify is human', the book's focus is on the implications of information infrastructures for the organisation of *human* lifeworlds.[68] Thus, while *Digital Ecologies* is animated by similar ethical questions and points of emphasis to Bowker and Star, we differ in our focus on the implications of mediation for more-than-human worlds. In other words, we place non-human animals, plants, and ecosystems front and centre in questions about who benefits and who is excluded by assemblages of digital mediation.

As illustrated by the above discussion, the phrase 'more-than-human' is used regularly throughout this book. This term's use has proliferated since the beginning of the twenty-first century, perhaps signifying a political choice to decentre human experience as the focal point of analysis in social research. More-than-human approaches to research broadly seek to conceptualise and examine the agency of non-human beings and materials in what were previously considered the sole domains of human activities: culture, society, politics, and the economy. Digital media (and mediation) are co-constituted with more-than-human environments. The theoretical lens of ecologies allows us to make sense of this in greater detail. 'Ecology' is conventionally defined as the biological study of relations and interactions between living and non-living bodies. However, the term has been adopted and reworked in the social sciences (as exemplified by media theory) because of its focus on relations, connections, assemblages, and entanglements between more-than-human actants.[69] New materialist scholars, for instance, have explored ecological frameworks for elucidating the relations between matter, bodies, environments, and their interactions. Digital geographers have, likewise, deployed an ecological lens to study the agencies of cybernetic matter such as algorithms and malware,[70] and ecological metaphors are commonly evoked in the study of human–computer interactions.[71]

We are drawn to the multiple interdisciplinary, collaborative, and conceptual potentials of 'ecologies', and thus find it preferable to alternative terms like 'digital nature'[72] and 'digital Anthropocene' (even though these frameworks are also critically important).[73] Our use of the term 'ecologies', however, is due to it being multiple from the outset, explicitly focused on interrelations between actants across species and spaces. Moreover, it refers to the critical tradition of political ecology, which combines the theoretical lenses of political economy and ecology to examine the relations between humans, non-humans, and capital.[74] As Taffel argues, in the context of digital mediation: 'A political ecology of media must additionally consider the relations that are embedded in and propagated by the infrastructures that support the production of content – the code, algorithms and programs which exist at the scale of software, and the components, cabling, cell towers and other entities which comprise the scale of hardware'.[75]

In co-authored work elsewhere, with a range of other scholars from across geography, media theory, and political ecology – namely Pauline Chasseray-Peraldi, Jennifer Dodsworth, Oscar Hartman Davies, Julia Poerting, and Erica von Essen – we have presented digital ecologies as an analytical framework to empiricise these overlapping areas of conceptual interest.[76] The structure of this book reflects this framework, although the areas are by no means mutually exclusive. The interrelated sections of the book – digital encounters, digital governance, and digital assemblages – develop the

conceptual framing of digital ecologies still further and highlight the importance of multiplicity, reflexivity, and adaptability in this approach.

Articulations: empirical engagements

Digital Ecologies is divided into three thematic parts, followed by three reflections from academics working in different fields related to the contributions of this book. These parts are by no means mutually exclusive, and some chapters certainly could have worked elsewhere within the collection. For us, this highlights the entanglements between theoretical, methodological, and empirical dimensions of the material and political realities of research in digital ecologies.

Starting with 'Digital encounters', Part I of the book highlights the heterogeneity of mediation across cultural, historical, technological, and ecological contexts. Encounters materialise in a given space and time when two or more entities come into contact. In the cases explored in this collection, these encounters are brokered through a variety of digital media.[77] Digitisation enables new ways of encountering non-humans that were (and are) encountered without digital mediation. These are encounters that took place before digitisation but which are now mediated by it. But also, entirely novel encounters are facilitated by digitisation, involving aspects of nature inaccessible to encounter without the use of digital technologies. To start with encounter, then, is to situate digital mediation and digital media, to ask what encounters they inaugurate, and to explore what knowledges are produced through these processes.[78]

In 'Running wild', William M. Adams, Chris Sandbrook, and Emma Tait examine the possibilities of augmented reality and smartphone gaming to foster a form of digital empathy towards far-away species on the brink of extinction. The role of games and gamification here is significant. While games can encourage human users to change their attitudes towards corporeal animals through building affinities towards digital avatars, gamification points to ethico-political tensions that arise through making life playable. Indeed, more broadly in the sociological literature, gamification has been accused of: 'replacing older forms of labour surveillance and oversight with seemingly "playful" forms'.[79] Speaking directly to the potentials and tensions of play, Catherine Oliver's chapter on the Twitch stream *Our Chicken Life* notes the affective atmospheres of gamification for fostering multispecies connection. In this case, direct user control is crucial: unlike many forms of online nature streaming that are unidirectional castings of wildlife (like AfriCam's gaze upon watering holes of Southern Africa),[80] *Our Chicken Life* relies on viewer input to directly shape the daily activities of chickens.

Yet both livestreams and exercise apps ultimately mobilise digital encounters in the pursuit of value generation, whereby non-human animals and their labour are used in the context of platform capitalism.[81] Whether for private wealth accumulation or for the benefit of conservation organisations, these chapters highlight the ways in which digital encounters can produce spectacular versions of nature,[82] as well as critical reflection on the new regimes of 'encounter value' instigated by these assemblages.[83]

While the aforementioned chapters bring well-known, widely documented, or even mundane ecological contexts into widespread public gaze through digitisation, Jon Henrik Ziegler Remme's 'Trap-cam of care' questions the novel ecologies brought into view through digital mediation itself. Prior to the installation of camera networks in traps, the captive behaviour of lobsters was left to the imagination. Remme's chapter shows how digitisation brings publics closer to these encounters – similarly to Oliver's detailing of user engagement, trap-cam viewers can offer suggestions to scientists about which foods to offer captive lobsters. Subaquatic ecologies are often argued to engage humans due to their inaccessibility and the need for them to be imagined.[84] However, through digital mediation, these more-than-human worlds are made knowable, and forms of digital intimacy have the potential to emerge. Again, though, while Remme's chapter underlines that mediation might foster new forms of knowledge and, in turn, care, these modes of care can also be entangled with violence, here due to the complex relations between lobster trap-cams and the fishing industry. In 'Digital sonic ecologies', Hannah Hunter, Sandra Jasper, and Jonathan Prior offer a different set of provocations for multispecies ethics, in turning to digital sound archives and sonic encounters. For instance, one of the chapter's many empirical illustrations discusses how digital traces of the now-extinct Kauaʻi ʻōʻō bird – once native to the Hawaiian archipelago – are found readily online. The spectral listening experience is now haunted by the knowledge of the animal's eventual demise and, the authors argue, provokes affectively charged responses critical of the settler colonial and capitalist processes underpinning its extinction. Ultimately, Hunter, Jasper, and Prior show how digital sonic recordings carry a multitude of material implications for more-than-human life.

Part II of the book, 'Digital governance', explores how digitisation generates opportunities for understanding pasts, governing presents, and forecasting futures across ecological contexts. Digital tools inaugurate many opportunities for the command and control of non-human life, and profoundly implicate the knowledge practices involved in mediating more-than-human worlds. For example, large conservation organisations are increasingly deploying algorithmic forms of governance that make 'smart' or 'real-time' decisions affecting non-human life anywhere in the world,

such as from a computer in California, which often comes at the expense of decentring local and embodied knowledge practices.[85] But there are also frictions within this techno-hegemonic narrative, and as work in this collection demonstrates, online spaces have capacities to foster alternative versions of environmental politics – whether progressive or conservative.

'On-bird surveillance' by Oscar Hartman Davies and Jamie Lorimer explores the novel modes of governance used by marine ecologists and inaugurated by a range of digital tracking devices. Animals have been made knowable to humans through their tracks since prehistoric times, but in recent decades the growing arsenal of digital devices on hand to movement ecologists has left wilderness well and truly 'wired'.[86] But Hartman Davies and Lorimer trace the emergence of an important shift for digital ecological governance: from the human tracking *of* animals to humans tracking other human activities *with* animals. Particularly in an oceanic context, this carries fascinating implications for 'smart' governance regimes that demand fluidity, leading certain actors to create more urgency for further technological intervention. The agencies of non-human animals often come to the fore through the deployment of 'lively surveillance', whereby human actors exploit the ecological adaptabilities of non-human life to an environment, in their case the mounting of tracking devices onto albatrosses covering vast oceanic distances to monitor fishing activities.

In a similar vein, '"Saving the knowledge helps save the seed"' by Sophia Doyle and Katherine Dow details where non-human agencies – in this instance, those of technologies themselves – can be used by other human actors for politically just means. The London Freedom Seed Bank uses the same tools and techniques associated with biopolitical governance – in this case databases and database infrastructures – to forge multispecies connections, centre non-human genetic knowledges, and cultivate more liveable futures. Their chapter emphasises the non-neutrality of environmental data,[87] and illustrates technological agency itself, showing how the use of – and socio-ecological relations mediated by – certain technologies differs significantly from their originally intended purpose. These arguments thus resonate with Star's reminder that technologies could always have been 'otherwise', as with *Sorting Things Out*'s observation that everyday data-gathering technologies are often dangerous due to becoming so routinely, and mundanely, used that they escape critical attention, thus obscuring the possibility of alternative ways of doing things. In Bowker and Star's words: 'when a seemingly neutral data collection mechanism is substituted for ethical conflict about the contents of the forms, the moral debate is partially erased'.[88] Speaking to these arguments, what is so critical about Doyle and Dow's chapter is that it does not solely work to denaturalise

data-gathering software, but offers a concrete sense of how socially and environmentally just alternatives could be realised.

Digital objects, technologies, and techniques are therefore deeply engaged and involved in ecological politics, as the '#AmazonFires' chapter by Jonathan W.Y. Gray, Liliana Bounegru, and Gabriele Colombo attests. They detail how political frictions can develop on social media platforms through digital objects like hashtags and images, and how such digital objects reconfigure knowledge practices concerning environmental events online. Alternative visions of the 2019 #AmazonFires can be understood through digital archiving, which emphasises the methodological potentials and complications digitisation poses to the praxis of historical research – as such the digital archive is an ever-expansive space in the perpetual process of recombination.[89] Yet far from being understood after the fact, digital tools are also used in a prefigurative politics with the objectives of inclusivity and visibility across diverse social groups, as discussed by Jess McLean and Lara Newman regarding 'Children and young people's digital climate action in Australia'. Through digitisation, the School Strike 4 Climate movement has facilitated alternative visions of environmentalism that are not inherently exclusive along lines of race, gender, age, or class, and provide important links between activism across spatial and temporal scales. Importantly, McLean and Newman explore the decolonial potentials of digital mediation through centring on place and co-belonging and discuss its implications for identity and activism online.

These chapters, in conversation, allow for broader reflections concerning how digital ecologies are mobilised in search of progressive ethics and political potential. As ethics are always situated and emergent,[90] these chapters highlight the importance of paying close attention to ecologists, policymakers, and other practitioners experimenting with digital technologies to determine the responsibilities and obligations they inaugurate.[91]

Part III, 'Digital assemblages', questions the broader material foundations and implications of digital mediation. Materiality is a key theme throughout this part of the book, which highlights the diversity of non-human actants implicated in the co-fabrication of social, political, and economic worlds. This diversity is frequently obscured by the seemingly immaterial character of digitised worlds – for example, those characterised by imaginaries of an invisible 'cloud'.[92] Thus, chapters in this section draw attention to the materials, devices, and infrastructures that are fundamental to the digitisation process. These chapters learn from conceptual discussions in media ecology in the 2010s and 2020s that advance the idea that ecologies do not surround or adjoin media, but rather support and enable them.[93] Contributions in this part of the book thus take an expanded view of

infrastructure, attentive to the ways in which non-human life is implicated in, and can be enrolled as part of, the biopolitics of infrastructure.[94]

Jennifer Gabrys offers a critical analysis of 'Programming nature as infrastructure in the Smart Forest City', proposed by its supporters as the meeting of technological and ecological urban design. This chapter was initially presented as one of the keynote lectures at the inaugural Digital Ecologies conference in 2021, inciting debate among attendees.[95] In contrast to many other chapters in this collection that examine the subversion of digital technologies by human and non-human actors, Gabrys importantly shows how smart green urbanism and its socio-technical – and ecological – formations potentially exacerbate urban inequalities. In considering the work of Lauren Berlant and the attestation that otherwise infrastructures carry transformative political potential while attending to their interrelations with social life,[96] Gabrys thinks through Smart Forest City infrastructures 'otherwise' to highlight the possibilities for less extractive and exploitative future practices.

Dwyer and Arold continue this expansion of what and how media ecologies are conceived, further strengthening dialogue between media theory and geographical and environmental humanities scholarship. Dwyer's chapter 'Ecological computationality' foregrounds potentials – and further complexity – opened up when conceiving of media in ecological terms, taking seriously the proposition that media have their own form of agency rather than simply mediating human intentions. Drawing on vignettes from the ethnography of malware, Dwyer traces how layers of self-referential relationships among code manifest agency in ways that disrupt the work of software engineers. Thinking across software studies, more-than-human and digital geographies, Dwyer thus poses provocations for digital ecologies research about how to accommodate the ecologies and agencies of digital media themselves. In 'Mediated natures', Arold draws on ethnographic observations from forest activism in Estonia, likewise offering an important provocation for digital ecologies in the rejoinder to remember the analogue. In other words, whereas Dwyer asks what can be gained from understanding software in ecological terms, Arold offers a reminder that the communications ecologies associated with environmental politics are always 'hybrid media' systems:[97] co-constituted, as Arold traces, not only by digital GPS and GIS technologies, but (in the case of forest activism) by discourse, diggers, and the agency of humans and non-humans with a stake in the forest. Arold's chapter, then, offers a framework for understanding how hybrid media systems are entangled with more-than-human worlds, expanding what counts as mediation in this context.

Together, the book's central chapters point to new disciplinary alliances and directions, and the value of thinking across academic fields. It should

be emphasised, however, that although we have divided the book into three parts, this is for heuristic purposes rather than a neat dividing line. Echoing Taffel, it is futile to examine the agencies of content, software, and hardware in isolation from one another, but it is not merely enough to describe these digital entanglements.[98] Instead it is vital to foster situated understandings of the political stakes of particular entanglements, in terms of the more-than-human worlds they enact and those they foreclose.

Directions: beyond the book

Part IV of *Digital Ecologies*, 'Digital ecological directions', consists of three invited reflections from academics working in different disciplinary domains – geography and visual studies, environmental history and humanities, media theory and sociology – about future directions for research in the overlapping remit of digital ecologies. Our hope with this part of the book is to acknowledge the aforementioned importance of interdisciplinarity to current and future digital ecologies scholarship while resisting the problems of hazy disciplinary boundaries – cognisant of critiques made by Cary Wolfe who suggests, in the context of animal studies, 'it is only through our disciplinary specificity that we have something specific and irreplaceable to contribute to this "question of the animal" '.[99] Echoing Wolfe's sentiment, in the context of digital ecologies, our hope in closing with reflections that are grounded in three specific disciplinary traditions that inform this book is threefold. First, these chapters elucidate some of the specific ways these disciplines shape – or could further inform – digital ecologies research. Conversely, and second, this part of the book foregrounds what digital ecologies scholarship might contribute to geographical, media, and environmental humanities research moving forwards. Third, and finally, these closing chapters also made us reflect back on the original conception of *Digital Ecologies*, what has changed over the years the book was being elaborated, and work that still needs to be done.

This book has developed over three years, and the ideas that have shaped it have come from many sources and interdisciplinary engagements, for which we are grateful. We had initially planned to hold a series of paper sessions at an international conference on the theme of digital ecologies. However, this event was due to take place in 2020 and shifted to a virtual format. At the height of the pandemic and its social and economic burden, many lacked the resources to pay high attendance or participation fees for an online event, which led us to withdraw. Instead, we ran a two-day conference online, with an open call for attendees across disciplines. This collection brings together some of the papers from these two days in

March 2021, in addition to other contributions from people working in the field.

The book's history, then, was beset with challenges. We were able to negotiate some of these challenges successfully, such as organising our first – then second – event, and working with an emerging community of scholars and practitioners engaged with digital ecologies. Other challenges were more complex. As with many books that have grown out of existing networks and collaborations, there are shared emphases and shared omissions in this collection. For instance, the geographical background of three of the editors and several authors means that there is rich engagement with care ethics, more-than-human agency, biopolitics, and the spatial dynamics of digitisation. In contrast, debates in media studies concerning datafication or media theory's reconceptualisation of what constitutes media began as more peripheral and have been intentionally integrated through ongoing interdisciplinary conversation.

Similarly, the theoretical background of the editors and many authors is grounded in literature from more-than-human thought, STS, animal studies, and the environmental humanities. This context means that a vocabulary of entanglement and relationality is threaded throughout the book and the lives of non-human animals and ecosystems is centralised. While this is (we hope) an important collective intervention, it also risks broader questions of data sovereignty and the relationship between digital ecologies, human labour, and precarity playing a less significant role in the conversation. Or, as Gillian Rose puts it in her afterword, there is less attention to the 'big social media platforms … their harvesting of user data and their algorithmic mediation of environmental data, nor their commodification of nonhuman life'. The book's focus on the way more-than-human worlds are mediated, moreover, at times risks rendering mediation itself as something all-pervasive. While contemporary ways of knowing and understanding environments are difficult to detach from media systems, these dynamics should not be taken for granted. Human relations with more-than-human worlds are always political and demand materialist (as well as new materialist) analysis, in order to identify extractive relationships fostered by mediation and carve out space for alternative imaginaries.[100] At times this might entail deciding to purposefully resist or contest the enrolment of non-human beings into media assemblages, to leave certain non-human animals alone, or allow particular ecologies to remain strange.[101] Our aspiration, therefore, in closing the book with reflections about pathways forward is to offer entry points into future conversations about what digital ecologies scholarship might be – not only serving to highlight the work undertaken by chapters in the book, but as an invitation for dialogue about possible future directions.

Notes

1 Adams, 'Digital animals.'
2 NFSA Films, 'Tasmanian tiger in colour.'
3 eBird, for instance, describes itself as 'among the world's largest biodiversity-related science projects, with more than 100 million bird sightings contributed annually by eBirders around the world and an average participation growth rate of approximately 20% year over year.' See: E-bird, Cornell Lab of Ornithology, https://ebird.org/about. Operation Turtle Dove is an international collaboration between conservation organisations in Western Europe and North Africa to address sharp declines in turtle dove populations due to disruption in their migration routes. See: 'Tracking turtle doves.' Operation Turtle Dove. RSPB, Pensthorpe Conservation Trust, and Natural England, https://operationturtledove.org/turtle-doves/titan/.
4 On camera traps and securitisation, respectively, see Mathur, 'Entrapment'; Duffy, 'Security technologies and biodiversity conservation.'
5 Cubitt, *Finite Media*.
6 We were not alone in doing so, either. See Turnbull et al., 'Quarantine encounters with digital animals'; Turnbull et al., 'Quarantine urban ecologies.'
7 For example, Schultz-Figueroa, 'Abandoned aquariums.'
8 Turnbull et al., 'Anthropause environmentalisms.'
9 See Basile et al., 'Birds seen and not seen during the COVID-19 pandemic'; Saraswat and Saraswat, 'Research opportunities in pandemic lockdown.'
10 Jørgensen, 'The armchair traveller's guide to digital environmental humanities.'
11 Searle et al., 'The digital peregrine.'
12 Bishop and Simone, 'Volumes of transindividuation.'
13 For a genealogy and critique of these theoretical moves, see Hörl (ed.), *General Ecology*.
14 Beck and Bishop, *Technocrats of the Imagination*.
15 Hayles, *How We Became Posthuman*, p. 7.
16 Wickberg, 'Environing media and cultural techniques.'
17 This line of questioning is informed by the book's engagement with insights from feminist science studies, which we elaborate upon subsequently. In particular, our perspective resonates with Donna Haraway's argument that, to unearth the ethical and political stakes of any socio-political context, it is vital to ask: 'what counts as nature, for whom, and at what cost?' Haraway, *Modest_Witness@Second_Millennium*.
18 Braun and Whatmore, *Political Matter*; Davis and Turpin, *Art in the Anthropocene*.
19 Edwards, *A Vast Machine*; Stengers, *In Catastrophic Times*.
20 Leszczynski, 'Spatial media/tion.'
21 Haraway, *When Species Meet*.
22 See in particular Taffel, *Digital Media Ecologies*; 'Data and oil'; 'Technofossils of the Anthropocene.'
23 See Giraud, *What Comes After Entanglement?*

24 Taffel, *Digital Media Ecologies*.
25 Kuntsman and Rattle, 'Towards a paradigmatic shift in sustainability studies.'
26 Louv, *Last Child in the Woods*.
27 Zylstra et al., 'Connectedness as a core conservation concern,' p. 120.
28 Fletcher, 'Connection with nature is an oxymoron.'
29 This argument is made in more detail with colleagues from the Digital Ecologies research group. See Searle et al., 'Glitches in the technonatural present.'
30 Goriunova and Shulgin, 'Glitch,' pp. 114–115.
31 Leszczynski and Elwood, 'Glitch epistemologies for computational cities,' p. 362.
32 Russell, *Glitch Feminism*.
33 Maalsen, 'Algorithmic epistemologies and methodologies,' p. 207.
34 Halpenny, 'Post-extractivist gardening.'
35 Leszczynski, 'Glitchy vignettes of platform urbanism,' p. 196.
36 Wickberg, 'Environing media'; Wickberg and Gärdebo (Eds.), *Environing Media*.
37 Ash et al., *Digital Geographies*.
38 Miller and Horst, 'The digital and the human,' p. 3.
39 Ash et al., *Digital Geographies*.
40 Nelson et al., 'Feminist digital natures.'
41 Turnbull et al., 'Digital ecologies,' p. 6.
42 Ibid., p. 11.
43 Ibid.
44 Ibid.
45 Arts et al., 'Information technology and the optimisation of experience.'
46 Helmreich, *Alien Ocean*; Herrera, 'Microbes and other shamanic beings.'
47 Turnbull et al, 'Digital ecologies', p. 20.
48 Couldry, 'Mediatization or mediation?' p. 375.
49 For a comparison between STS and media studies approaches, see Wajcman and Jones, 'Border communication.'
50 Bruno Latour's definition(s) of mediation is perhaps exemplary here, e.g. Latour, 'On interobjectivity.'
51 Treré and Kaun, 'Digital media activism.'
52 For more sustained reflections in relation to this case study, see Searle et al., 'The digital peregrine.'
53 Cubitt, 'Decolonizing ecomedia.' Here Cubitt makes the broader point that media industries are often bound up with regimes of racial capitalism.
54 E.g. Bellet, 'Reconfiguring the senses'; Langstone, ' "No shit Sherlock"!'
55 Treré and Kaun, 'Digital media activism,' p. 201.
56 For a succinct overview of media ecological thoughts, see Treré and Mattoni, 'Media ecologies and protest movements.'
57 For especially valuable work in this tradition from software studies, see Fuller, *Media Ecologies*; Taffel, *Digital Media Ecologies*; for social movement media studies, see Mattoni, 'A situated understanding of digital technologies in social movements'; Treré, *Hybrid Media Activism*.
58 Taffel, 'Digital media ecologies.'

59 Berland, *Virtual Menageries*.
60 Peters, *The Marvelous Clouds*.
61 Helmreich, *Sounding the Limits of Life*, p. 186. For an alternative theorisation of seawater, as a route into 'milieu-specific analysis' that transforms conception of the fundamental elements of media theory 'interface, inscription, database storage', see Jue, *Wild Blue Media*.
62 Jue, *Wild Blue Media*.
63 Outside of the field itself, STS can sometimes be conflated with a comparatively small number of thinkers and frameworks that have had the most prominence in other disciplines, e.g. Bruno Latour and Michel Callon in relation to actor-network theory, or influential and important interventions made by feminist, postcolonial, and queer science studies, such as Donna Haraway's companion species, Sandra Harding's standpoint theory, Karen Barad's agential realism, and Maria Puig de la Bellacasa's theorisations of care. For particularly helpful accounts of the different traditions of STS, some of which are contemporary and others which retain value despite being over twenty years old, see Biagioli, 'Introduction'; Cipolla et al. (eds.), *Queer Feminist Science Studies*; Law and Singleton, 'Performing technology's stories.'
64 This valuable exchange between STS and the environmental humanities is crystallised, for instance, by Thom van Dooren's engagement of conceptions of 'entanglement' from feminist science studies in van Dooren, *Flight Ways*.
65 Star, 'Power, technology and the phenomenology of conventions,' p. 38.
66 Ibid.
67 Bowker and Star, *Sorting Things Out*, p. 6.
68 This is not to say that other non-human beings are omitted; indeed, in the opening pages of the book (p. 7) seed categorisation is referred to as an instance of classification, but the book's emphasis is on IT infrastructures and their implications for work and biomedicine.
69 Latour, *Reassembling the Social*.
70 Dwyer, 'Cybersecurity's grammars.'
71 Helmreich, 'What was life?'
72 Nelson et al., 'Feminist digital natures.'
73 McLean, *Changing Digital Geographies*.
74 For more on digital political ecology, see Tait and Nelson, 'Nonscalability and generating digital outer space natures in no man's sky.'
75 Taffel, 'Digital media ecologies,' p. 16.
76 Turnbull et al., 'Digital ecologies.'
77 For more on the ethics of encounter, see Wilson, 'Contact zones.'
78 Haraway, 'Situated knowledges.'
79 Woodcock and Johnson, 'Gamification,' p. 544.
80 See Kamphof, 'Webcams to save nature.'
81 Barua, 'Nonhuman labour, encounter value, spectacular accumulation.'
82 See Büscher, *The Truth About Nature*; Igoe, *The Nature of Spectacle*.
83 Haraway, *When Species Meet*, pp. 45–68.
84 See Bastian, 'Whale calls, suspended ground, and extinctions never known.'

85 Adams, 'Conservation by algorithm'; Bakker and Ritts, 'Smart Earth'; Duffy, *Security and Conservation*.
86 Benson, *Wired Wilderness*.
87 Nost and Goldstein, 'A political ecology of data.'
88 Bowker and Star, *Sorting Things Out*, p. 24.
89 Hodder and Beckingham, 'Digital archives and recombinant historical geographies.'
90 Haraway, *When Species Meet*.
91 Stengers, *Cosmopolitics I*.
92 For conceptualisations and imaginaries of the cloud, which stress its epistemological and ethical significance, see Amoore, *Cloud Ethics*; Peters, *The Marvelous Clouds*.
93 For example, Kember and Zylinska, *Life After New Media*; Parikka, *The Anthrobscene*.
94 Barua, 'Infrastructure and non-human life.'
95 A recording of this lecture is currently hosted on the *Digital Ecologies* website and YouTube channel, in addition to the other keynote lecture, delivered by Etienne Benson. See: https:/youtube.com/watch?v=IX7pXHfjzKE.
96 Berlant, 'The commons.'
97 See Chadwick, *The Hybrid Media System*.
98 Taffel, *Digital Media Ecologies*
99 *What is Posthumanism?* p. 115.
100 Wadiwel, 'Animals & capital.'
101 Davé, *Indifference*; Neimanis, 'Stygofaunal worlds.'

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