Political ecology and the Foucault effect: A need to diversify disciplinary approaches to ecological management?

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Abstract
While explicitly Foucauldian analyses have declined in recent years in the social sciences, Foucault’s ideas continue to strongly influence scholars’ approaches to power, governance and the state. In this article, we explore how Foucauldian concepts shape the work of political ecologists and social scientists working on environmental management, multispecies ethnography and the Anthropocene – often in an unrecognized way. We argue that – regardless of whether or not Foucault’s work is explicitly cited – his legacy of linking scientific projects, population management and state control continues to have an outsized impact on thinking in these fields. It is time, we assert, to directly consider how such theoretical inheritances are affecting the shape of political ecology, in particular, and the social sciences, more generally. How, we ask, are Foucauldian traditions at once enabling and constraining more-than-human scholarship? In this article, we explore the contributions and limitations of Foucauldian approaches in environmental contexts through empirical attention to trout introduction and management efforts in South Africa. Our overall aim is to call for a deeper conversation about how scholars working on environmental topics engage the science-governance nexus. The article ends with proposing landscape, as a material enactment of more-than-human politics, as a useful analytical category to this end.

Keywords
Foucault, biopower, landscape, environmental management, scientific knowledges, trout

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Michel Foucault has been among the most influential thinkers in the humanities and social sciences from the 1980s onwards. While explicitly Foucauldian analyses are not as fashionable across wide swathes of scholarly fields as they were a decade or two ago, there seems to be a renewed interest in his work among social scientists concerned with environmental issues. One example of this trend is the growing body of literature that examines how Foucault’s notion of biopower can be used to analyze the scientific management of nonhuman populations (Biermann and Anderson, 2017; Cavanagh, 2018; Perkins, 2020; Srinivasan, 2017). Havlick and Biermann (2020), writing within this tradition, have recently demonstrated how molecular data and DNA analyses have led to a shift in the understanding of what constitutes a species, and how this in turn has profound implications for understandings of wildness, nativeness and the management of trout. But even when Foucauldian scholarship is not explicitly engaged, Foucauldian concepts actively shape analyses of topics common to environmental anthropology, political ecology and some strands of science and technology studies (STS), such as environmental management efforts, conservation conflicts and multispecies relations – often in unrecognized ways. We argue that – regardless of whether or not Foucault’s work is explicitly cited – his legacy of linking scientific projects, population management and state control continues to have an outsized impact on thinking in these fields. From our position as environmental anthropologists, we consider how such theoretical inheritances are affecting environmental social science and humanities subfields in general, but specifically through attention to how they do so at the interfaces of anthropology and other fields, including political ecology and the environmental humanities. Within this context, we ask how Foucauldian traditions are at once enabling and constraining new directions in environmentally-focused research, such as more-than-human scholarship and multispecies ethnography. To probe this question, we explore the contributions and limitations of Foucauldian approaches in environmental contexts through empirical attention to the case of trout introduction and management efforts in South Africa. Our overall aim is to call for a deeper conversation about how scholars working on environmental topics engage the science-governance nexus.

As a number of scholars have illustrated, landscape-making and environmental management have been central institutions of biopower, along with the prisons, clinics and schools that feature so prominently in Foucault’s work (Dean, 1999; Foucault, 1965, 1972, 1979). Around the world, strategies of mapping forests, establishing local resource management councils and implementing land use plans have at once made people’s everyday lives more visible to the state (Scott, 1998) and remade the ways people interact with their environs (Agrawal, 2005). Landscape interventions have been especially important in managing human populations in the colonies, where agricultural systems have frequently been used as tools of governance. Plantations, for example, are a well-known colonial technique for restructuring modes of production and labour in order to control the bodies and lives of colonial subjects (Casid, 2004; Tsing, 2012a). Conservation projects – including NGO-led initiatives – have relocated people to make nature parks, and implemented new modes of surveillance to track wildlife populations and police hunting and gathering activities (e.g. West et al., 2006). As anthropologist Paige West’s Papua New Guinea collaborators have pointed out, for them – as well as for others living in spots of biodiversity – ‘conservation is our government now’ (West, 2006).

Clearly, Foucault offers us important tools for thinking through such emerging modes of environmental governance and subject-making. But might his legacy also be overdetermining our analyses of ecological research and scientific management projects? In the social sciences and the humanities, Foucault’s work on psychiatry, sexuality and criminal rehabilitation has created a strong sense that science is a hegemonic project allied with
the state – something that should be first and foremost an object of critique. Foucauldian concepts such as biopower, subjectivity and attention to practices of ordering, have either explicitly or implicitly been used to illustrate how scientific management has become integral to state control over people via the re-making of their relations to land, plants and animals (see Cavanagh, 2018, for an overview). These approaches have also been common in research specifically focused on fisheries science and management (Havlíček and Biermann, 2020; Perkins, 2020). Palsson (1998), for example, a key text in the anthropology of fisheries, has drawn strongly on Foucauldian analytics, referring to the rise of ocean fisheries management practices that convert marine spaces and fish populations into governable units as the ‘birth of the aquarium’ (Carothers and Chambers, 2012).

While Foucauldian scholarship has played an especially strong role in critiques of science as a component of governance, this is not the only genealogy of this critique. Political ecology was highly critical of state science from its inception in the 1980s, initially articulating its concerns via critical realist and Marxist trajectories, rather than Foucault (Blaikie and Brookfield, 1987). Reflecting debates within Marxism about the ontological status of the state, these early studies tended to place state science as a force in opposition to colonized people, viewing it either as an integral part of the state, or as part of the ideologically construction of the state that helped maintain a state apparatus (Abrams, 1988; Krohn-Hansen and Nustad, 2005; Poulantzas, 1968). Yet, while state science was seen as an important object of critique within these Marxist/critical realist traditions, scientific knowledge as such was not seen as inherently suspect, and many political ecologists drew on the biological and physical sciences to make realist and materialist arguments (Beinart, 2003; Blaikie, 1985; Blaikie and Brookfield, 1987), a trend that continues today in some fields, such as geography (Barrett et al., 2013; Benjaminsen and Sjaastad, 2008; Benjaminsen and Svarstad, 2009).

In the early to mid-1990s, however, with the turn to post-structuralism and the rise of Foucauldian environmentality analyses, scientific knowledge itself, and not merely particular incarnations of state science, became seen as integral to state power and colonial projects, especially in environmental anthropology, but also to some degree in political ecology (Agrawal, 2005; Fairhead and Leach, 1995). In recent years, some strands of STS and STS-inflected anthropology have drawn further attention to the serious issues of how modern scientific knowledge practices can be used to discredit and displace other ways of knowing, especially those of indigenous and local communities seeking to protect their lifeways (e.g. Blaser, 2018; Law and Joks, 2018). While those drawing on this trajectory do not necessarily cite Foucault, such scholarship resonates with the more explicitly Foucauldian work discussed above by emphasizing related analytical concerns about the knowledge-power practices of modern governance regimes. It is within such governance projects that states dismiss the claims of particular groups on the grounds that their knowledges are ‘unscientific beliefs’ or do not otherwise meet the evidentiary rules of science and scientific management.²

While we do not seek to contradict any of these lines of critique (which certainly make much needed interventions), our work on the dilemmas of introduced trout suggests that environmental anthropologists and political ecologists might want to take a more open and uncertain stance towards the practices of fisheries science and its use in management conflicts – a stance that follows Foucault’s call to attend to the relations among science, populations and the state, while further attending to their heterogeneous and the unexpected relations. More generally, we also ask how scholars might use Foucauldian concepts and sensibilities in ways that continue to open up curiosities rather than close them down by providing answers that are too quick and too in line with what we think we know about the controlling and colonizing effects of science.
We are not the first to point out such challenges, nor are we the only ones to give empirical attention to how science exceeds or runs counter to state frames. Many STS scholars have explored how science in the colonies, while clearly a part of colonial projects, has also often exceeded them (e.g. Anderson, 2009; Harding, 2011; Seth, 2009\(^3\)), with others noting how the assertions and practices of colonial science have sometimes undermined the very epistemologies and knowledges they were designed to bolster (Tilley, 2005). Along with this research that shows how science is more-than-Western, scholars have also pointed out the heterodoxy within Euro-American state science itself, including (1) the ways that government-employed scientists become activists who challenge the states of which they are a part (Frickel, 2004), and (2) how environmental justice movements generate transformations in mainstream scientific practice and scientific identities (Ottinger and Cohen, 2011).\(^4\) Fortun and Fortun (2005) have developed this line of thinking within anthropology by examining practices of toxicology in the US, emphasizing the frequent non-alignment of scientists and the state. Indeed, they refer to the scientific practices they study as ‘civic science’, not ‘state science’ even when those involved may be employed by state agencies, as they are not the obedient ‘sovereign subjects assumed to be necessary in many modernist constructs of world and ideal’, and instead enact ‘a science that questions the state of things, rather than a science that simply serves the state’ (2005: 50).

Furthermore, since the 1990s and the highly visible case of activist involvement in HIV/AIDS treatments (Epstein, 1996), scholars working across medical and environmental fields have paid growing attention to how social movements and community groups themselves deploy scientific practices to make demands on governmental agencies and to develop alternative forms of medicine and restoration (e.g. Lorimer, 2020, see also work on toxicology, such as Boudia and Jas, 2014; Corburn, 2005). By illustrating popular science efforts alongside activist calls for increased state monitoring of toxins and pollutants, such research has challenged the assumption that quantification, numbers and data production are unequivocally tools of state projects (see Aasdal, 2007 on the monitoring of factory emissions).

Environmental anthropologists – who have long critiqued the ways that Foucauldian analyses often render state governance in overly coherent and monolithic terms – have also begun to bring such insights to bear on questions of scientific practice. To offer but one example of this emerging trend, Mathews (2011) demonstrates, through attention to Mexican forestry, how state science is often incoherent and unpredictable. In one instance, Mathews traces how a scientific theory originally used by the Mexican state to try to control rural forest areas subsequently became a ‘boundary object’ for forging alliances between rural communities and urban environmentalists to oppose state-sponsored forest industrialization (Mathews, 2009).

In resonance with these bodies of research, we ask how biological and ecological research sometimes can be ‘against the state’ as well as with it (Clastres, 1989). Overall, we seek to amplify attention to such issues in relation to the ecological sciences in part because we are concerned about the challenges we face as social scientists to contribute to environmental knowledge in a time of widespread ecological damage – one sometimes referred to as the Anthropocene (Tsing et al., 2017). In light of warming temperatures, rising seas, eroding lands and mass extinctions, blanket criticism of state-based environmental management seems like an overly simplistic argument (see Kolbert, 2015). We worry that scholars may have partially backed themselves into a corner: In trying to critique forms of environmental management that force state plans on people and landscapes, they have painted much of ecological science and policy as rooted in what Donna Haraway (1988) has called ‘the god trick’ – the assumption that a disembodied, unresponsive and ostensibly objective scientific manager could rationalize the world from above.
Environmental anthropology and political ecology continue to offer much needed critiques of pernicious state plans that enact precisely this kind of approach—eliminating the lifeways of indigenous and local peoples and multispecies relations in which they participate (Büscher and Fletcher, 2014; Sullivan, 2010). Still, might there be a need for more robust attention to the complex politics of environmental science, including attention to inversions and disruptions of what are assumed to be conventional state science logics? Ongoing forms of industrial landscape destruction point towards the need for some kind of state-based management. We want to ask how environmental anthropology in particular and allied social sciences more generally might contribute to debates around environmental governance in ways that view it and its practitioners as potential allies in building more liveable worlds rather than as de facto enemies. As we do so, we aim to bring Foucault more directly into conversation with multispecies ethnography and environmental history. How, we ask, might social scientists better attend to the complex politics of a more-than-human bios and contribute to ongoing management conversations?

We add to the conversations described above by drawing more in-depth inspiration from the growing body of multispecies and more-than-human scholarship. This body of work, partially inspired by Haraway’s writings, has had an ambivalent relation towards the natural sciences, rather than one of exclusive critique (Haraway, 2008). As humanists and social scientists have reconsidered how ‘being human is a multispecies relationship’, scholars have sought ways to adapt and expand their methods to engage with more-than-human beings (Tsing, 2012b). To this end, a growing number of more-than-human social science/humanities scholars have stressed the possibility of re-appropriating scientific tools and building alliances with natural scientists in order to better engage with non-humans (Swanson, 2017) and to address environmental concerns such as pollution and toxicity (e.g. Liboiron, 2015, see more below). Drawing on insights on knowledge politics and scientific methods in feminist STS and geography (e.g. Nightingale, 2003),5 more-than-human scholars have increasingly argued that categorizing, naming, mapping and counting might be tools of open and careful curiosity – of exploring new ways of ‘becoming-with’ – as well as tools of fixity and control (Tsing, 2015; van Dooren, 2016). Alongside long-standing attention to indigenous and local ecological knowledges, they have also asked how ecological and biological knowledges might provide ways to better relate and respond to more-than-humans. They have also pointed out the diversity of the natural sciences: while many science explorations and nature conservation projects have aided state control and the displacement of indigenous people, others have worked contra state goals of productivity, growth and landscape rationalization (Nustad, 2015; Swanson, 2019).

These altered research objects have generated substantial changes in methods and modes of collaboration, as scholars increasingly view ‘science’ as a form of inquiry with which the humanities and social science can work and in which they can robustly participate. Social scientists and environmental humanities scholars are now more frequently approaching natural scientists as allies rather than as objects of critique, especially in relation to the human health effects of environmental issues (e.g. Hoover, 2017; Kierans, 2017; Roberts and Sanz, 2018), and they are more widely experimenting with scientific techniques and quantitative methods within their own methodological practices. Among the many exciting examples, we are most directly inspired by how Tsing and colleagues (Bubandt and Tsing, 2018) have brought such collaborative approaches to bear on questions of more-than-human landscape relations, working with biologists to study the interactions of multiple species, chemicals and forces in sites of industrial ruination. Our aim here is to bring this approach to the specific case of introduced trout, while questioning why this approach continues to be seen as somewhat suspect by some scholars within anthropology, STS
and related fields, due to the ways its collaborative engagements with natural science knowledge practices risk revalorizing scientific onto-epistemologies (Swanson 2019, 2020; Tsing, 2018).

In the remainder of this article, we engage in both critical and propositional work. First, we support our calls for a more open approach to science through a detailed case study of the controversies and the shifting alliances surrounding trout, ecological sciences and state bodies in South Africa. Trout in South Africa helps us see the unstable and shifting relations between these entities and why we cannot assume that they constitute just one knowledge/power nexus. Second, we return to multispecies scholarship itself, asking how Foucauldian approaches might be useful to political ecology, environmental anthropology and related fields in new ways. Lastly, we end with a proposition about how an emergent set of analytics linked to a new notion of landscape might offer a point from which to develop a different type of Foucauldian-inspired environmental scholarship. This, we believe, is necessary for developing analytic tools and collaborations that will enable us to better engage present ecological challenges.

**Introduced trout and salmon**

Empirically, we turn to trout and salmon, fish central to European colonial landscape management projects. Beginning in the second half of the 19th century, European colonists, primarily British men, sought to bring fly-fishing – and ‘proper’ fish – to the new places they settled (Bull, 2009). Fish introductions created spaces that cultivated European masculinities that enabled, justified and facilitated colonial rule. To be civilized in the colonies required proper leisure-time self-making. European men who spent their days at desks, keeping the books and tallying the numbers for rational rule, tested themselves against the wilds of nature in their free time via sport hunting and fishing (Christensen, 2019).

Colonial officials, few of whom would have had access to salmon and trout in England, saw sport fishing as a way to enact ‘gentlemanly’ civilization in uncivilized places. But as Draper (2016) points out, there was also a sense in which trout fishing in the colonies was about building a fresh national culture where all had access to sports and fishing, not controlled by an elite class system (2016: 182). Yet the forms of fishing they preferred required very specific fish, namely large-bodied freshwater species that would provide a fight on a rod (Douglas, 2003). While the rivers of the world were filled with fish that could be netted or trapped, few of them were amenable to the performative modes of capture favoured by European sportsmen. Thus, the British government – and later those of other Western nations – backed the translocation of salmonid species around the world (Dunlap, 1999; Lien and Davison, 2010), although, as we shall see, the initiative often came from well-connected individuals with private means.

Today, far more rainbow (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) reside outside their original ranges than within them. While rainbow trout originated in the U.S. West and brown trout in northern Europe, these two fish species are now found in more than 100 countries and on every continent except Antarctica (Crawford and Muir, 2008). These trout have subsequently reconfigured ecologies and social formations in the places where they have been introduced. They have driven out other species, altered nutrient regimes in aquatic ecosystems, sparked new property claims and drawn foreign fly-fishing tourists (Halverson, 2010). Overall, they have created complicated debates about environmental management. Because they have been central to efforts to ‘Europeanize’ landscapes, trout pose difficult questions for the places they now dwell, which must grapple with their ongoing ecological and social disruptions (Ritvo, 2012).
There is no doubt that classic Foucauldian approaches can help us analyze how trout have been important in the making of human subjectivities and how trout help structure the dispositifs of European colonial rule. These assemblages of race, class and gender require – and come into being with – particular landscape formations. Take, for example, the introduction of trout to South Africa, where establishing trout was a state-sponsored project that supported specific ways of being European. As W. Wardlaw Thompson, a late 19th and early 20th century Cape Colony civil service official and member of the Fisheries Board wrote, ‘the colonist, especially if of British blood, seems unable to settle down in a new land until many of the animals and plants that ministered to his pleasure or profit in the homeland have followed him’ (in Brown, 2013: 31–32). Just as, in Foucauldian terms, the bricks of the prison were part of the assemblage of prison reform, so too were trout a part of the discursive formations that allowed for the enactment of 19th century European manhood.

Colonial trout introductions also helped to birth fisheries science, which – like forestry and the agricultural sciences – has long been closely aligned with projects of state governance (Hubbard, 2017). Initially, fly-fishermen often sought the backing of various branches of government to support their trout projects, but in South Africa and in other colonies, once established, the management of trout became part of the responsibility of those branches of government in charge of conservation more generally. In time, those efforts, and the fascination with fish biology they fostered, spawned the first generation of government salaried professional fisheries scientists.

However, the birth of the hatchery is not simply a redox of the birth of the clinic. Foucault’s work has trained us to pay attention to the making and management of human populations and subjects – to techniques of governance, including, since the 19th century, the widespread use of ‘science’. Close attention to trout and scientific fisheries management has led us to doubt such a solid link between science and state governance. Can we really claim that science always produces the ‘modern’ or that it is always on the side of the state or colonial power? While 19th century trout biologists were embedded in projects of colonial governance, fisheries scientists today are as likely to be arguing against the state or capitalism or other forms of hegemonic power as for them. How, might environmental scholars better describe such ambiguities and amplify already existing forms of more-than-normal science?

Let us consider a practice which is usually associated with state regimes of power/knowledge: mapping. One of the examples James Scott used in Seeing Like a State (1998) was the cadastral map and the way in which mapping renders only those aspects of the land of importance to the state visible and suppresses others. Mapping has been used in the ongoing controversies over the future of trout, most prevalently and controversially in South Africa. But unlike what most adaptations of Foucault to environmental management would suggest, mapping is more than a way of indirect state control through power/knowledge relations. While maps, and especially maps that purport to present scientific facts, have power effects, we must avoid an analytical shortcut from map to state effect, as the following example demonstrates.

### Mapping trout in South Africa

As indicated above, trout were introduced to South Africa from the 1890s onwards, after several unsuccessful attempts, the first in 1875. But once introduced, the acclimatization of trout was a huge success. This was partly due to the trout’s ability to adapt to the new climate, but also because of the elite political support they enjoyed (Curtis, 2005). Trout were protected by the Crown and annual reports of the success or otherwise of their
acclimatization were delivered in Parliament. At the time, as Curtis (2005) points out, there was no opposition from nature conservationists either within or beyond the state. On the contrary, provincial nature conservation bodies prioritized the conservation and growth of trout stocks as one of their main duties. Draper (2003) argues that the widespread introduction and stocking of trout could never have taken place without the active backing of the state and of elite interests. Trout introductions initially took place as private initiatives with some state backing towards the end of the 19th century, but from the 1940s onwards, trout management became an integral part of state conservation policies, although to varying degrees in the different provinces. While some of the South African provinces had no trout policies at all, the first conservation body in Natal was originally named the Natal Park, Games and Fish Preservation Board. With the inclusion of hatcheries in the provincial conservation authority, scientific principles were increasingly used, and the managers of the provincial hatcheries were often ecologists (Alletson, 1990). Thus, trout introductions, which began as private activities by what Christensen (2019) has called feral amateurs, became a state project through the active work of making it one.

This close association of state conservation and alien fish in Natal is rendered visible in a map that was part of a book written by Bob Crass, an ecologist and fisheries officer, in 1964. Titled FISHING WATERS, Game reserves, Nature reserves, and Parks OF NATAL, it depicts Natal as a landscape of river systems containing nothing but trout (Crass, 1964). The legend explains that trout can be found upstream of the arrows on the map, which also gives information about the state of roads to these fishing waters as well as height above mean sea level – vital information for anyone wanting to fish for trout, as these can only survive in the cooler upper parts of water systems. No information is given about human settlements, apart from the names of the major administrative centres (Figure 1).

So is this an instance of Foucauldian power/knowledge, where a white masculine colonial gaze is eradicating other representations and other ways of being in the landscape in order to promote assemblages that sustain trout? This is certainly one aspect of such representations. However, as we see through another example from 50 years later, it is not the only possible effect of scientific mapping practices.

Trout wars, counter mapping and sanctuaries

In the mid-1980s, the relationship between the government, trout producers and fishers changed dramatically. Instead of actively protecting trout through legislation, a system of permits, closed seasons and bag limits, state conservation agencies decided that trout was an invasive species whose presence in South African waters was problematic. Amid protests from fishing clubs and trout producers (in what became known as the ‘trout wars’), the state conservation authorities withdrew protection of trout and handed over hatcheries and responsibility for stocking waters to fishing associations (Brown, 2013; Nustad, 2018).

This policy change should not be read as a simple shift in opinion in which state-science interfaces remained unchanged. First, this was not a unitary policy across different state branches in South Africa. The initiative was taken by a group of scientists associated with Cape conservation authorities, while the Natal Parks Board long continued its management approach to trout. Second, the shift in trout policy was complex and included a diversification of modes of doing science. The repositioning of trout was partially linked to international trends in conservation biology that stressed native species diversity and raised alarms about the effects of alien species. As Jean Comaroff and John Comaroff (2006) have pointed out, in South Africa, this mounting concern about introduced organisms coincided with the beginning of the political transformations that led to the first democratic
elections in 1995. They and others have seen the concern over alien species as profoundly linked to debates about who belongs in post-apartheid South Africa. In general, nature politics in South Africa, especially in relation to the creation and management of conservation areas, are deeply embedded in racialized histories of land dispossession (Kepe, 2009; Ramutsindela and Shabangu, 2013), and debates about which colonially introduced organisms should remain in South Africa is certainly a component of alien species conversations from the 1980s onwards. Yet – as we discuss below – the ways that these broader trends have

Figure 1. A colonial gaze? Trout areas in Natal, South Africa.
Source: From Crass (1964).
influenced state and scientific orientations toward trout is far from straightforward. Nonetheless, some of the most controversial questions at the heart of trout debates are fundamentally entwined with questions of race, nature and colonialism: Should introduced trout be killed and the landscape returned to something more closely resembling its pre-colonial conditions? Or should future South African landscapes make room for trout and the avid fishing communities, largely white, who claim trout as important to their identities?

In 2004, the debate resurfaced in connection with the adoption of the National Environmental Management: Biodiversity Act (NEMBA). Its treatment of trout and other alien species was influenced by the scientific thinking on invasion biology and biodiversity which had gained a foothold in South Africa by then and which formed the basis for the policies of the Department of Environmental Affairs (DEA). Consequently, it listed trout as an alien and invasive species. The Federation of South African Fly Fishers (FOSAF) and other interest organizations argued that while trout were clearly alien, they should not be treated as invasive. As a hundred-year history has shown, they argued, trout do not spread to new waters, even if they sometimes do displace native fish in the waters where they are stocked. Further, they argued, with the backing of some ecologists, the presence of trout in a freshwater system was actually an indicator of an unpolluted, healthy watershed (Alletson, 2018; Nustad, 2018).

Since then, there has been a deadlock between the DEA and the trout producers, with the former insisting on labelling trout as alien and invasive under NEMBA and the latter resisting this through advocacy and court hearings. This was the situation when another branch of government intervened in 2014. Inspired by a trip to Malaysia, the then President Jacob Zuma launched Operation Phakisa, a series of economic development initiatives aimed at delivering ‘big results fast’, in support of the National Development Plan. As part of such initiatives, the Department of Planning, Monitoring and Evaluation launched new development programmes for several sectors, including one called ‘Oceans Economy’, which included a decision to amplify freshwater aquaculture. It ordered the DEA, the trout producers and FOSAF to sort out their disagreements so that trout aquaculture development could move forward in some way. As FOSAF recounts the story, DEA grudgingly agreed to four principles: that trout should remain in the areas where they now occurred, that they should not be established outside these areas without official permission, that trout production should be regulated under the Department of Agriculture, Forestry and Fisheries (DAFF) in the area where they existed and lastly, that they could be removed from some conservation areas. The DEA relented, and as a follow-up, the parties met to plan the future process.

This was the background for a very different mapping process to that which took place in the 1960s. FOSAF and DEA recognized that in order to develop a policy based on the principles they had agreed to, they first needed a map of where trout now occurred. This proved to be less than straightforward. The FOSAF representatives detail a process where every criterion for establishing trout presence was contested. For example, the DEA wanted to include only areas where trout had reproduced for five generations. This would exclude almost all trout areas in South Africa, as trout are only able to reproduce in a few high-altitude rivers. FOSAF countered that the vast majority of trout exist in artificial ponds, and as these are man-made structures made for irrigation in the first place, they are really no concern of the DEA. FOSAF, building on previous work led by a freshwater ecologist, started a mapping exercise in 2014 and continued its work until 2017. The mapping came to a halt, however, when the DEA declared trout invasive anyway.

Even though this map never became a formal basis for state policy, it embodies a different constellation of state, fishing interests and science than did the mapping efforts of the
1960s. Part of the explanation for the difference in these scientific mapping practices lies in the fact that ecological science is not a simple handmaiden of state knowledge regimes. Rather, ecological science insights – as amplified by the DEA – produced trout maps and policies diametrically opposed to other scientists and ecological research that advanced a notion that while trout were clearly alien, they were not invasive, and thus did not merit aggressive removal. Furthermore, these two maps remind us that the state is not unitary, and this matters to environmental policy and its sciences. While the DEA wanted to declare trout alien and invasive, drawing on scholarly traditions rooted in the growing international field of invasion biology, another branch of the state, mandated to ensure economic development, demanded that the DEA and FOSAF come to an agreement that would facilitate continued trout aquaculture in South Africa. The resulting mapping, undertaken by FOSAF and led by a freshwater ecologist, built on other ecological logics that stressed ecological limits and landscape adaptation, as part of wider efforts to force the DEA to accept a deal aiming at aligning trout production to national economic development.

So what do these struggles over mapping tell us? Trout mapping has been used to create a colonial world where these fish occurred in a naturalized landscape dominated by elites. Then 50 years later, trout mapping was used to argue for the eradication of trout by marking where they should not occur. Furthering these contradictions, mapping has also been used by other scientists as an indicator of healthy river ecologies. What this demonstrates is the complex relationship between state projects and environmental management. Unlike the binary implied by notions of counter-mapping (Peluso, 1995), where official and state representations of landscapes are resisted by counter-hegemonic maps that strengthen oppositional claims to resources, the mapping of trout in South Africa reveals a more complex story, where state projects are as diverse as scientific approaches to environmental management.

We do not want to ignore that these mapping practices are highly classed, gendered and racialized. As Green (2014) has argued, the kind of knowledge produced by these mapping exercises is intrinsically bound up with race. Environmental science, she has pointed out, often produces scientists as active knowing subjects along with nature and race as objects of examination and study. Further, race is also made salient in environmental science when it is pitted against the need for economic development, for redress, for economic profit in the name of redistribution, as has been the case in arguments for allowing fracking the Karoo (Green, 2020). The racialized dynamics of scientific practice are particularly relevant to the case of trout mapping: it is always embedded in them and never located in a neutral space. Yet the racial politics of trout and their mapping are also not fully stable. As our case shows, the always already political nature of environmental science does not necessarily determine those politics – or necessarily align them with the state. As we see in the case above, trout move from alien invaders to indicators of environmental health in relation to consistently racialized – but different and fluctuating – modes of environmental science.

**Foucault, environmental management and nonhuman agency**

While we argue that power/knowledge relations are less stable than typically assumed and that the relations between science and the state are far from straight forward, we continue to believe that Foucauldian insights are essential to analyses of contemporary ecological problems. Our goal is not to throw Foucauldian insights out, but to foreground how Foucault’s scholarship might be brought into political ecology and the social sciences in a somewhat different way than with the post-structuralist turn of the 1990s. As we argued in the introduction, robust understandings of more-than-human worlds require attention to materiality
and the agency of non-humans. How does Foucauldian scholarship enable the development of such attention – and how might it be engaged in ways that further amplify these contributions? Returning to the case of trout, we argue that attention to the agency of these fish and the materiality of the landscapes they inhabit is essential for developing new analytics attuned to the complexities of current environmental issues. We argue that, when applied in new ways, Foucauldian approaches can contribute strongly to multispecies scholarship – not by providing tools for critiques of science, but by offering openings for new modes of collaboration with natural scientists. Although more-than-human scholars have tended to turn to Latour and other actor-network theorists, along with growing work on new materialisms as central analytical resources, we argue that there are substantial reasons to pull Foucault’s work more centrally into such conversations, as it foregrounds slightly different concerns about the politics of materiality and agency.

Consider, for instance, how Foucault treats the materiality of the courtroom in a discussion with Maoists about the possibility for a post-revolution ‘popular justice’. Foucault is at pains to point out why the form of the court cannot be adopted to a true expression of the will of the people (Foucault, 1980). The form of the court, Foucault argues, is an expression of a bourgeois idea of justice, and this is expressed in its material set-up:

> a table, and behind this table, which distances them from the two litigants, the ‘third party’, that is, the judges. Their position indicates firstly that they are neutral with respect to each litigant, and secondly this implies that their decision is not already arrived at in advance, that it will be made after an aural investigation of the two parties, on the basis of a certain conception of truth and a certain number of ideas concerning what is just and unjust, and thirdly that they have the authority to enforce their decision (1980: 8).

The physical arrangement of the court, Foucault argues, contradicts the very idea of popular justice. In this way, Foucault stressed, material objects and architectural forms are themselves integral to discursive formations (this holds for other discursive formations as well, such as intentional development, see Nustad, 2001). For Foucault, while materiality is integral to enactments of power, humans are the actors who set up material formation: they build the court table and design the prison, which then shape the subjectivities of others, as well as themselves. A number of critical animal studies scholars have drawn directly on Foucault to examine how institutions such as slaughterhouses and industrial farms shape the subjectivities of the animals and people within them (LeDuff, 2003; Lien, 2015). Yet instead of conceptualizing animals as living judges’ tables, merely interpellated into projects of control, more-than-human scholars have actively sought to demonstrate how nonhumans’ agential force exceeds human intent. They have explored how humans are remade by non-humans through a reciprocal remaking of bodies and selves that does not begin solely in human projects and intent. Scholarship on more-than-human beings has shown how nonhuman beings often disrupt state plans and scientific management goals rather than merely docilely conforming to them (see Mitchell (2002) on mosquitoes who render irrigation projects unfeasible, and Callon (1986) on uncooperative scallops, for example). On the whole, multispecies scholarship has stressed ‘becoming-with’ – i.e. the mutual co-constitution of humans and nonhumans in an effort to show how nonhumans also actively contribute to the making of bodies and worlds (Despret, 2004; Hansen, 2017; Haraway, 2008). The limitation of these strands of multispecies scholarship, however, is that – in their focus on becoming-with – they have given relatively less attention to power of the classic Foucauldian type, i.e. of the planned agential power of the state and other people in positions authority.
In the case of trout, we need both Foucauldian approaches that focus on the profound force of governmental plans and multispecies analytics that point us towards the agential ways that nonhumans shape worlds. Trout bodies and populations are indeed significantly shaped by such management activities, both in the case of South Africa and in countless other places around the world (Havlick and Biermann, 2020; Perkins, 2020; Swanson, 2017). The lives and evolutionary futures of fish are fundamentally remade by efforts to manage hatchery production, population numbers, harvest levels, habitat conditions and genetic diversity. While the rainbow and brown trout that were introduced to diverse places around the world came from nearly identical brood stock in the 19th century, they have now taken on very different population structures and developed new traits in the wide variety of locations in which they now reside.

When we focus on the changes in these fish, we see that while their subjectivities are shaped by management efforts, human management practices do not ‘make’ fish alone. Trout too become active world-makers. Once trout are released into new waters, they take on new feeding behaviours, reproductive practices and relations with other species.

In light of their world-shaping effects, can we imagine trout as beings who participate in the emergence of new regimes of power in the rivers that they come to inhabit? This is a different form of biopower to be sure, but one that we should not ignore. Like the doctors and wardens in Foucault’s work, trout come to have agency and power within institutional arrangements. But the assemblages in which trout come into being are not only those of colonial projects. Yes, certainly, colonial projects cannot be ignored, but neither are they sufficient to understand the new forms of power that are remaking rivers and their inhabitants. Major shifts in regimes of power are happening underwater in places like South Africa – shifts as great as those from punish to discipline that Foucault describes in his work on shifts in governmental approaches (Foucault, 1979). With introduced trout, entirely new ecological configurations and human affinities are coming into being. First, consider the humans: in many cases, such as in South Africa, introduced trout are themselves affecting peoples’ environmental concerns. Sidney Hey, South Africa’s first inlands fisheries officer, was deeply concerned with soil erosion and how agricultural mismanagement choked rivers with silt. And today, many South African fishermen have come to care about water pollution first and foremost because trout in rivers demand clean habitats. These mostly middle-class men are now out protesting fracking.

Second, ecological relations have also been remade. Consider the case of Patagonian rivers. These primarily glacier-fed rivers have long been relatively nutrient poor, and slow-growing species specifically adapted to such conditions of scarcity – algae, insects, plants, animals – have tended to predominate. Trout have reconfigured those worlds in various ways: Some trout in Patagonia have taken up sea-run life cycles in which they migrate from the river in which they are born, to the ocean to feed, then back to their river to spawn. Many of the trout die after spawning, and their decomposing bodies release large quantities of marine-derived nitrogen and phosphorus into Patagonian rivers, essentially dosing them with a new form of fertilizer. These new nutrients have changed which species live and die in these rivers; the slow-growing species adapted to barren conditions are pushed out by fast-growing species that can take advantage of the new nutrients, leading to a wholesale ecological shift. While the nutrients from trout bodies have increased the abundance of some macroinvertebrate species, this has not led to an increase in food for native fish. Because trout become very aggressive feeders in these new environments, they tend to consume any additional food resources themselves. We want to stress that trout are not inherently dominant and aggressive. Rather, they become so within certain webs of relations. In the ecologies where they have long lived, trout do not dominate in these ways. They take
on these new subjectivities when they are transplanted to new locales. Trout subjectivities and agencies, we want to stress, are situated and relational, as they are for all beings and entities. Trout in Patagonia and South Africa, for example, share some similarities, but also many differences – as a result of the different more-than-human landscapes of which they are a part. Thus, while trout in Patagonia tend to spread rapidly and act aggressively towards other organisms, those in South Africa have a contracting range due to climate change, and thus extensive invasion and widespread ecological effects are unlikely. These are, indeed, different biopolitical assemblages, or different landscapes.

**Thinking Foucault through landscapes**

Let us end by proposing a more concrete path for developing tools that retain key insights from Foucauldian analyses, but that (1) does not assume a fixed relationship between ecological science and the state, (2) is sensible to the materiality of environments and (3) includes more-than-human agency. While Foucauldian approaches have stressed wilful state efforts to make landscapes governable, multispecies scholarship has highlighted how nonhumans – including animals, plants, and geologic formations – have a world-making agency that exceeds intentional plans. Trout are not the bricks of a prison or clinic – they are active subjects, not mere materials; they are beings whose behaviours and selves are remade. Our goal here is to move from critique towards more open-ended exploration of analytical possibilities at these junctures. Overall, there are two important concepts we would like to point out, which we believe are of key importance in developing new tools for Foucault-inspired more-than-human scholarships:

1. The subject-making force of *dispositifs* does not stop with humans. The colonial projects within which European masculinities took shape are the same ones in which particular aggressive trout bodies and behaviours have also emerged. Colonial projects literally make their way into the flesh of fish and into the ecologies of rivers (Swanson, 2018). Indeed, they have so significantly transformed trout that it makes sense to think of colonial projects as one of the key evolutionary forces on these fish and the rivers into which they have been transplanted.

2. Rivers are institutions to which we must attend. Foucault has repeatedly directed our attention to a particular set of institutions that discipline and shape human subjects and bodies – to schools, clinics and prisons. But might rivers also be considered as institutions that merit similar study? They most certainly shape people, as well as fish. Some rivers, such as England’s chalk streams, are explicitly human-made institutions, carved out by people with particular landscape dreams. Yet rivers are never entirely the product of human initiative, as non-human beings and forces are integral to their composition. Would we be willing to contemplate a more-than-human institution – one made at the confluence of geologies, the actions of nonhuman species and human projects? Might we think of Foucault’s immanent and diffuse power as both productive of and emerging from more-than-human assemblages? How might the structures of more-than-human relations constitute a form of discursive power?

Together, these two points lead us to consider what we might gain from shifting the central object of biopolitics from the *human species body* to the *more-than-human assemblage*. To do so, we enter into dialogue with a line of more-than-human scholarship, as elaborated below, that focuses on landscapes as a core analytical entity. We make this move because these conversations emphasize how ecologies and terrains are historically emergent
from specific natural-cultural relations and that their material forms and species interactions are themselves political. This particular view of landscapes articulates with the reworking of Foucault and aids us in describing the potential purchase of our moves. In engaging it, we seek to use already ongoing efforts to explore landscapes in a material-discursive manner – albeit without explicit consideration of Foucault – to highlight possibilities for further pursuing more diverse Foucauldian inspired analyses in environmental anthropology and environmental humanities that take up natural science knowledges and practices without abandoning critical projects.

We draw most substantially on the concept of landscape and associated analytics developed by Tsing et al. (2019), Mathews (2018) and Tsing (2015) because this approach presents the historically emergent structures of more-than-human relations in a way that resonates with Foucault’s work on dispositifs and institutions that we invoke above.7

In contrast to notions of landscape derived from art and visual perception (Cosgrove, 2005), these scholars take landscape ecology, a natural science field, as one of their key intellectual starting points. Landscape, here, is not ‘nature’ in the abstract, nor is it a visual practice linked to romantic representations. Instead, it is a material enactment of historically contingent more-than-human interactions that, despite their variability, show clear patterns. Landscapes, here, are far more akin to Foucauldian institutions than to timeless nature: Tsing et al. (2019) describe landscape structure as the ‘morphological patterns in which humans and nonhumans are arranged’ in ways not so dissimilar from Foucault’s description of the courtroom and the judge’s bench, viewing such patterns as explicitly political in that – in their empirical form – they are emergent together with economic practices, governance regimes, etc. As Mathews (2018) shows in his study of Italian chestnut woodlands, the structure of forests comes into being at the juncture of peasant cultivation strategies, state policies, market conditions and fungal pathogens that cause tree disease.

In response to such an analytical entity, Mathews (2018) and other scholars working in this vein draw on a variety of natural science knowledges and techniques – from DNA sequencing of pathogens to natural history observation – alongside archival and ethnographic research. The science within such research is not in service of state or capitalist aims, but rather part of an effort to foster new ‘arts of noticing’ (Tsing, 2015) that work against ongoing more-than-human (as well as human) ruination and damage. With a sensibility not unlike that of Foucault’s practices of genealogy (1972), these scholars seek to read the structures of landscapes as always intertwined with power and politics. Both this line of scholarship and our own work here are further inspired by the work of environmental historians and political ecologists who have sought to study how power relations are embedded in living landscapes – i.e. how they are shaped by geological and biological agencies at the same time that they remake them (see, for example, Cronon, 1996; Crumley, 2017; Nustad, 2019). It also resonates with the growing body of work on infrastructure at the borders of STS and anthropology, which explores the historical emergence of structures and forms, with careful attention to the ways that power, politics and more-than-human relations are bound up with their construction, repair and breakdown.8

Because the concept of landscape pulls us into dialogue with these bodies of research, we turn to it despite its awkwardness in the context of our work on rivers and fish. While landscape has a terrestrial bias, we see its analytics as easily extended to fluvial spaces, which are intimately entangled with the lands around them. In doing so, we convert landscape into something more like watershed, a term that stream ecologists often use to describe ecological relations that stretch across lands, rivers and lakes. This elision helps us to engage not only with the more-than-human scholars above, but also with others who use landscape to think through questions of governance and politics, such as geographer Kenneth Olwig (2002).
Olwig has argued that the term landscape, or landskab in Old Norse, originally referred not to a mode of depiction in the arts, but to a highly politicized entanglement of customs and traditions – of who could use land in which way – that were seen as at once emergent from and inscribed in physical surroundings (2002). According to Olwig, landskab – in early Scandinavian contexts – was not a ground for human actions, but was itself political. Landscapes were not defined via physical features of terrain, but socially, as places of politics: a landskab was the unit – human and nonhuman – that was governed by a particular ting, or representative council. The physical manifestations of landscapes were thus understood as inseparable from the common laws and modes of governance (ting) that defined the polity and political landscape. It is this point that is especially important for our arguments about new forms of Foucauldian thinking: through his mode of engagement with landscape, Olwig shows how to shift its analyses from a focus on the politics of knowledge to the politics of landscape assemblages. This brings forth a different configuration of the knowledge-materiality nexus – one that focuses not merely on the politics of knowing more-than-human worlds, but that also opens up for more critical and careful attention to the material politics of landscape relations and their generative role in politics itself.

By detailing the history of the Scandinavian landskab, Olwig shows how politics has always been an embedded material practice – i.e. that politics are not merely arguments over land as object, but that political forms themselves emerge from the interactions of people and landforms. As Olwig traces the capture of the pre-state common law ting by elites who sought to craft modern states, he shows how governance forms became less responsive to, and more controlling over, landscapes (Olwig, 2002). States came to see land as something onto which to write grid-like visions rather than as a lively set of relations to be dialogically engaged as political. Beginning in the Renaissance, the idea of landscapes as expressions of human and nonhuman customs was replaced by an idea of landscapes as places for the performance of nationhood and the body politic. Northern Europe’s huge landed estates were explicitly crafted to conform to ideas of universal law and rule, and, later, the national parks of the new world were likewise seen as enactments of the ideals of the new state. By tracing these histories, Olwig shows how modern state ideologies of governance thus work on and embed themselves in landscapes, conceiving landscapes as institutions in the Foucauldian sense, e.g. arrangements made to embody specific forms of governmental power. Like Olwig, we want to assert that landscapes are a crucial site for thinking about modes of governance and thus intend for this description of the pre-state Scandinavian ting to hone our attention to ways that nonhumans can be active in shaping governance forms, rather than merely acted upon by them.

If – with Foucauldian eyes – we combine the ideas of Olwig, Tsing and Mathews, then a key challenge for environmental scholarship becomes how to trace the making of nonhuman subjectivities and shifts in more-than-human institutions, such as rivers. To develop landscape genealogies at the intersection of Foucauldian scholarship and environmental history, might we need new engagements with natural science tools and techniques? Within the social sciences, the natural sciences and the scientists who enact them are more often seen as objects of critical analysis than as possible communities with which to engage in collaborative scholarship. Such an orientation seems at least partially attributable to the legacies of Foucault’s work. Foucault’s texts on the human sciences have depicted science as a practice of normativity, as a practice of state-power that aims to make docile bodies. One of the central accomplishments of Foucauldian scholarship has been to denaturalize discourses that gain power through their claims of being ‘scientific’. This is an incredibly important mode of analysis, not only in general, but also in the specific case of colonial trout introductions. As we mentioned earlier, modern fisheries science emerged partially in relation to
colonial projects of trout introduction, and like the human sciences on which Foucault focused, it has long been deployed within discourses of state power.

But close attention to trout and the fisheries sciences have led us to doubt the tendency to de facto politically categorize science as on the side of the ‘modern’, the state, or colonial power. While 19th century trout biologists were embedded in projects of colonial governance, contemporary fisheries science is a mixed bag: while some scientists work to enhance industrial extraction, resource commodification and governmental management, others argue against the state, capitalism, or other forms of hegemonic power. For example, some fisheries scientists struggle to oppose dam construction projects and the neoliberal development plans with which they are entangled. Others support indigenous land rights and foster meaningful collaborations with communities. Still others demand attention to endangered species that governmental authorities would rather ignore. And they often do so with and through their scientific research. Some of them are also humble about the claims of scientific knowledge-making, stressing that their research provides information that is situated and partial.

It seems that, in order to more carefully examine more-than-human assemblages, we need these new forms of fisheries science and serious dialogue with them. How can we study the workings of a river without knowing something about them? How can we see the ways that human projects have remade more-than-human worlds without getting to know something about more-than-human lives? Paying attention to the multiple relations and genealogies that make up a landscape is a first step to disrupting the hierarchies of knowledge that makes up landscapes as representations. Foucault has sometimes referred to his forms of genealogical analysis as ‘anti-science’. For Foucault, ‘anti-science’ is not a rejection of scientific practices per se, but an ‘opposition to the scientific hierarchization of knowledges’ (Mitchell, 2002; Smart, 1983). The time seems right to ask how scientific practices might themselves also enact genealogical analysis in a Foucauldian sense. Might there be a place for the sciences as participants in genealogical projects and in radical politics? Might science itself be an integral part of what Foucault calls ‘anti-science’?

In this article, we have argued that the answer to such questions is yes. For us, thinking multispecies scholarship and Foucault together opens up the possibility of understanding and enacting ecological history as a form of Foucauldian genealogy. If human discursive projects so dramatically shape more-than-human worlds, it seems crucial to collaborate with scientists to trace such effects. In addition, attention to how non-humans may contribute to making discursive formations – to the idea that human subjectivities are not the product of human actions alone but of more-than-human worlds seems an important contribution to approaches that have assumed that knowledge practices are human practices. We have attempted here to create a space for expanded inquiries into how knowledge practices themselves are more-than-human relations. These, we believe, are the important legacies of Foucauldian scholarship that, once carefully reworked, will better position environmental social scientists to engage in more robust forms of collaboration with other scientific traditions.

**Highlights**
- Argues that Foucauldian perspectives continue to influence political ecology analyses, often in unrecognized ways.
- Shows that this has impacts for how we understand environmental management, the sciences and the state.
• Uses the introduction of trout to South Africa and its management as a case to discuss these issues.
• Proposes landscapes as an analytical category to engage the science-governance nexus.

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Notes
1. For overviews of Foucauldian influences in various fields, see, for example, Cavanagh (2018) (political ecology), Boyer (2002) (general anthropology), Winkel (2012) (forest management/political ecology) and Law (2008) (STS/sociology of science).
2. Such issues with ‘expertise’ and state frameworks have long been noted in anthropological literature, e.g. Clifford (1988).
3. For an example tied to the regional context of this article, but from history rather than from STS, see Beinart et al. (2009).
4. Kelty (2010) also describes how science is filled with diverse subject positions, including outlaws (‘those with slightly nutty ideas’), hackers (tinkerers who ‘reconfigure the system from within’) and Victorian amateurs (who are focused on intellectual ideals). As a far-from-uniform field of practice, science has always been multiple (and with multiple political valances).
5. While Nightingale speaks directly to environmental politics, other examples of the broad debates about quantitative methods, objectivity and scientific approaches within feminist geography include Mattingly and Falconer (1995), as well as Moss (1995).
6. Renamed the Department of Environmental Affairs, Forestry and Fisheries (DEFF) in 2019.
7. Although we draw most closely on the academic lineage described here, there are other scholars working in related ways at the intersection of more-than-human assemblages, materiality and politics. For example, Elden (2020) has recently added to his analysis of territory, understood as the political-economic, strategic, legal and technical registers of land, an understanding of terrain as the
political materiality of territory. Similarly, Gordillo (2018), in dialogue with Elden’s work, uses the same concept in a related way to focus on bodies, affect and materialities. A number of archaeologists have also developed allied approaches to landscape, e.g. Denham (2017).

8. We draw this point about the similarity to infrastructure studies from Mathews (2018), as well as from our conversations with Penny Harvey. For more on infrastructure studies itself, see Harvey and Knox (2012, 2015), Carse (2014) and recent edited volumes such as Hetherington (2018) and Anand et al. (2018).

References

Aasdal K (2007) Re-inventing politics of the state: Science and the politics of contestation. In: K Aasdal, B Brenna and I Moser (eds) Technoscience: The Politics of Interventions. Oslo: Unipub, pp.309–326.

Abrams P (1988) Notes on the difficulty of studying the state (1977). *Journal of Historical Sociology* 1: 58–89.

Agrawal A (2005) Environmentality: Technologies of Government and the Making of Subjects. Durham: Duke University Press.

Alletson J (1990) From greenheart to graphite: One hundred years of trout in Natal. Federation of Southern African Flyfishers, Lonehill, Johannesburg, 16 pp.

Alletson J (2018) The passing scene: A tale of two KZN streams. *South African Fly Fishing* 32(169): 72–74.

Anand N, Gupta A and Appel H (2018) The Promise of Infrastructure. Durham: Duke University Press.

Anderson W (2009) From subjugated knowledge to conjugated subjects: Science and globalisation, or postcolonial studies of science? *Postcolonial Studies* 12(4): 389–400.

Barrett G, Brooks S, Josefsson J, et al. (2013) Starting the conversation: Land issues and critical conservation studies in post-colonial Africa. *Journal of Contemporary African Studies* 31(3): 336–344.

Beinart W (2003) *The Rise of Conservation in South Africa*. Oxford: OUP.

Beinart W, Brown K and Gilfoyle D (2009) Experts and expertise in Colonial Africa reconsidered: Science and the interpenetration of knowledge. *African Affairs* 108(432): 413–433.

Benjaminsen TA and Sjaastad E (2008) Where to draw the line: Mapping of land rights in a South African commons. *Political Geography* 27(3): 263–279.

Benjaminsen TA and Svarstad H (2009) Questioning conservation practice - And its response: The establishment of the Namaqua National Park. *Current Conservation* 3(3): 8.

Biermann C and Anderson RM (2017) Conservation, biopolitics, and the governance of life and death. *Geography Compass* 11(10): 1–13.

Blaikie P (1985) *Political Economy of Soil Erosion in Developing Countries*. London: Longman.

Blaikie P and Brookfield H (1987) *Land Degradation and Society*. London and New York: Methuen.

Blaser M (2018) Doing and undoing Caribou/Atiku: Diffractive and divergent multiplicities and their cosmopolitical orientations. *Tapuya: Latin American Science, Technology and Society* 1(1): 47–64.

Boudia S and Jas N (2014) Powerless Science? Science and Politics in a Toxic World. New York: Berghahn Books.

Boyer D (2002) The medium of Foucault in anthropology. *Minnesota Review* 58(1): 265–272.

Brown D (2013) *Are Trout South African? Stories of Fish, People and Places*. Johannesburg: Picador Africa.

Bubandt N and Tsing AL (2018) An ethnocology for the anthropocene: How a former brown-coal mine in Denmark shows us the feral dynamics of post-industrial ruin. *Journal of Ethnobiology* 31(1): 1–13.

Bull J (2009) Watery masculinities: Fly-fishing and the angling male in the South West of England. *Gender, Place & Culture* 16(4): 445–465.

Büscher B and Fletcher R (2014) Accumulation by conservation. *New Political Economy* 20(2): 273–298.
Callon M (1986) Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuc Bay. In: J Law (ed.) Power, Action and Belief: A New Sociology of Knowledge. London: Routledge, pp.196–233.

Carothers C and Chambers C (2012) Fisheries privatization and the remaking of fishery systems. Environment and Society 3(1): 39–59.

Carse A (2014) Beyond the Big Ditch: Politics, Ecology, and Infrastructure at the Panama Canal. Cambridge: MIT Press.

Casid JH (2004) Sowing Empire: Landscape and Colonization. Minneapolis: Minnesota University Press.

Cavanagh CJ (2018) Political ecologies of biopower: Diversity, debates, and new frontiers of inquiry. Journal of Political Ecology 25(1): 402–425.

Christensen PA (2019) Fly-Fishing in Paradise: Nature, Science and World-Making in the Contemplative Man's Recreation. Aarhus: Aarhus University.

Clastres P (1989) Society against the State. New York: Zone Books.

Clifford J (1988) The Predicament of Culture: Twentieth-Century Ethnography, Literature and Art. Cambridge: Harvard University Press.

Comaroff J and Comaroff J (2006) Naturing the nation: Aliens, apocalypse, and the postcolonial state. In: TB Hansen and F Stepputat (eds) Sovereign Bodies: Citizens, Migrants, and States in the Postcolonial World. Princeton: Princeton University Press, pp.120–147.

Corburn J (2005) Street Science: Community Knowledge and Environmental Health Justice. Cambridge: MIT Press.

Cosgrove D (2005) Maps, mapping, modernity: Art and cartography in the twentieth century. Imago Mundi 57(1): 35–54.

Crass B (1964) Freshwater Fishes of Natal. Pietermaritzburg: Shuter & Shooter.

Crawford SS and Muir AM (2008) Global introductions of salmon and trout in the genus Oncorhynchus: 1870-2007. Reviews in Fish Biology and Fisheries 18(3): 313–344.

Cronon W (1996) The trouble with wilderness: Or, getting back to the wrong nature. In: W Cronon (ed.) Uncommon Ground: Rethinking the Human Place in Nature. New York: W. W Norton & Company Inc., pp.69–90.

Crumley CL (2017) Historical ecology and the study of landscape. Landscape Research 42(sup1): S65–S73.

Curtis P (2005) Fishing the Margins: A History and Complete Bibliography of Fly Fishing in South Africa. Johannesburg: Platanna Press.

Dean M (1999) Governmentality: Power and Rule in Modern Society. London: Sage.

Denham T (2017) Landscape archaeology. In: AS Gilbert (ed.) Encyclopedia of Geoarchaeology. Netherlands: Springer, pp.464–468.

Despret V (2004) The body we care for: Figures of anthropo-zoo-genesis. Body & Society 10(2–3): 111–134.

Douglas M (2003) The gender of the trout. RES: Anthropology and Aesthetics 44: 171–180.

Draper M (2003) Going native? Trout and settling identity in a rainbow nation. Historia 48(1): 55–94.

Draper M (2016) Holy trout: New Zealand and South Africa. In: S Snyder, B Borgelt and E Tobey (eds) Backcasts: A Global History of Fly Fishing and Conservation. Chicago: University of Chicago Press, pp.178–194.

Dunlap T (1999) Nature and the English Diaspora: Environment and History in the United States, Canada, Australia, and New Zealand. Cambridge: Cambridge University Press.

Elden S (2020) Terrain, politics, history. Dialogues in Human Geography. Epub ahead of print 21 August 2020. DOI: 10.1177/2043820620951353.

Epstein S (1996) Impure Science: AIDS, Activism, and the Politics of Knowledge. Berkeley: University of California Press.

Fairhead J and Leach M (1995) False forest history, complicit social analysis: Rethinking some West African environmental narratives. World Development 23(6): 1023–1035.

Fortun K and Fortun M (2005) Scientific imaginaries and ethical plateaus in contemporary U.S. toxicology. American Anthropologist 107(1): 43–54.
Foucault M (1965) *Madness and Civilization: A History of Insanity in the Age of Reason*. New York: Pantheon Books.

Foucault M (1972) *The Archaeology of Knowledge*. London: Tavistock.

Foucault M (1979) *Discipline and Punishment: The Birth of the Prison*. New York: Vintage.

Foucault M (1980) On popular justice: A discussion with Maoists. *Power/Knowledge: Selected Interviews and Other Writings 1972 -1977*. New York: Pantheon Books, pp.1–36.

Frickel S (2004) *Chemical Consequences: Environmental Mutagens, Scientist Activism, and the Rise of Toxicology*. New Jersey: Rutgers University Press.

Gordillo G (2018) Terrain as insurgent weapon: An affective geometry of warfare in the mountains of Afghanistan. *Political Geography* 64: 53–62.

Green L (2014) Ecology, race, and the making of environmental publics: A dialogue with silent spring in South Africa. *Resilience: A Journal of the Environmental Humanities* 1(2): 1–20.

Green L (2020) *Rock, Water, Life: Ecology and Humanities for a Decolonial South Africa*. Durham: Duke University Press.

Halverson A (2010) *An Entirely Synthetic Fish: How Rainbow Trout Beguiled America and Overran the World*. New Haven: Yale University Press.

Hansen NC (2017) Dressage: Training the equine body. In: M Chrulaw and DJ Wadiwel (eds) *Foucault and Animals*. Netherlands: Brill, pp.132–160.

Haraway D (1988) Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist Studies* 14(3): 575–599.

Haraway D (2008) *When Species Meet*. Minneapolis: University of Minnesota Press.

Harding S (2011) The Postcolonial Science and Technology Studies Reader. Durham: Duke University Press.

Harvey P and Knox H (2012) The enchantments of infrastructure. *Mobilities* 7(4): 521–536.

Harvey P and Knox H (2015) *Roads: An Anthropology of Infrastructure and Expertise*. Ithaca: Cornell University Press.

Havlick DG and Biermann C (2020) Wild, native, or pure: Trout as genetic bodies. *Science, Technology, & Human Values*. Epub ahead of print 9 December 2020. DOI: 10.1177/0162243920978307.

Hetherington K (2018) *Infrastructure, Environment, and Life in the Anthropocene*. Durham: Duke University Press.

Hoover E (2017) *The River Is in Us: Fighting Toxics in a Mohawk Community*. Minneapolis: University of Minnesota Press.

Hubbard J (2017) Fisheries science and its environmental consequences. *Oxford Research Encyclopedia of Environmental Science*. Oxford: Oxford University Press.

Kelty CM (2010) Outlaw, hackers, victorian amateurs: Diagnosing public participation in the life sciences today. *Journal of Science Communication* 9(1): 1–8.

Kepe T (2009) Shaped by race: Why race still matters in the challenges facing biodiversity conservation in Africa. *Local Environment* 14(9): 871–878.

Kierans C (2017) Renal care in an unequal world: Anthropological reflections. In: G Garcia-Garcia, L Agodoa and K Norris (eds) *Chronic Kidney Disease in Disadvantaged Populations*. Cambridge: Academic Press, pp.263–271.

Kolbert E (2015) *The Sixth Extinction: An Unnatural History*. London: Picador.

Krohn-Hansen C and Nustad KG (2005) *State Formation: Anthropological Perspectives*. London: Pluto.

Law J (2008) On sociology and STS. *The Sociological Review* 54(4): 623–649.

Law J and Joks S (2018) Indigeneity, science, and difference: Notes on the politics of how. *Science, Technology, & Human Values* 44(3): 424–447.

LeDuff C (2003) At a slaughterhouse, some things never die. In: C Wolfe (ed.) *Zoontologies: The Question of the Animal*. Minneapolis: Minnesota University Press, pp.183–198.

Liboiron M (2015) Redefining pollution and action: The matter of plastics. *Journal of Material Culture* 21(1): 87–110.

Lien M (2015) *Becoming Salmon: Aquaculture and the Domestication of Fish*. Oakland: University of California Press.
Lien ME and Davison A (2010) Roots, rupture and remembrance: The Tasmanian lives of Monterey Pine. *Journal of Material Culture* 15(2): 1–21.

Lorimer J (2020) *The Probiotic Planet: Using Life to Manage Life*. Minneapolis: University of Minnesota Press.

Mathews A (2009) Unlikely alliances: Encounters between state science, nature spirits, and indigenous industrial forestry in Mexico, 1926–2008. *Current Anthropology* 50(1): 75–101.

Mathews A (2011) *Instituting Nature: Authority, Expertise, and Power in Mexican Forests*. Cambridge: MIT Press.

Mathews A (2018) Landscapes and throughscapes in Italian Forest Worlds: Thinking dramatically about the anthropocene. *Cultural Anthropology* 33(3): 386–414.

Mattingly DJ and Falconer-Al-Hindi K (1995) Should women count? A context for the debate. *The Professional Geographer* 47(4): 427–435.

Mitchell T (2002) *Rule of Experts: Egypt, Techno-Politics, Modernity*. Berkeley: University of California Press.

Moss P (1995) Embeddedness in practice, numbers in context: The politics of knowing and doing. *The Professional Geographer* 47(4): 442–449.

Nightingale A (2003) A feminist in the forest: Situated knowledges and mixing methods in natural resource management. *ACME* 2(1): 77–90.

Nustad KG (2001) Development: The devil we know? *Third World Quarterly* 22(4): 479–489.

Nustad KG (2015) *Creating Africas: Struggles Over Nature, Conservation and Land*. London: Hurst Publishers.

Nustad KG (2018) Wilderness through domestication: Trout, colonialism, and capitalism in South Africa. In: HA Swanson, M Lien and GB Ween (eds) *Domestication Gone Wild: Politics and Practices of Multispecies Relations*. Durham: Duke University Press, pp.215–231.

Nustad KG (2019) Traces of pasts and imaginings of futures in St Lucia, South Africa. In: P Harvey, C Krohn-Hansen and KG Nustad (eds) *Anthropos and the Material*. Durham: Duke University Press, pp.161–178.

Olwig KR (2002) *Landscape, Nature and the Body Politic: From Britain’s Renaissance to America’s New World*. Wisconsin: University of Wisconsin Press.

Ottinger G and Cohen B (2011) *Technoscience and Environmental Justice: Expert Cultures in a Grassroots Movement*. Cambridge: MIT Press.

Palsson G (1998) The birth of the aquarium: The political ecology of Icelandic fishing. In: TS Gray (ed.) *The Politics of Fishing*. London: Palgrave Macmillan, pp.209–227.

Peluso NL (1995) Whose woods are these? Counter-mapping forest territories in Kalimantan, *Indonesia. Antipode* 27(4): 383–406.

Perkins HA (2020) Killing one trout to save another: A hegemonic political ecology with its biopolitical basis in Yellowstone’s native fish conservation plan. *Annals of the American Association of Geographers* 110(5): 1559–1576.

Poulantzas N (1968) *Political Power and Social Classes*. London: NLB.

Ramutsindela M and Shabangu M (2013) Conditioned by neoliberalism: A reassessment of land claim resolutions in the Kruger National Park. *Journal of Contemporary African Studies* 31(3): 441–456.

Ritvo H (2012) President’s lecture * going forth and multiplying: Animal acclimatization and invasion. *Environmental History* 17(2): 404–414.

Roberts EFS and Sanz C (2018) Bioethnography: A how-to guide for the twenty-first century. In: M Meloni, J Cromby, D Fitzgerald, et al. (eds) *The Palgrave Handbook of Biology and Society*. New York: Springer.

Scott JC (1998) *Seeing Like a State: How Certain Schemes to Improve the Human Condition Has Failed*. New Haven: Yale University Press.

Seth S (2009) Putting knowledge in its place: Science, colonialism, and the postcolonial. *Postcolonial Studies* 12(4): 373–388.

Smart B (1983) *Foucault, Marxism, and Critique*. London: Routledge & Kegan Paul.

Srinivasan K (2017) Conservation biopolitics and the sustainability episteme. *Environment and Planning A: Economy and Space* 49(7): 1458–1476.
Sullivan S (2010) 'Ecosystem service commodities’ - A new imperial ecology? Implications for animist immanent ecologies, with Deleuze and Guattari. New Formations 69(1): 111–128.

Swanson H (2017) Methods for multispecies anthropology: Analysis of Salmon otoliths and scales. Social Analysis 61(2): 81–99.

Swanson H (2018) Landscapes, by comparison: Practices of enacting Salmon in Hokkaido, Japan. In: K Omura, G Otsuki, A Morita, et al. (eds) The World Multiple: The Politics of Knowing and Generating Entangled Worlds. Abingdon: Routledge, pp.105–122.

Swanson H (2019) An unexpected politics of population: Salmon counting, science, and advocacy in the Columbia River Basin. Wenner-Gren Symposium special issue. Current Anthropology 60(20): S272–S285.

Swanson H (2020) Curious ecologies of knowledge: Anthropologists engaging a former mining site in Denmark. In: P Zurn and A Shankar (eds) Curiosity Studies: A New Ecology of Knowledge. Minneapolis: University of Minnesota Press, pp.15–36.

Tilley H (2005) Ambiguities of racial science in Colonial Africa: The African research survey and the fields of eugenics, social anthropology, and biomedicine, 1920-1940. In: B Stuchtey (ed.) Science Across the European Empires, 1800-1950. Oxford: Oxford University Press, pp.245–287.

Tsing A (2012a) On nonscalability: The living world is not amenable to precision-nested scales. Common Knowledge 18(3): 505–524.

Tsing A (2012b) Unruly edges: Mushrooms as companion species. Environmental Humanities 1(1): 141–154.

Tsing A, Swanson HA, Gan E, et al. (2017) Arts of Living on a Damaged Planet: Ghosts and Monsters of the Anthropocene. Minnesota: Minnesota University Press.

Tsing AL (2015) The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins. Princeton: Princeton University Press.

Tsing AL (2018) A multispecies ontological turn? In: K Omura, GJ Otsuki, S Satsuka, et al. (eds) The World Multiple: The Quotidian Politics of Knowing and Generating Entangled Worlds. London: Routledge, pp.233–247.

Tsing AL, Mathews AS and Bubandt N (2019) Patchy anthropocene: Landscape structure, multispecies history, and the retooling of anthropology: An introduction to supplement 20. Current Anthropology 60: S186–S197.

van Dooren T (2016) Flight Ways: Life and Loss at the Edge of Extinction. New York: Columbia University Press.

West P (2006) Conservation Is Our Government Now: The Politics of Ecology in Papua New Guinea. Durham: Duke.

West P, Igoe J and Brockington D (2006) Parks and peoples: The social impact of protected areas. Annual Review of Anthropology 35: 251–277.

Winkel G (2012) Foucault in the forests: A review of the use of ‘Foucauldian’ concepts in forest policy analysis. Forest Policy and Economics 16: 81–92.