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A Sea of Gamba: Making Environmental Harm Illegible in Northern Australia

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ABSTRACT
Science and Technology Studies (STS) scholarship has often been suspicious of the role of scientific knowledge and scientists in environmental governance, notably through paying critical attention to the workings of calculative rationalities and techniques. However, recent reforms within certain extractivist regions and nations such as the United States of America and Australia suggest that calculative management and the environmental data on which it is based is no longer a given. Arguably, the politics of rendering the ecologies around us legible through measures and values has changed. This is apparent by examining the case of Gamba grass (*Andropogon gayanus*), an invasive and fire-promoting 'weed' which is threatening the lives and futures of humans and nonhumans alike in Australia's Northern Territory. After becoming a target of environmental regulation in 2008, the plant has continued to thrive and expand its reach. Interviews and fieldwork with a range of practitioners engaged in bushfire and weed management show that there are many challenges to interceding in forms of environmental harm when we are governed by a politics of environmental illegibility. Pragmatic empirical engagements by STS scholars and others are necessary if these intercessions are to succeed.

KEYWORDS
Legibility; governance; environment; weeds; fire; Australia

Introduction

Over the past several decades, environmental and demographic changes in fire-prone nations – such as Australia, the United States, Chile and elsewhere – have amplified the human impacts of bushfires (Doerr and Santín, 2016). Such hazards are correlated to existing and anticipated increases in other extreme weather events, such as heat waves and droughts, which help produce the conditions for bushfires. Curiously, as the impacts of such hazards have increased, governments in many fire-prone countries have sought to variously limit and dissolve the apparatuses through which environments are regulated and monitored. This includes not only the radical changes to the Environmental Protection Agency

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under the Trump administration in the United States, but also the waves of deregulatory policy 'reforms,' defunding and restructuring that have swept through land and resource use in the United States, Canada, Australia and elsewhere over the past two decades (Castree, 2008; Dillon *et al.*, 2017; Fredrickson *et al.*, 2018). To illustrate, just as a recent internal review revealed that a third of Australia's threatened species were not being monitored, the Australian government's lead environmental agency had a quarter of its budget cut (Slezak, 2018). In 2012, the federal agency responsible for weeds governance stated that collecting data on the distribution of Gamba grass (*Andropogon gayanus*), an invasive grass which fuels destructive wildfires in northern Australia, was 'essential' to management efforts (DSEWPC, 2012). For no known reason, this agency was suddenly defunded in early 2013.

In recent years, Science and Technology Studies (STS) scholars have sought to attend to a broad spectrum of environmental hazards as 'slow disasters'; that is, incidences of bushfire, air pollution, marine plastics, urban flooding, earthquakes, and other environmental hazards all have socially complex, temporally protracted and spatially distributed causes and effects (Fortun *et al.*, 2016). Articulating these causes and effects is challenging. But while many scholars have focused on activist interventions in these 'slow' problems, the undermining of state agencies and their scientific capacities point to other important questions about 'the state' and its ability to make the dimensions of such problems apparent or legible. Arguably, the current combination of increases in hazards, such as bushfires, and decreases in monitoring present epistemic and political difficulties to us all. In particular, it affects actors within the institutional machinery of government entrusted to articulate how environmental harms are distributed and managed. In short, how is the absence or restriction of environmental monitoring and regulation infrastructures encountered by actors within those infrastructures? When assumed forms of evidence do not exist, how do those actors themselves make environmental harm legible to others, if at all, and how do they think such harms might be suspended or ceased?

In the following sections I first review the rich literature in STS on counting, or enumeration, in relation to environmental governance. As I then demonstrate, attention to the 'Gamba-bushfire nexus' (see Head and Atchison, 2015) in northern Australia suggests that there is much to be gained from ethnographic analysis of the networks of practitioners (ostensibly) charged with enumerating and mitigating environmental harms or threats today. Gamba grass's emergence as a 'weed' and 'fire risk,' the result of intersecting histories of settler colonial invasion and value extraction, signals broader concerns about how environmental harms or threats are made (il)legible within and by government agencies.

Analytical Perspectives

Latour (1999) and others (e.g. Callon *et al.*, 2009) have demonstrated how simple scientific facts – such as that Gamba grass can burn with eight times the intensity

of northern Australia's native grasses – conceal the material transformations and translations necessary to their social circulation. Relays of practices, apparatuses, institutions and labouring agents are required in order to credibly assert that one formation of things is 'up to eight times' another. Such submerged fact-making work requires the standardisation of ways of ordering and counting things, or what Verran (2011) calls 'enumerated entities.' Contemporary environmental governance would not be possible without the historical sedimentation of 'measures' (categorisations) and 'values' (counting within categories) for the piecemeal enumeration of ecologies as entities, whether in terms of river flow, ambient temperature or legion other measures. Verran describes such enumerations as '*lively* semiotic-material actants' which, despite their innate artificiality, are routinely presented as somehow 'non-interpretive' or objective truths (see also: Poovey, 1998). Natural hazard management is replete with such entities, as its practitioners imagine and estimate acts of precaution, preparedness, or pre-emption by arranging measures and values in forms of comparison (Callon and Muniesa, 2005, p. 1231).

In recent decades, scholarship on environmental governance has often been suspicious of making 'nature' numerically legible at all. After Scott (1998) and others (e.g. Smith, 1996), critical analyses have frequently presented taking environments 'into account/ing' (Asdal, 2008) as servicing hegemony and extraction (Parenti, 2015). This follows a broadly Marxian distrust of abstraction which – alert to how nature 'as numbers' can be both obscure and socially transformative (Verran, 2009) – understands enumerated entities as political tools that conceal social and economic exploitation. A similar, but distinct, critique has suggested that the production of scientific knowledge about nature (or *naturpolitik*) has been used to foreclose political contests (Latour, 2004). From this perspective, statements made on the basis of ecological science are implicitly arguments from authority which, first, rely upon the fallacy that there is a singular 'nature' about which scientists can gain 'objective' knowledge, and, second, exclude minority entities and ways of knowing (e.g. Plumwood, 2002). Subsequently, *naturpolitik* is demonstrably false and disfigures the processes through which collectives' futures are decided (Latour, 2004, pp. 34–40). Arguably, those who have developed these critiques do not seek to end enumeration but rather hold it in permanent distrust, hailing the non-dualistic ontologies ignored by the dominant institutions of contemporary governance (e.g. Latour, 2004, pp. 44–45; Verran, 2009).

Empirical studies of such governance suggest, however, that making nature legible to enumeration is not necessarily as ubiquitous, unambiguous or politically powerful as these critiques suggest (e.g. Dempsey, 2011; Neale, 2017). Controversies or 'hot' situations (Callon, 1998), where the status quo of knowledge is in play, are not necessarily calmed or 'cooled' by adding a greater diversity or depth of data. This is apparent from research on the 'structural production of ignorance' (Proctor and Schiebinger, 2008), or agnotology, which indicates

that since enumeration can be vital to the proliferation of minority knowledge and majority ignorance alike it has no necessary connection to either knowledge or ignorance as such (see Mair *et al.*, 2012). But if counting environments is neither as powerful or trustworthy a weapon as we thought, what is it good for after all? The answer, I argue, lies in the context. Like the politics of biosecurity, environmental governance more generally 'is a deeply empirical affair,' as Hinchliffe and Bingham (2008, p. 1541) state, 'one that requires us to investigate the practices as they make and remake the real.' In other words, assumptions about environmental governance as a generic formation obscure the actual practices involved in making environments legible as enumerated entities, making it difficult to trace changes in their competence, consistency and effects.

In the following sections, I adopt a constructivist approach to knowledge production (e.g. Whatmore, 2002) in interpreting narratives of environmental governance, understanding how a 'problem' species and the institutional capacities to know and manage it as co-evolved and interdependent. Tracing how Gamba grass has become variously legible and illegible to governance in the Northern Territory, I argue, illustrates why critiques of enumerating environments need to be tempered by empirical insight into what the presence and absence of measures and values makes possible in a given context.

Seeing a 'Weed'

My own attention to Gamba grass began with an assumption that its transition into the institutions of weed governance in Australia's Northern Territory (NT) was a 'good news story' of how scientific research had effectively transformed policy and practice. However, my fieldwork in 2015 and 2016 quickly demolished this narrative. As I spoke with practitioners – planners, bushfire, park and weed managers, and university and government researchers – professionally engaged in bushfire and weed management it soon became apparent that while Gamba was steadily expanding its terrain, massively increasing bushfire hazards and impacts, there were few resources devoted to making this expansion scientifically legible.[1] As one senior weed manager stated at a workshop, 'We know our current circumstance allows [Gamba] to spread.' When I asked at different times what their surrounds would look like in 20 years' time, most predicted 'a big Gamba grassland' or, as a bushfire manager and university researcher separately stated, 'a sea of Gamba.'

The difficulty of perceiving this 'sea' and its ascendance over this region's native grass and tree species was illustrated to me time and again through routine experiences of discernment and categorisation. From a few metres distance, I learned, mature Gamba grass is clearly taller and more dense than other grasses, growing in solid tussocks up to four metres high. Up close, its thick stems and long thin leaves are distinctively bearded with white hairs soft to the touch. From the celestial perspective of GoogleEarth, its monocultural

Figure 1. A property near Batchelor infested with Gamba grass (credit: T. Neale).

communities appear as patches of unusual 'hummocky' consistency. Once, flying in a helicopter over the residential subdivisions and pastoral stations surrounding Batchelor, 100 kilometres from the NT's capital of Darwin, the pilot asked me 'do you see it?' I said nothing at first, floored by the difficulty of discerning the ecological 'exotic' from the 'native' as we cruised over spare islands of canopy composed from wiry sclerophylls set in a matt of grasses 'curing' from lush greens into arid browns under the influence of the incipient 'dry' season. We approached some white shapes which, I realised, were corrugated iron roofs bracketed in thickets of Gamba grass (see Figure 1).

Elsewhere, Gamba's presence was marked by its apparent absence, in expanses of blackened sparse ground interrupted, here and there, by scorched trunks and denuded canopy. A regular occurence throughout Greater Darwin, these desolate sites were the result of bushfires which, fed by Gamba grass, burn much hotter and higher than those that have ranged across north Australia for millennia.[2] In Litchfield National Park, which neighbours Batchelor, the charred and denuded roadsides index Gamba's presence, as they are sprayed with herbicide and then burned to reduce the risk of intense bushfires affecting the park's 400,000 annual visitors. Almost a fifth of the 'must see' park, to quote the NT tourism website, is infested with Gamba.

Just so, learning to 'see' this grass led me to correlate questions about how its diverse effects are legible within regimes of knowledge and modes of governance. Only in the past two decades has Gamba been explicitly identified as a 'hazard,' morally distinguished as an 'invader,' and, in 2008, legal declared to be a 'weed' in Western Australia, Queensland and the NT. A body of research has emerged to progressively render this grass's behaviours, characteristics and populations into scientific knowledge. How did Gamba attain an ecological foothold only to radically shift status both politically and epistemologically? This was the question I had when I travelled to Greater Darwin in 2015 to begin fieldwork with

practitioners within the Gamba Management Area (see Figure 2), my ostensible aim being to provide insight into how natural hazards management agencies had used science to intervene in Gamba's future. But, I soon learned, the plant's history on the Australian continent has always been thoroughly scientific.

Like many other weeds, Gamba emerged from public and private attempts to render the variable north Australian environment amenable to the agricultural practices of European settlers (Beattie *et al.*, 2014). These 'northern development' proposals have reimagined the continent's relatively sparse tropical north as an industrialised and economically robust 'food bowl,' remade through technical ingenuity and deregulation (Holmes, 2010); some of these dreams have materialised though many more lie dormant (Lea, 2014). The

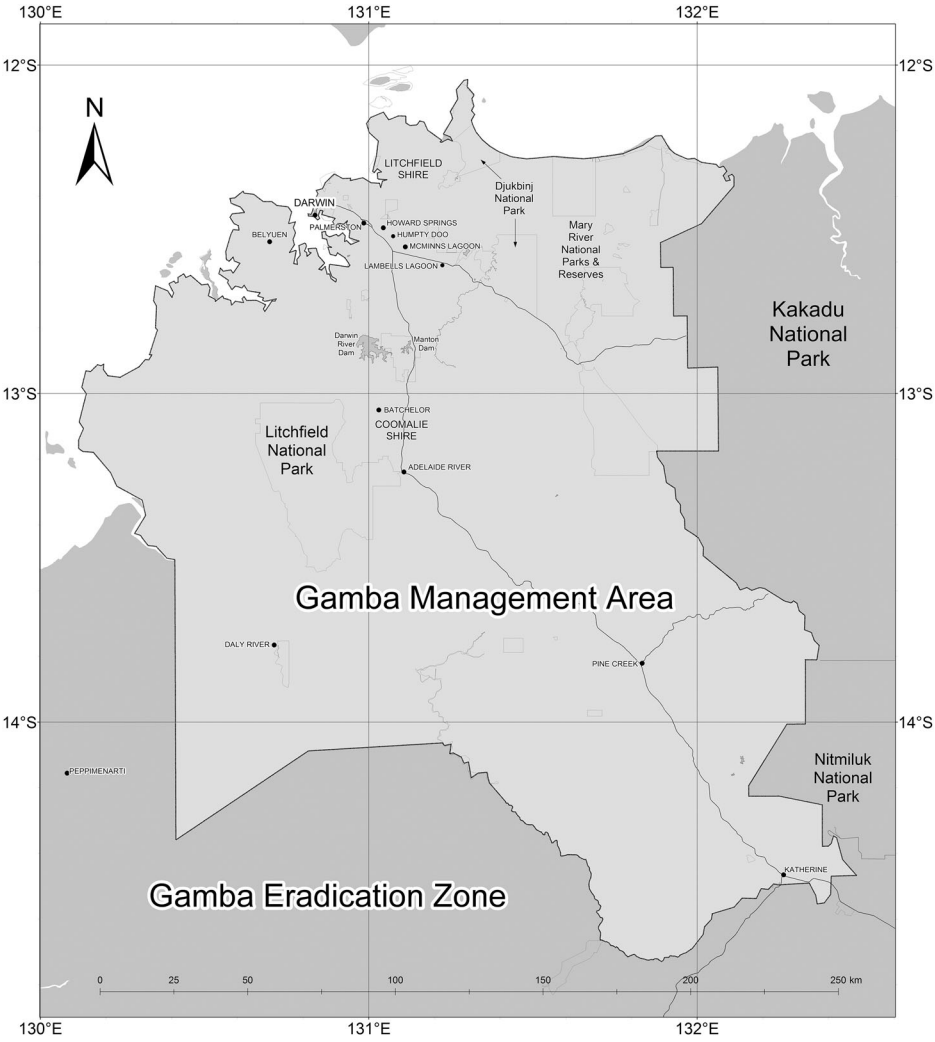

Figure 2. Map of Greater Darwin showing key sites, national parks and present Gamba management area (credit: A. Edwards).

lead scientific organisation in these efforts has been the Commonwealth Scientific and Industrial Research Organisation (CSIRO), responsible for introducing more than 8200 plant species and at least 2250 exotic grasses into Australia since 1924 (Cook and Dias, 2006), many specifically to assist the extractive processes of meat and dairy production. Whereas in earlier times, the settler colonial state had sought to exclude Indigenous peoples from their territories, this modernist iteration aspired to irrevocably redesign the ecologies Indigenous peoples nurtured.

Making a 'Weed'

Between 1931 and 1949, a CSIRO 'experimental farm' near Darwin cultivated Gamba's two principal varieties with seeds from Nigeria and Brazil, but the residual material from these trials was warehoused after uninspiring results. However, in the 1950s, a new trial produced a hybrid from these remainders with morphological characteristics of the two varieties (Cameron, 2000). Evaluations began, and by the 1970s the hybrid was being discussed as a promising pasture fodder, 'an aggressive colonizer' that survived 'under very adverse conditions' and, notably, flourished after fire (Reid and Miller, 1970; Jones, 1979). The grass proved itself worthy according to the criteria of CSIRO's reterritorialising project, and so, following formal endorsement in 1978, commercial quantities were sourced and sown widely in the NT and elsewhere across over 180 locations (Csurhes, 2005). In the late 1990s, as evidence mounted that it had become rampant and uncontrollable, government agencies continued to describe it as 'highly productive' for pastoralists while, at the same time, beginning to educate land managers and residents to 'control' the species with Monsanto's glyphosate herbicide Roundup® (Howard, 2001, pp. 50–51).[3] When Gamba became a 'weed' in 2008 it already covered 10,000–15,000 km^2 of the NT, including a core infestation in the Greater Darwin area (DLRM, 2014).

One way of narrating the story of Gamba becoming a 'weed' is a just-so story of scientific research: a naturalised actor, unproblematic to state and industry alike, is rendered newly legible by independent scientific research, prompting legal changes in the public interest. But this was not a narrative that the practitioners I met recognised, even if they did admit that the Kent hybrid had to be epistemologically reframed to become 'a weed.' Whereas previously CSIRO researchers had sought to make Gamba intelligible for production, assessing it as a vector for transforming water and soil into beef, researchers in the 1990s began to redraw its character in terms of an 'impending doom' (Cook, 1991). In the early 2000s, results emerged from ecologists based at Darwin's Northern Territory University about Gamba's rate of spread and annual seed production, followed by the first field study near Batchelor which showed its 'grass-fire cycle' (Rossiter *et al.*, 2003). This is where a grass increases the frequency and intensity of bushfires, reducing both competition and canopy cover to facilitate deeper

invasion, greater availability of fuel, and so on into dominance. Further research from the University soon established other characteristics – such as that Gamba causes nutrient loss and reduced water availability (e.g. Rossiter *et al.*, 2004), and it can lower tree recruitment by 75% (Clifton, 2004) – while government researchers released the first coarse map of Gamba's spread (Kean and Price, 2002).

Gamba developed as a political entity at large during this same period. In the mid-2000s, concerned residents began holding 'Gamba Action Group' meetings, while some NT politicians committed to 'help the fight against the invader' species (Anon, 2005), prompting an NT government committee to hold hearings between 2005 and 2006 regarding invasive plants. By the time its recommendations emerged, almost 200 ecologists and weed scientists had signed a 'Gamba Declaration' calling for the grass to be banned, while pastoralists continued to profess that it was 'a very productive pasture species' (Anon, 2008). Then, in May 2008, the committee recommended its legislative control (SCESD, 2008) before, a few months later, the Martin administration made the official declaration under the *Weeds Management Act 1999 (NT)*. The federal government then listed Gamba as a 'key threatening process' to the nation's ecologies in 2009. Two years after its legal declaration, the NT government's finalised 'Weed Management Plan' was released, establishing a Management Zone (MZ) covering Greater Darwin, where the weed was considered only 'controllable,' and an Eradication Zone (EZ) across the remainder of the NT, where eradication was considered 'feasible' (Head and Atchison, 2015).

How the Kent hybrid had reproduced so rapidly and pervasively in Greater Darwin between 1978 and the 1990s has been a matter of discussion amongst practitioners and residents alike. One proffered reason is that a series of unusually wet years (1991–1995) gave the grass a competitive advantage to produce more biomass. More biomass meant more intense fires which, in turn, advantaged the invader. While out following practitioners I saw this cycle in action, witnessing how, as several weed managers had told me, lone Gamba plants are not hard to kill but they are virulent as a collective. Property after property was almost completely surrounded by a three-metre curtain of green Gamba, waving its cream-coloured combs of seeds over the desiccated native grasses around it. Sometimes, as fire crews arrived to voluntarily burn someone's land as 'risk reduction,' the landowners would wrest minivans, fridges, or an old sedan from behind the curtain, before the stands of Kent's hybrid were lit and lifted flames and seed into the air, leaving behind burnt stalks. Afterwards we would find the grass had taken advantage of our presence, tightly wedging its pointed seeds into the trucks' grates and tyres (see Figure 3) and our clothes and hair.

Whether burned in such 'risk reduction' fires, misadventure or casual arson, the Gamba would once again recover faster than the other plant competitors, casting greater volumes of seed into the wind, and expanding into new

Figure 3. Practitioner vehicle after Crater Lake burn showing Gamba grass seed (credit: T. Neale).

uninvaded areas across the region. According to one estimate, frequently cited in government documents, Gamba has the capacity to find a suitable ecological niche across a quarter of the NT, roughly 380,000 square kilometres, as well as large savanna areas in neighbouring Queensland and Western Australia (Setterfield *et al.*, 2013). The progress of this potential empire may also expand and accelerate as, under a changing climate, north Australia becomes seasonally hotter, wetter and more frequently subject to cyclones. The disaster of Gamba's slow expansion has the potential to create an enduring set of transitions. A transition to an ecology in which the one excludes the many. A transition from an ecology assembled through millennia of use by Indigenous peoples to one assembled by the fallout of unsustainable settler pastoralism. A transition from an ecology in which fire is a source of common renewal and flourishing (humans included) to one in which it is a common mortal threat.

Close encounters with Gamba clarify why some practitioners speak about an emerging 'sea of Gamba.' Like a sea, the infestation in Greater Darwin seems ungovernable; it seems to swarm with intent; it seems menacing and inhuman. Wherever they take root, the descendants of Kent's hybrid grass will likely foster conditions towards their own flourishing once again, monopolising nutrients and eliminating its vegetal cohort. But while most practitioners I met focused upon biological causations, many also identified cultural and political causes for Gamba's initial and continuing ecological success.

The Northern Political

Head and Atchison (2015) argue that much of the attention Gamba has received from government agencies is owed to its flammability and proximity to Greater Darwin's peri-urban residents and, thereby, its intersection with bushfire management priorities. This acute assessment benefits from a brief explanation of the

NT's political culture. Frequently during fieldwork, I was reminded that the NT is definitively 'not like down south' (i.e. the rest of Australia). Since the colonisation of the continent by Europeans began in the seventeenth and eighteenth centuries, both the NT and Darwin, its capital, have been marginal within national political and economic debates. Despite recent mining and military booms, Darwin's population remains more than an order magnitude smaller than capitals in other Australian states and territories, and it has long depended upon the importation of food, skilled labour and funding from the federal government (Lea, 2014). At the same time, attempts to critically analyse the NT have historically been vitiated by 'Territorianism,' 'an aggressively presented sense of identity' based in ideals of independence and economic development (Carment, 2007, p. 8). In everyday life, lifelong residents and new arrivals alike would regularly explain everyday events – whether racist remarks, low-level corruption,[4] missed appointments, or throwing lit matches out a car window – as evidence of this place's eccentric norms.

Practitioners spoke of bushfire as another site of difference, framing the north's more frequent and less intense grassfires as eliciting different attitudes amongst practitioners and publics compared to 'down south.' 'Fire's good in the north,' as one senior fire manager put it to me. Approximately 40% of the Greater Darwin area burns annually in recent decades (Price and Baker, 2007), and 54% of the wider Vernon-Arafura region was burnt at least once between 2011 and 2017 (DENR, 2018, p. 24). This frequency of fire is chiefly due to the fuels, seasonality and human population of the tropical savanna. Over 1000 ml of rain falls in the annual monsoonal wet season, promoting the widespread rapid growth of annual grasses that cure and become increasingly flammable during the dry season between April and November. From early May, significant portions of the landscape are set alight legally and illegally, 'breaking up' the continuity and availability of fuel later in the season. Thus, an abundance of fire, soot and smoke is widely considered a 'natural' occurrence that, while an occasional hazard to motorists, asthmatics, fences and fauna, also reduces fuel levels and promotes new grass growth (see Russell-Smith *et al.*, 2013).[5]

But practitioners' celebration of the cultural acceptance of bushfire was not without limits. Mirroring many others, a senior fire manager explained to me that residents typically believe grassfires are not a significant threat to their lives. Also, he added, some residents feel they have a right to 'light up' public lands, buoyed by the fact that investigations of arson have been extremely rare. Over a coffee, another bushfire manager with over two decades experience in the area explained to me that

> it's a pastime for people to go and burn the bush … if [a specific area] hasn't been burnt by people enjoying having a good fire by this time of year, well it's going to get burnt later in the year!

Figure 4. A bushfire fuelled by Gamba grass on a property near Batchelor (credit: M. Carter Jr.).

Even as bushfire intensities and frequencies have changed due to Gamba grass it has been hard to alter these attitudes. There is perhaps no better example of this than the annual 'Cracker Night' when, in the middle of the dry season, residents use approximately 300 tonnes of fireworks to celebrate the NT's political independence. Hundreds of bushfires and dozens of hospitalisations reliably result (e.g. Jones, 2017).

Many practitioners told me that they had been 'stunned' that Gamba had been declared as a weed in 2008. For most, the grass's danger had been obvious since the early and late 1990s, when they had each first witnessed its invasive spread and intense fire behaviour (see Figure 4). But, as I was told repeatedly, there are certain 'facts of life' about how policy changes occur in the NT. For decades, the Territory's economic dependence has enabled clientelism to become widespread within government, meaning government agents foster relations of patronage with parties (ostensibly) able to attract investment (Carson *et al.*, 2010).[6] As practitioners verified, exceptions to planning and environmental regulations, often through intervention by politicians, have long been unexceptional in pastoralism, real estate development and resource extraction (Carment, 2007). A junior planner explained how often 'we'll say, "but that's bad planning policy," [and the politician says] "It doesn't matter. I want it to happen".'[7] This was no less true of the pastoral industry, which was also widely understood to have such substantial influence within both policymaking circles and the bushfire sector that, as a senior university researcher suggested to me, 'they can dwarf any opposition.'

Formulating a Threat

Therefore, how were such political and cultural obstacles to regulating Gamba grass overcome? While bushfire and weed managers described 'science' and

scientific institutions as generally of limited interest, because they are disengaged from the realities of governance, in this instance they drew upon personal relationships with university-based researchers first formed in the mid-2000s. As one senior bushfire manager recalled, prior to this time, 'all the stuff we were saying was just anecdotal – we don't have the real qualifications to talk about this sort of stuff – but once we got the [researchers] on board then things really started changing.' '[T]hat science side of things,' another explained, effectively enabled practitioners to tell policymakers '"no, no, we're actually not making this up, here's proof, here's the facts, here's the data".' Nonetheless, having data alone was not seen as sufficient to convince policymakers and others about the seriousness of any threat, let alone one in which pastoralists and real estate developers had a financial interest. Different practitioners had to make leaps across several 'intermediary pathways' (Latour, 1999, p. 40) to make Gamba cohere as a meaningful threat.

Reflecting on a long career in the NT, one government researcher surmised to me that 'without political will, you can have the best science you like but it's not going to mean anything.' Just so, to change Gamba's status, practitioners had to make it legible in the received terms of the political. In a series of interviews, I learned that, first, university researchers and their allies within government agencies 'took a different tack when they didn't feel there was enough buy-in' from the initial findings. Subsequently, they worked to place Gamba within two key frames. Combining what was known about Gamba's current spread with its fire behaviour showed that it was a threat to the residents of majority-white Darwin suburbs 'where all the rich tax-paying people are.' It was therefore a risk to the lives and property of the voting districts that, typically, decide NT elections. Further, practitioners within and outside government were able to 'put a monetary value on it,' pointing to how Gamba's spread was leading to steeply rising fire suppression costs.[8]

These were the measures – fatal risk and government expenditure – that 'cut through' and 'scared the bejesus' out of policymakers, reaffirming practitioners' shared view of the 'facts of life' in their world. At moments such as Gamba's declaration, rather than the complexities of spatially and temporally distributed harms that they might have faced previously, politicians and senior bureaucrats were catalysed by fear of being held responsible for deaths and financial costs within their terms in office. But, I realised, this transformation was also aided by practitioners' own social networks, as many were personally familiar with politicians, lobbyists and residents alike. They live in the same suburbs. Their children go to the same schools. 'We're very close to our political masters here and we know them and they know us,' one senior career bushfire manager explained; this means politicians can be influenced, but they 'would see you fixed … if you fucked up with them.'

It was clear early into my fieldwork that there were diverse accounts of the effects of the 'policy change' of the 2008 declaration. To a minority it was a

landmark moment, putting in motion a set of strategic assessments and rendering landowners and the state as *ostensibly* accountable. It also, for instance, helped university researchers continue to find the resources to define the grass ecologically while also turning their attention to management. One key paper (Setterfield *et al.*, 2013), funded by A$900,000 from the privatisation of a major public asset, produced the first aerial surveys of Gamba's Greater Darwin empire.[9] From this, researchers could recalculate the area's fuels, data that were then used to recalibrate the government's standard bushfire hazard measure. Higher hazard scores of 'Extreme' and 'Catastrophic,' an unprecedented number of 'fire ban' days and new resource allocations to manage these risks followed. Enumerating entities had led to tangible changes in governance.

Nonetheless, most practitioners were dubious that 'change' had occurred at all, believing the 2008 declaration to have been an inevitable but superficial concession leading to little effective action or investment. During the eight years following the declaration, weed managers were actively told by their executive 'not to do any enforcement' of Gamba restrictions, despite being legally entitled to do so. Miners, pastoralists and developers alike knew that, as one bushfire manager said, 'there's never been a single infringement or a single prosecution' for violating weeds laws in the NT. In fact, between 2015 and 2018, the government's Weeds Branch actually granted several pastoralists permits to grow Gamba grass within the 'Eradication Zone' (EZ). At the end of my 2016 fieldwork, it was widely understood that Gamba's insertion into regimes of environmental management had not ceased its creeping harms; it remained, steadily encroaching over airfields, urban and rural national parks, military lands, and on the subdivided 'lifestyle blocks' of peri-urban shires. 'What's changed?' some asked darkly, except that Gamba had moved further into the EZ and Gamba-fuelled fires were now starting to incinerate homes and property (e.g. McCartney, 2014; Aisthorpe, 2017).

Avoiding Measures and Values

How had Gamba become less politically visible during exactly the same period that it became a target of state management? One answer is that such 'hot' situations (Callon, 1998), wherein the status quo is put in play, often turn 'cold' once new governance norms emerge. After the declaration, the NT government formulated weed management plans in 2010 and 2014 which set out how its Weeds Branch would combat the threat. However, as weeds practitioners explained, these plans were completely undermined by two factors: the executive prescription against enforcement, and the plans' vague stipulations about measuring the effects of Gamba management. For example, the management 'targets' in both plans were identical and contained no quantified benchmarks. In 'Years 1–5,' both stipulated, the Weeds Branch would 'develop' a monitoring programme,

'investigate' a public reporting system, publish 'results' of management activities, and 'review the effectiveness' of the plan (NRETAS, 2010; DLRM, 2014). Both plans gave the same non-quantifiable answers to the obvious question: 'how will we know if this Weed Management Plan is working?'

The implications of this approach became obvious in conversations with weed managers. First, rather than enforcement, Weeds Branch's funding and resources went towards hiring contractors to spray Gamba on public lands and supplying Greater Darwin residents with free glyphosate and spraying equipment through an annual A$100,000 'Gamba Grass Assistance Program' (GGAP). Second, quantifying the 'effectiveness' of these efforts amounted to counting the number of GGAP participants and surveying their awareness of Gamba issues. Of course, as one weed manager explained, attracting more participants each year 'doesn't mean you've been successful, it just means more people want free herbicide.' Within Weeds Branch it was understood that 'a proper scientific program' of baseline and temporally continuous data on Gamba's whereabouts was required to actually assess their efforts over time. But while the declaration implied that making ecological realities legible in terms of risk to particular favoured humans could generate political pressure, what followed was a management regime unable to detect if these realities or hazards were being reduced. It was not 'intentional,' practitioners told me, they had just not been resourced to do anything more.

This is not to say, though, that practitioners were not active in producing measures and values to generate political leverage. Let me give two examples. After 2012, park managers formulated a new set of planning documents to address Gamba within Litchfield National Park, on the southwestern edge of Greater Darwin, released in 2015. These documents stated that the park's infestation 'is not under control and is deemed uneconomical to manage' (PWC, 2015b, p. 6) and, using free satellite imagery and university aerial surveys, made two key quantified claims: the park's infestation of 17% in 2014 would likely increase to 47% by 2035; and, over 90% of the park was burning annually (PWC, 2015a, p. 43). With these numbers, park managers could establish clear objectives for 2020 which, when they were inevitably not met, would make the ecological crisis unavoidable to policymakers; management failure, or 'underperformance,' would be enumerated. In the meantime, they also used these same measures to request A$15–20 million from the government to reduce Gamba within the park.[10] This proposal was 'knocked back,' one long-time park manager explained, 'because our powers-that-be don't think it's the right time.'

A second example of enumeration, ongoing during my 2016 fieldwork, involved a small set of bushfire practitioners working on a method to spatially measure bushfire risk. This was, a senior bushfire manager told me, in part to help them bid for funds from a A$13–15 million pool of federal money to invest in 'bushfire risk mitigation.'[11] The major obstacle to capturing more from this federal fund was its focus on risk to human life and assets. Greater

recognition and support hinged upon creating 'something measureable,' as a more junior bushfire practitioner pointed out, and the NT was 'right at the bottom' of such scales compared to other states and territories, like Victoria, with long records of fatal bushfires. But while practitioners could map fuel loads, frequent sites of fire, infrastructure and housing, there was no obvious way to create calculable relationships between these things. Only a ratio of intense bushfires to residential houses could speak in the metric favoured within natural hazards governance nationally: anticipated life loss (cf. Neale, 2016). This problem itself suggests not only a lack of scientific method – namely, how to correlate different entities – but why resources have failed to flow to Gamba management more generally since 2008.

Frequently during my time with practitioners, I asked them how a more effective response to Gamba's presence might yet emerge. The answer was nearly universal: someone dying. This refrain – that effective investments for interventions in Gamba will flow only when it claims a resident's life – echoed through my fieldwork. Sitting in their office, one practitioner gave an assessment that aligned with many others':

> There's been lip service to change … [but] until a nice little white family with their beautiful blonde kids get killed in a Gamba fire, nothing will change. When that happens, and a coronial inquiry is on, the shit will hit the fan. People will be looking around saying 'what the fuck? How did you let this happen?'

Rendering this narrative in blunt terms made clear three important shared understandings implied in other retellings.

The first understanding, as suggested above, is that the executive levels of government are singularly responsive to the concerns of the residents of certain Darwin suburbs, where the majority are Anglo-Australian and relatively affluent. When one government researcher told me that 'We all know policy is not driven by science' they were, in truth, summarising what everyone I encountered told me. The second is that practitioners also understood the necessary response to Gamba as radical, if not impossibly so. 'How much money would it take to get rid of Gamba in the Top End?' a senior bushfire manager asked me, '$80 million, $100 million maybe?' Consequently, third, it was broadly understood that altering this situation was beyond any individual. During a 2015 workshop, for instance, I asked a dozen practitioners what they *personally* could each do to 'improve the situation.' Policymakers needed to provide the appropriate mandate and resources, they replied, on this occasion and others.

Organising Deferral

By failing (or neglecting) to either maintain monitoring systems or set numerical targets, the NT and federal governments alike have continued to 'manage'

Gamba grass while progressively absenting themselves from accountability for it. When NT bureaucrats again seek to 'review the effectiveness' of their efforts in future years, they may have little data of their own to draw upon, and few markers against which to measure it, barring the volumes of herbicide they purchased and the number of people who volunteered to take it. Regrettably, practitioners reflected, making risks to human life legible was the best way to intervene in policymakers' apathy. Taking this logic to its conclusion, as they did, only a fatal bushfire has the potential to prompt meaningful action from superiors who are motivated primarily by the deferral of budgetary costs and causal responsibility. A death would trigger formal inquiries, investment and action from 'above,' and, in all likelihood, attempts to attribute blame 'down' to practitioners. Stepping back, I argue, we can see this shared narrative as part of a structure of deferred responsibility that is conditioned by other factors.

As discussed above, practitioners universally accepted that attempts to stop Gamba overwhelming the tropical savanna are failing. 'It's just an inevitable change, you know?' one senior bushfire manager told their colleagues during a workshop, 'It'll be tragic but it is what it is.' On this topic, many career public servants insisted that neither they nor their employer had the capacity or mandate to 'deal' with Gamba. This was the point where I often witnessed a tactical differentiation between the self and an imagined state. Were the pastoralists responsible, perhaps, for planting the grass and then watching it expand past their boundaries? Was it the real estate developers, who advertised infested properties as 'the ideal location for the family' without notifying buyers of the bushfire risks? Fundamentally, as one bushfire manager summarised, 'the government's introduced this stuff, [and so] the government's responsible for it.' The fact that such arguments were put forward by people whose careers have largely been spent within government agencies suggests that this 'government' was not to be found in their offices, or the offices of their colleagues. Rather, 'the government' was always out-of-office, a phantom abstract subject imagined to be both ultimately responsible and capable.

This differentiation was compatible with practitioners' shared ideals of personal autonomy, which most celebrated as part of the 'NT lifestyle.' Nearly every time we met, one career bushfire manager would remind me that 'practically everything I've ever done with my job I've just made it up,' adding with a smile that 'no one else anywhere is allowed those freedoms.' Stressful as their work was, many were happy that they were not restricted by '10,000 levels of approval' like their colleagues 'down south.' Others feared that implementing greater compliance in their own work would lead to less effective management outcomes and, more personally, undermine the respected and cherished liberties of their workplaces. This was evident whenever I raised the prospect of enforcing the Territory's dormant weeds management legislation, because while some said that greater regulation and compliance in all land planning processes would have significant benefits, the idea of expanding regulatory *culture* was itself

disagreeable. Most were confident that neither Greater Darwin's residents nor policymakers would actually support anything more than tokenistic implementation of Gamba regulations on private land.

Though a statist imaginary and ideals of autonomy clearly vitiate against practitioners altering the status quo, these are perhaps less influential than workplace conditions. Several practitioners were very cautious about being interviewed, as it was understood that criticism of government policies and inconsistencies could have serious career consequences. Just as senior policymakers and politicians could create exceptions to planning policies, they could ruin the careers of government employees or have non-government practitioners informally blacklisted. Examples abounded, though the most widely and freely discussed was that of the former director of Bushfires NT. As several people explained to me, the director and others had forecast a bad fire season in 2011, relaying this information to the responsible Minister and upper levels of management. But, as one person said, 'very little got done about it.' When the predicted intense bushfires then occurred, the director was fired for allegedly failing to warn senior bureaucrats, or so the public were told.

For practitioners, such stories were part of a common mythology, revealing the potential consequences of 'speaking up.' But while, as one university researcher stated, it might appear that there is 'a fair bit of political censorship' within NT agencies, I think this may be too simple. Rather, it is more accurate to say practitioners within those agencies inhabit several different tensions which hold back change. They care about problems of environmental governance and harm, but do not perceive these problems as their personal responsibility. They understand the need for long-term planning in order to avoid disastrous consequences, but their time is largely occupied with everyday emergencies and annual budgets. They value the income, liberty and career experience of their roles, understanding the NT government as a good place to work on these measures, but are also cognisant of those who no longer enjoy these benefits because they got 'too political.' In light of all this, one can see how practitioners typically have little to gain, and much to lose, from identifying problems internally or externally.

In their study between 2011 and 2013, Head and Atchison (2015) suggested that generalised 'cynicism and paralysis' could lead to effective action against Gamba in northern Australia if there was 'more honest acknowledgement from government' about its limited capacity to act, and if government could abandon discourses of ecological control. Several years later, I encountered practitioners who were still pessimistic or, in their own words, 'pragmatic' about their capacity to intervene. Many were weary and disappointed, beleaguered by workplaces slowly drained of funding, and anxious about future restructurings and redundancies; some looked fondly towards their retirement. Most also confirmed Head and Atchison's account of what should be done while, crucially, refusing to implicate themselves.

Therefore, I asked, who was implicated? 'The government,' they agreed, were responsible. 'The government' should be honest. 'The government' should acknowledge Gamba cannot be eradicated. Of course, the practitioners I encountered within government agencies never saw themselves as the appropriate point of address for this advice. For them, I suggest, their duties were maintenance and 'making do,' working to engineer new strategies to make Gamba politically and epistemologically legible in the absence of robust measures and values.

To recall Hinchliffe and Bingham (2008, p. 1541), avoiding a future in which a 'sea of Gamba' washes over northern Australia requires academics and others to engage with practitioners and institutions of environmental governance 'as they make and remake the real.' This is not a simple undertaking, as time spent in Greater Darwin has shown me, though it is a necessary one. As elsewhere (e.g. Dempsey, 2016), policy processes in the NT are responsive to forms of political pressure, sometimes coming from the application of scientific enumerations that have been translated into the received terms of the political. Policymakers are not so much responsive to 'science' as to the anticipated and expressed values of elite publics. Spending time with practitioners revealed how their attention and efforts are conditioned by this set of beliefs – many of them shared – about agency, responsibility and efficacy. Their own experiences and understandings assure them that it is always 'other people,' and not them, who are the primary drivers of the institutional worlds they inhabit.

It would be easy to be critical of the practitioners' apparent fatalism and acceptance of institutional limitations, and in fact several practitioners did exactly this. But rather than allot blame, we should remain attentive to how their responses to these trying contexts, and how they scavenge opportunities to challenge frames and think strategically beyond their immediate crisis. If, on the one hand, the response to Gamba grass has illustrated how a politically 'hot' situation (Callon, 1998) can be kept 'cold' through limiting the state's internal capacity for measurement, it has also demonstrated, on the other, how individuals can antagonise against such limitations. Whether through engagements with scientific or (in my case) social scientific researchers, they try to make threats legible in order to make them political. Maintaining the aura of the capable and coordinated liberal state, they have progressively lost the tools to enumerate their sites of governance, to the point that they struggle to reveal either the limitations of government agencies themselves, or the effects of systemic cultural and economic disinvestment.

Conclusion

Have the many established and compelling critiques of enumeration in STS painted us into a corner? After establishing the social construction of calculation and counting, theorisations of number in STS have continued to remain

suspicious of the laborious and piecemeal work of bringing environments and other worlds 'into account/ing' (Asdal, 2008). Nonetheless, if we read empirical situations of governance through the work of Verran and others, the nature of enumeration becomes more clearly ambivalent. The liveliness of enumerated entities, as theorised by Verran, is not solely in the service of extraction and hegemony. By looking for these entities, and tracing their journeys through social worlds, we can see that their absence also presents a challenge to democratic governance. Measures and values remain crucial to the task of making environmental harms and threats legible to government institutions, publics, and others.

Far from dominating with *naturpolitik* (Latour, 2004), actors within state environmental monitoring and regulation infrastructures are often struggling to 'make do' with the tools available, unable to speak in terms of countable measures and values or, more specifically, the things most valued within their political context. Though, for various structural reasons, practitioners within government do not necessarily see themselves as primarily responsible for ceasing or suspending environmental harms, the undermining of their capacity to monitor environments has far-reaching consequences for how they might at least make the limits and shortfalls of governance discernible. Attention to Greater Darwin, I argue, warns of an emerging *politics of environmental illegibility* now taking shape in extractivist and deregulatory contexts such as Australia, the United States and elsewhere.

Nonetheless, do not mistake this article for an apologetic for calculative rationality. Rather, this is a call for the pragmatic defence of measures and values, or enumerated entities. Mindful of the remaining need to attend to other ways of knowing, it is worth stating the obvious truth that no one (including environmental management practitioners) gets to simply choose to abandon the terms of the political. Enumeration remains the dominant language of governance, even as state-generated environmental data are being removed from public access or simply no longer being generated (see Whitington, 2017). Environmental harms continue to slowly waste away the worlds in which we live, but we – academics, practitioners, publics, activists and others – have fewer tools to make them legible and, thereby, participate in the making and remaking of 'the real.' Critiques of environmental enumeration need to be tempered by empirical insight into what the presence and absence of measures and values makes possible for those within and without the state.

The practitioners I worked with in Greater Darwin often reminded me that it is irresponsible to diagnose problems without offering some paths forward. Therefore, this article offers three possible directions. First, researchers with environmental concerns should work in coalitions with practitioners to meaningfully change how environmental harms are made legible, improvising strategically with what is available to intervene where possible. By engaging in applied research, researchers within social science fields, such as STS, can also contribute

to the explicit conduct of a politics which is normally invisible or implicit.[12] Subsequently, second, the time may be right for the critical social sciences, such as STS, to temper their normative claims regarding the nature of environmental enumeration and legibility. This could begin, thirdly, by seeing 'deregulatory' policies and funding cuts to state environmental agencies as twinned strategies of a politics of environmental illegibility. The retrenchment of enumeration is not our liberation. Rather, it is starving those agencies and others of opportunities to make the progressive degradation of more-than-human worlds legible. Absent the ability to articulate these harms, practitioners triage the hazards around us, deferring an ecological reckoning to unknown others, elsewhere and else-when.

Notes

1. A short note on the data collection and analysis methodologies used for this article. This article is primarily based upon fieldwork conducted between June 2015 and June 2016. This involved several research methods including; the recruitment of 32 individuals engaged in bushfire and weed management in the Greater Darwin area identified through a 'snowball' sampling method, beginning with executive members of the relevant bushfire (Bushfires NT) and weed (Weeds Branch) management agencies. This included federal government researchers (3), park rangers (2), state officers (14) and senior managers (3) from a variety of government agencies, traditional owners (2), university researchers (6), and volunteer fire managers (2). Fieldwork involved one or more face-to-face semi-structured interview with every participant; a one-day workshop on the future of the study area with 12 participants; participant observation and follow-up interviews with 15 participants. Interviews were transcribed and coded according to 'descriptive codes' (topics set by the terms of the study) and 'thematic codes' (topics that arose during fieldwork). All participants have been anonymised here due to their politicised work environment.
2. Throughout this article I use the Australian term of 'bushfire' rather than the North American term 'wildfire.'
3. Glyphosate is amongst is amongst the most widely used herbicides in the world and there remains significant debate about whether it harms human and animal cardiovascular, endocrine, nervous and reproductive systems.
4. During the conservative Giles administration between March 2013 and August 2016, seven of its sixteen members defected or resigned, and the ministry went through thirteen iterations, dogged by accusations of corruption.
5. It is precisely due to the regularity and low intensity of these fires, compared to southern Australia, that their emissions are included under the Kyoto Protocol as part of the nation's annual greenhouse inventory, and that demonstrated emissions abatements from savanna burning are today tradeable as carbon credits.
6. For example, the Minister responsible for the NT's weeds agency resigned in early 2016 when journalists revealed he had a significant financial and personal involvement in a foreign horticultural development. See Anon (2016).
7. Recent examples include the A$130 million port built on Melville Island without environmental assessment and 18 illegally granted major groundwater extraction licences in the Greater Darwin area.
8. Researchers helped bushfire practitioners demonstrate that there was a ninefold increase in the cost to the NT government of fire suppression between 2002–2003

and 2010–2011, and that this cost would continue to grow. See: Setterfield *et al.* (2013) Adding fuel to the fire: the impacts of non-native grass invasion on fire management at a regional scale. *PLoS ONE* 8: e59144.

9. These funds were acquired through the National Heritage Trust, itself funded from the privatisation of the state's telecommunications company Telstra between 1999 and 2006.
10. This dwarfed the park's annual A$180,000 budget to manage fire, feral species *and* weeds, and so, to further its case, the submission laid bare how Gamba's presence eliminated the possibility of generating income from carbon credits within the park.
11. This is the National Bushfire Mitigation Program (2014–2017). The NT government was paid the same annual amount under the Commonwealth's preceding Bushfire Mitigation Program (2008–2014), equivalent to 8% of each programme's total.
12. It would be a trap for any of us, STS scholars included, to pretend that knowing about and intervening in the environments around us is the duty of an effective abstract 'government' when we have good reasons to suspect it does not exist.

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