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CLEANING, PROTECTING, OR ABATING? MAKING INDIGENOUS FIRE MANAGEMENT "WORK" IN NORTHERN AUSTRALIA

Aaron M. Petty[1]*, Vanessa deKoninck[2] and Ben Orlove[3]

Kakadu National Park in northern Australia was one of the first jointly managed parks in the world, and offers an important case study of how public institutions and indigenous communities interact in the management of landscapes. In the 1990s, an extensive fire management program was instituted in Kakadu. The aim of this program was to shift the timing of fires from the late dry season to the early dry season, a pattern that on its surface more closely reflects precontact Aboriginal fire patterns. Despite broad success in this fire regime shift, Kakadu has come under particularly intense criticism from local Aboriginal communities, as well as the conservation sector and the wider public, for failures in fire management. These perceived failures are, however, assumed to be a feature of Kakadu specifically, rather than early season burning generally. Consequently, the model of extensive fire management in the early dry season continues to be a key goal for Aboriginal-owned lands across northern Australia, with early-burning projects that derive funding tied to reduced net carbon emissions now emerging as the most promising potential for reinstating indigenous fire management in northern Australia. We argue, however, that these new emissions-reducing programs run the risk of following the same fraught path of dissatisfaction and disassociation as Kakadu, because it is inherent in the nature of institutionalized management programs to replace the complexity and contingency of indigenous fire management with standardized goals. In so doing, such programs treat indigenous people as workers executing plans developed by others rather than as genuine partners in the design and implementation of management programs.

Keywords: *carbon abatement, environmental policy, joint management, landscape anthropology, social-ecological systems*

Introduction

Fire has been used for millennia by humans to clear fields, improve pasture, ease travel, establish tenure over land, signal during warfare, and accomplish ritual purposes. It has been employed on vast scales by foraging, horticultural, and pastoralist groups to increase productivity and the quantity and quality of food and fiber plants (Blackburn and Anderson 1993; Bliege Bird et al. 2008; Boyd 1999; Eriksen 2007; Lewis 1989; Maxwell 2004; Mistry et al. 2005). Fire alters pathways of vegetation succession, changes nutrient cycling processes, and, over time, can alter the distribution and abundance of species (Bond and Keeley 2005). Fire practice over centuries and millennia has left long-term legacies on landscapes (Bohte and Kershaw 1999; Bowman 1998; Fraser 2010; Lightfoot et al. 2013; Maxwell 2004).

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Following the industrial revolution, the use of landscape fire has declined markedly in developing nation-states as these states have sought to closely control if not contain fire. While control of fire by the state has been largely successful, there remain significant regions of industrialized nations where fire use by small-scale communities is still tolerated by the state, or where communities have been able to exert some degree of autonomy in using traditional forms of fire management (e.g., Coughlan 2014; Miller and Davidson-Hunt 2010; Yibarbuk et al. 2001). However, there is now a strong multi-national push, supported by the Intergovernmental Panel on Climate Change (IPCC), to control fire on a global scale as a means of reducing emissions and minimizing the impact of anthropogenic climate change (IPCC WG3 2014). As this push creates further incentives for states to develop projects to ''fix'' problematic fire in regions where fire management is still practiced at the community level, it is likely that in the future, fire management in these regions will fall under further state control. Through rendering complex and dynamic social-ecological phenomena ''legible'' to centralized institutions, such projects almost invariably diminish the agency of individuals and replace complexity with standardized formulas (Scott 1998:335).

Fire management is a particularly useful field in which to explore this process of making community-level management legible to state actors (Scott 1998:33), and to examine how this process leads to the increasing influence of simplified modes of acting on the landscape. Fire is a technology readily employed, for good or ill, by any individual or community (all one needs are the right conditions and a match), and burning should be understood as an activity performed by individuals but shaped by particular economies, institutions, and historical and environmental legacies (Coughlan and Petty 2012). As state and market forces expand their influence into ever more remote spheres, understanding the history and development of fire management institutions within a region, how people within those institutions perceive fire, and finally how decisions to make fire are employed will be critical to meeting the cultural and livelihood needs of small-scale communities, preserving ecosystem structure and function, and minimizing emissions and climate impacts from large-scale fires.

In this paper we consider the Top End of Australia's Northern Territory, a region where indigenous fire use is still prevalent, but where state and market forces are expanding their influence into the fire management sphere through natural resource management institutions whose stated aims include the promotion of indigenous fire management. We describe how an institutionalized fire management program developed in Kakadu National Park, one of the first jointly managed parks in the world and the first region of the Top End to develop a large-scale fire management program in consultation with local Aboriginal people. Finally, we consider the implications of the Kakadu program's successes and shortcomings for the Western Arnhem Land Fire Abatement Project (WALFA), an ongoing fire management program in the rugged plateau region neighboring Kakadu, which aims to use revenue generated from emissions offsets from fire abatement to fund improved fire management by Aboriginal communities (Russell-Smith et al. 2009a).

Our aims are twofold: 1) to describe how a particular understanding of, and approach to, fire management in Kakadu emerged that interpreted historical

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Aboriginal practices of fire management through institutional structures and the filter of European understandings of fire; and 2) to investigate the parallels between the WALFA fire management program and Kakadu's fire management program, and describe the structural and cultural factors that may lead to some of the same negative outcomes that Kakadu, and especially Kakadu's Aboriginal landowners, have experienced. We argue that the Kakadu case is not a special one. It is illustrative of a much wider pattern of the simplification and diminution of local knowledge and practices that occurs through the process of institutionalization of localized land management by individuals based in national and international centers of power, who draw on national institutions and global science.

Study Area

The Top End of Australia occupies the center part of the tropical savanna zone that spans the northern third of the Australian continent (Figure 1). In contrast to the temperate and densely settled regions of southern Australia, the tropical savanna region is remote and sparsely populated. Fire use in the region has largely been unregulated despite it being one of the most flammable places on Earth (Russell-Smith et al. 2007).

Of the three regions of the savanna zone (Cape York, the Kimberley, and the Top End), the Top End was historically the most isolated and least economically productive, primarily because it was not hospitable for the cattle industry. Elsewhere, the cattle industry facilitated European settlement and both displaced Aboriginal people from their traditional lands and brought in distinctive fire practices centered on increasing cattle productivity (Crowley and Garnett 2000; Shaw 1992; Vigilante et al. 2004).

Perhaps as a result of its economic and physical isolation, the Top End became the site of both Australia's first jointly-managed national parks—Garig Gunak Barlu National Park on the Cobourg Peninsula, declared in 1981, and Kakadu National Park, Australia's largest national park, declared in 1979—and the Arnhem Land Aboriginal Reserve. This reserve was established in the 1930s and later became the Arnhem Land Aboriginal Land Trust, the largest freehold indigenous property in Australia, following passage of the Aboriginal Land Rights Act [Northern Territory] in 1976 (see Figure 1). Together, these estates comprise a reserve of over 120,000 km^2 where Aboriginal people are able to exert a far greater degree of autonomy over their lives than in most other parts of Australia.

The major ecological driver in northern Australia is the southern monsoonal system that carries moist air and rainfall from the north during the austral summer months (November to March) and dry air from the south during the winter (April to October). In the Top End the seasonality of rainfall is particularly extreme, with an average of 1000–1600 mm of rain falling during the wet season and an average rainfall near zero during the dry season, particularly from June to August. This cycle of wet and dry creates a highly flammable environment where around 50% of the landscape burns in a typical dry season (Russell-Smith et al. 2003).

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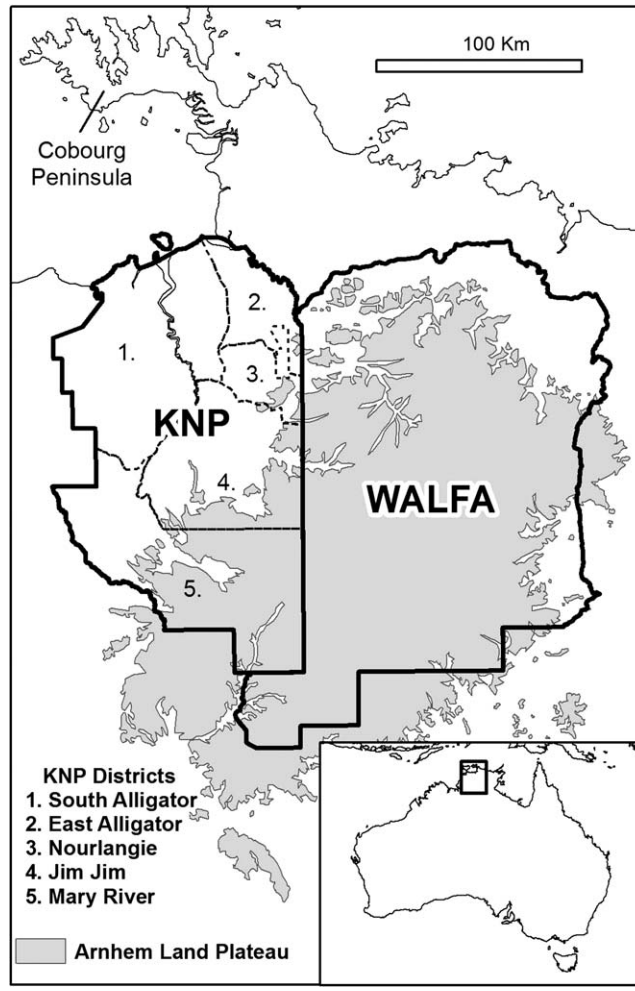


Figure 1. Kakadu National Park and the WALFA management region.

One of the key biogeographic features of the Top End is its system of substantial raised sandstone plateaus. These plateaus are heavily dissected and weathered, and rise up to 200 m above the otherwise flat expanse of the Top End. The ruggedness of the plateaus provides shelter from fire for many endemic species, and the plateau regions are the most biodiverse of the Top End (Woinarski et al. 2006). The largest plateau region, the Arnhem Land Plateau, is approximately 20,000 km² in extent and makes up part of both Kakadu National Park and the WALFA region (Figure 1).

Methods

To aid in our analysis of the process of institutionalization of fire management in northern Australia, we make use of the three conceptual

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Table 1. Distribution of age and gender of Aboriginal people interviewed in 2007.

Age groups	Male	Female
Young (25–39 years)	5	3
Elder (40–54 years)	4	4

domains suggested by Coughlan and Petty (2012) to ask questions that explore the relationship between humans and fire. These domains cover spatial, social, and temporal scales, and range from large to small: 1) the history of social and ecological dynamics over large spatial and time scales (how are landscapes shaped by fire and how do cultural practices develop and change over time?); 2) knowledge and practice (how do people within a landscape perceive fire and how does this understanding of fire inform the practice of landscape fire?); and 3) human agency and decision making (how do patterns of ignition develop as the emergent property of human decisions and actions at the point of ignition?).

We investigate fire management in Kakadu across these three domains, beginning with the ecology of fire in the region and the practice of fire management prior to the establishment of Kakadu. We then look at how Aboriginal people and Kakadu rangers understand the purpose of fire and perceive the state of fire management in Kakadu, and finally describe how fire management is practiced in Kakadu.[1] We then use a similar structure to briefly describe the development and structure of WALFA.

Our data derive from reviews of available literature, reports, and archival material, as well as semi-structured interviews with Kakadu park staff and Aboriginal people. In addition to the formal interviews we describe below, we also draw on the experience of Petty and deKoninck, who have conducted research with Aboriginal people and park rangers in Kakadu and Arnhem Land on a number of land management issues over the past 12 years, as well as research by Orlove, who has visited Kakadu three times between 1999 and 2004 for a total of two weeks.

There were three different types of interviews conducted by Petty from 2003–2007 in Kakadu: 1) interviews with 16 Aboriginal people between January 2003 and September 2004; 2) interviews with four park rangers between January 2003 and September 2004; and 3) interviews with six park rangers and three Aboriginal people between January 2007 and June 2007.

For the 2003 and 2004 interviews with Aboriginal people, Petty interviewed most of the adult individuals who identified themselves as belonging to one of the three cultural groups with claims to the central or southern regions of the park: Murumburr, Ngomburr, and Jawoyn (the northern part of the Park was beyond the scope of this particular study). Nine of the interviewees were male and seven were female and at the time of the interview they ranged in age from 25 to 54. We further split these interviewees into two evenly divided cohorts: 1) ''young'' Aboriginal people (aged 25–39) who grew up most of their lives during the period of land rights recognition and establishment of Kakadu National Park; and 2) ''elder'' Aboriginal people (aged 40–54) who grew up during an era of limited rights and recognition of Aboriginal autonomy (Table 1). Three of the elder Aboriginal women interviewed were among the last of the

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local members of the ''stolen generations''—Aboriginal children forcibly removed from their families and raised in mission boarding schools from 1900–1970 (Read 1999). Two of these three were also the only Aboriginal people interviewed who were employed full time as park rangers. The remaining Aboriginal people had limited local schooling. No Aboriginal people interviewed had any education beyond the secondary level.

The aim of this first set of interviews was to investigate people's understanding of landscapes and landscape change within the park, which typically led to extensive discussion about fire and fire management. Each of the 16 participants was interviewed on their traditional estate at two or three locations in the park that were significant for the participant. The interviews began by constructing a sketched map of the area, highlighting resources and areas that had changed. Often this led to a discussion of plant and animal abundance and management of the area. Participants were asked for their opinions on the nature of change, and what they thought the trend was. We asked, what would the place look like in ten years' time? Other questions were concerned with resource management and park management of the area. These visits were done in conjunction with a vegetation survey that usually took about two days to complete. This afforded sufficient time for discussion outside the formalized context of the interview.

The aim of the second set of interviews, which involved engaging with non-Aboriginal park rangers between 2003 and 2004, was to understand the park fire management program from the point of view of the district head rangers and district fire officers who were in charge of implementing the program. The four rangers we interviewed—two male and two female—were in charge of fire management for two Kakadu districts. The two male rangers were the head district rangers, and the two female rangers were in charge of fire management operations. All had completed trade or tertiary education. For the interviews, fire strategies were recorded on 1:100,000 topographic map sheets, and notes were taken regarding the strategy and implementation of fire management.

The third set of interviews, with six rangers and three Aboriginal people in 2007, was conducted by Petty as part of the development of the Kakadu Arnhem Land Plateau fire management plan (Petty et al. 2007a). These interviews took place with the four park rangers who were interviewed in 2003–2004 and two additional male park rangers (one a head district ranger with trade qualifications, and the other a senior staff member at headquarters charged with implementing the park-wide Kakadu fire program and who holds a tertiary degree). The three Aboriginal people interviewed in 2007 were three of the Aboriginal people interviewed in 2003–2004: an elder man and woman who are considered by the Park as the senior traditional authorities of the Arnhem Land Plateau region, and a young man. The aim of these interviews was to understand how fire management was strategized and to receive feedback on how the fire-management plan should operate. These interviews were extensive and recorded in detail, and they took place over the course of several meetings.

To identify statements and data collected through these interviews, we will cite whether the interviewees were rangers or Aboriginal (and the age cohort if Aboriginal), the gender and the year of the interview (e.g., Aboriginal young

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male, 2003; Aboriginal elder female, 2007; ranger male, 2003). Where multiple interviewees provided the same information, the number of respondents will be indicated (e.g., two ranger males, 2004; two ranger females, 2007).

Fire in the Top End and the Development of the Kakadu Fire Management Program

Fire has been a major driver of Australian biogeography for millions of years. The antiquity of the monsoon and the ancient phylogeny of plant adaptations to fire indicate that vegetation evolved to cope with a late dry-season fire regime, and that fire-sensitive communities persist in moist or sheltered regions where it is difficult for fire to penetrate (Bowman 2002). At the end of the dry season, usually by October, storms begin to form and lightning strikes are common. As lightning is the only non-human ignition source, fire regimes in the absence of humans would have much greater patch sizes (on the order of hundreds or even thousands of km^2), occur exclusively during the late dry season, and be of very high intensity (Russell-Smith and Edwards 2006).

The current extreme seasonal rainfall pattern may be geologically recent, coinciding with the gradual strengthening of the El Niño weather pattern over the past 5000–6000 years (Head 1994), some 40,000 years after humans first arrived in Australia and grazing by megafauna was replaced by anthropogenic fire as the major disturbance regime in tropical savannas (Bond and Keeley 2005; Bowman 1998). This means that the contemporary extreme wet/dry weather pattern coevolved with human fire management, and that the distribution of flora and fauna at contact was a result of the coevolution of biota with Aboriginal fire management (Gammage 2011; Head 1994, 1996).

Several influential papers on traditional fire management in the Top End, particularly Haynes (1985) and Russell-Smith et al. (1997a), have reported that traditional Aboriginal burning was focused early in the dry season, and that late-season fires were avoided as dangerous and destructive. Other investigations of the historical record show fire use occurring throughout the dry season with no apparent bias towards early-season burning (Preece 2002, 2013; Vigilante 2001). Other ethnographic accounts from Arnhem Land have also indicated no particular aversion to burning late in the dry season (Bowman et al. 2004; Lewis 1994; Yibarbuk et al. 2001), although Garde et al. (2009) report from extensive interviews with Aboriginal elders in western Arnhem Land that great care was taken with fire in the late dry season.

Before contact, ignition sources, particularly in the early dry season, were probably concentrated along walking routes and campsites. These walking routes formed an extensive network across the landscape that left a much smaller percentage of area far from any route than is true today, where transport is much more centralized and road dependent (Cooke 2009). Yibarbuk et al. (2001), Russell-Smith (1997a) and Haynes (1985) all describe burning commencing in upland areas with the cessation of the rains and gradually moving towards lowland areas as grass cured. Fires were also lit late in the dry season for large ''fire drives'' that concentrated kangaroo and other game animals and released new herbaceous growth after early wet-season rains (Yibarbuk et al. 2001).

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Frequent fires in well-travelled areas probably created consistent fire breaks that prevented the spread of fires later in the dry season.

It is impossible to ascribe one motive or rationale to Aboriginal fire management. The reasons given for fire management are numerous, ranging from practical landscape management objectives to aesthetic and religious obligations; every individual fire likely achieved several objectives at once. Aboriginal fire was used to improve productivity of floodplain resources (Russell-Smith et al. 1997a), to improve ''green-pick'' and attract wallabies and other game (Bowman et al. 2001a; Lewis 1989), and to create firebreaks to protect fire-sensitive vegetation against fire (Garde et al. 2009; Russell-Smith 1996; Russell-Smith and Stanton 2002). Using fire was also a kinship obligation of individuals to their ancestral lands (Yibarbuk et al. 2001), and formed part of an aesthetic of ''cleaning'' or renewing the land when it became too overgrown and dense (Haynes 1985; Lewis 1994; Rose 1992).

European Settlement

Aboriginal depopulation following European settlement was the biggest change to fire management in the Top End, at least since the recent climate stabilized 4000 years ago. In the region around Kakadu National Park and WALFA, it is estimated that the original Aboriginal population was reduced by 97% between 1800 and 1900 due to premature death, disease, and movement towards mining camps and towns to the west (Cooke 2009; Keen 1980). It is likely that the fire regime shifted towards much larger and intense late-season fires such as those now found in other depopulated areas of northern Australia (Russell-Smith et al. 2003). Some longtime Aboriginal residents of Kakadu recall a clear increase in late-season fires coming from the Arnhem Land Plateau in the early 1960s (Lucas and Russell-Smith 1993:44), possibly reflecting the final abandonment of the Plateau, which remained a refuge from European control until after World War II (Merlan 1998).

From after World War II until the 1970s, the area that later became Kakadu National Park was the focus of two distinct regions of pastoral-related production. Two immense cattle stations operated in the southern region: Gimbat and Goodparla. The northern region became the hub of a diffuse industry dedicated to processing the hides of feral Asian water buffalo that were introduced by European settlers in the 1820s. Soon after the park was established in 1979, domestic cattle were destocked and there was a buffalo eradication program to eliminate the large number of buffalo extant in the park. This program initiated a cascade of ecological changes, including an increase in fuel loads and fire frequency (Petty et al. 2007b), that increased the urgency to develop large-scale fire management in the park.

Although fire use by Aboriginal people declined dramatically after settlement, fire was used by pastoralists and buffalo-hide shooters as a tool to aid in mustering the dispersed herds together (Cole 1988). By reducing fuel loads, it was easier to ride and drive over the land. Some burning was done to entice animals to areas for muster. For example, the Goodparla pastoral lease had a one-in-three-year mustering cycle for areas away from the South Alligator River. By contrast, areas near the South Alligator River probably burnt annually (ranger male, 2003).

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Nonetheless, there is little doubt that large and intense late-season fires were much more common in the absence of small-scale burning by Aboriginal people, particularly burning conducted early in the dry season. The evidence of environmental impacts from Aboriginal depopulation is particularly apparent in the Arnhem Land Plateau region of Kakadu, where a high proportion of obligate seeder species persist—plants that cannot resprout, but must reproduce from seeds and hence are much more susceptible to fire impacts. The native conifer *Callitris intratropica* R.T.Baker & H.G.Sm. is declining (Bowman et al. 2001b; Price and Bowman 1994) and sandstone heath, a community comprised of obligate seeder shrubs, is considered under threat because average fire frequencies are too high to permit continued recruitment (Price et al. 2003; Russell-Smith et al. 2002).

Park Establishment and Governance of Fire Management

Institutional fire management in Kakadu began with the establishment of the park in 1979. Like today, the goal then was ''to re-establish as far as possible the patterns of traditional Aboriginal burning; to reduce the frequency and extent of late dry-season wildfire and to create diversity of habitat'' (Press 1986:174) with a focus on burning from May to July. As occurred elsewhere in northern Australia, Aboriginal fire as a tool for managing the land, particularly protecting against late dry-season fires, was emphasized over other Aboriginal uses of fire (Fache and Moizo, this volume). At the time, the program relied principally on burning by vehicle, augmented by fixed-wing aerial burns (ranger female, 2004; ranger male, 2004). Park establishment changed the character of fire management in Kakadu in two important respects: 1) it established an institutional framework within which fire management was conducted; and 2) it provided equipment, infrastructure, and labor to implement a management plan on a much larger scale than was possible following Aboriginal depopulation.

The strategic goals for Kakadu are determined by a 15-member Board of Management that was established by legislation in 1999. The board comprises Aboriginal Traditional Owners,[2] the director of Parks Australia North, and representatives from the tourism and scientific communities. The goals for fire management set by the Board under the Plan of Management (Parks Australia North 2007) include the active recognition of traditional burning practices, the prevention of large, unplanned late-season fires, close coordination with neighboring regions, and the protection of biodiversity, sites of cultural and historical heritage, and park assets such as buildings, walking tracks, and other infrastructure.

Fire Management and Legislation

As a national park situated in the Northern Territory, Kakadu is subject to numerous legislative requirements that, in principle, restrict the flexibility of land managers to make decisions related to fire management. Chief among these are the Northern Territory Bushfires Act and Australia's Environment Protection and Biodiversity Conservation (EPBC) Act 1999 (Commonwealth).

Under the Bushfires Act it is the responsibility of individual landholders to manage fire on their land, provide for the maintenance of natural ecosystems, and ensure the protection of life and property. The Act formally recognizes that traditional burning is still practiced on Aboriginal land, including Kakadu,

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although it provides no legal framework for dealing with traditional burning, leaving it in a legal limbo (Preece 2007).

Perhaps the biggest significance of the Bushfires Act to Kakadu is in relation to fires crossing the park boundary, as the Act places legal responsibility on landholders to ensure that their fires do not spread into adjacent lands. Boundary protection, both from fires outside the Park and to prevent fires from escaping the Park, is the highest landscape management priority in Kakadu, and a significant amount of Kakadu's fire management effort goes into trying to prevent fires from coming in from neighboring areas and particularly to preventing fires originating in Kakadu from going out.

The EPBC Act was enacted by the Commonwealth Government of Australia in 1999 as legislation to create a framework for the protection of ''matters of environmental significance.'' These ''matters''—which include nationally and internationally important species, habitats, and places—include several that are directly relevant to Kakadu: World Heritage and National Heritage areas, threatened species and ecological communities, migratory species, and wetlands of international importance. The EPBC Act rarely comes into play in practice, but does leave Kakadu liable for damage arising from fires to threatened and endangered species and communities, and to items of cultural heritage. For example, the Arnhem Land Plateau region contains the highest endemic biodiversity (Woinarski et al. 2006) and the largest collection of indigenous art sites (Jones 1985) in Kakadu. Recurring fires in the area have prompted intense criticism of fire management within the Park (Parr et al. 2009) and a reevaluation of Park fire management practices. One outcome of this has been the development of a fire management plan for the Plateau as a whole as well as a framework for improved monitoring of fire and fire effects on vegetation (Petty et al. 2007a). Additionally, concerns over protecting this sensitive area by developing a more strategic regional management program were a significant component in the development of the WALFA program (Russell-Smith, personal communication).

Development of Management Plans with Aboriginal People

The development of fire management plans for Kakadu in conjunction with Aboriginal people occurred over three distinct phases. Each phase has led to the diminution of Aboriginal involvement in fire management from expertise to labor. The first phase was in the early 1980s, soon after the establishment of the park, when there was close consultation between senior Aboriginal men and Park staff about burning on country. These early consultations are deemed authoritative by senior Park staff who cite them when strategizing current fire plans. Many of the paradigms for current park management, particularly early burning to ''break up country'' and prevent the spread of fires later in the year, and burning along creeks as fire breaks, were communicated by these senior Aboriginal figures (ranger male, 2004, 2007).

The second phase began in the late 1980s and lasted throughout the 1990s, and resulted in the gradual isolation of Aboriginal people from involvement in day-to-day fire management activities. This followed from two developments: 1) those rangers charged with managing districts or managing the fire program for districts became more knowledgeable and confident about fire management; and 2) most of

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the senior Aboriginal men who at the time were considered by non-Aboriginal park rangers to be the authoritative sources of traditional knowledge about fire management died during the 1980s and 1990s—the last of these senior men died in 2001. The park's burning program was run almost exclusively by the senior park rangers with very little input from Aboriginal people during this time.

Since 2000 there has been a growing involvement of Aboriginal people in the day-to-day burning program (2 ranger females, 2004, 2007; ranger male, 2007). However, rather than seeking input from Aboriginal people on park fire management practice, much of this has involved the transfer of knowledge from senior Park staff to Aboriginal people about technical operations (e.g., accompanying staff in helicopter rides, learning how to operate the incendiary devices, and so on). Aboriginal input is sought for some matters including hazard reduction for the protection of culturally important sites and vegetation communities, and Aboriginal people attend formalized pre- and post-fire-season meetings (2 ranger females, 2004, 2007; 2 ranger males, 2004, 2007). Further, some Aboriginal people have been specifically charged with responsibility for managing particular floodplain areas. However, in general, Aboriginal involvement in the decision-making processes of fire management in the Park is seen to be lacking, and most park rangers involved in fire management see their task as educating Aboriginal people about the fire management program and, where possible, employing Aboriginal people in fire management operations (ranger male, 2007).

In 2006, Kakadu staff involved Aboriginal people in a program to place firebreaks by walking along some valleys of the Arnhem Land Plateau. This program expanded greatly in 2007. Although the program was far smaller than the aerial program, walking is believed to be cost-effective relative to helicopter burning. The main constraints on adopting this approach more widely are the difficulty in finding participants willing to work within the schedule of a normal working week, as favored by rangers, and enough time to complete walking trips (ranger female, 2007; ranger male, 2007).

Fire Management in Practice

Day-to-day fire management is largely controlled by administrative districts (Figure 1) that have considerable authority in how they implement the fire program. Across districts, fire is employed more as a hazard reduction tool than as an ecosystem management tool per se. Priority for hazard reduction burns descends from asset protection as first priority, followed by border protection, protection of monsoon forest and other fire sensitive vegetation as well as sites of cultural significance, and finally broad-scale breaks, particularly along creek lines, against late dry-season fires (all rangers interviewed, 2004, 2007).

Despite the autonomy afforded to districts, the pattern of fire management is quite consistent between districts (all rangers interviewed, 2004, 2007): 1) burn hills and upland areas first as they dry out the earliest in the dry season; 2) burn the boundaries to prevent outside fires from coming in to the park; 3) burn along upland creek valleys and along roads to create small, patchy burns that limit spread in these areas; and 4) progressively burn wetter areas as they dry out.

Firebreaks are also established along areas that are regarded as Aboriginal hunting areas (2 ranger females, 2003, 2004; ranger male, 2007). These are areas

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that are visited regularly by Aboriginal people, particularly in the late dry season when access is easier. They are often burned early by helicopter, and fire breaks are usually put in place between these areas and any regions containing sensitive vegetation. The stated aim of these breaks is to protect the park from late-season fires started by Aboriginal people visiting these regions.

Areas that rangers know will be burned by Aboriginal people early in the dry season, particularly those areas near outstations and those that are easily accessed in the dry season by vehicle are often not burned by rangers but delegated to the Aboriginal communities. These are discussed with Aboriginal people before the start of the fire season (ranger male, 2007). Rangers from at least one district burn bush tracks and some floodplain regions by helicopter to improve Aboriginal access to remote areas, and to break up the landscape in these areas in anticipation of Aboriginal fires (ranger female, 2004).

The implementation of the fire program is limited by helicopter access, which during the dry season rotates between districts so that each district goes on a helicopter run about once per week. As pilots are generally hesitant to work beyond regular working hours by continuing to fly late into the afternoon, there is strong motivation to use the helicopter as much as possible in the morning and midday (ranger female, 2007). This is seen by many Aboriginal people to be the worst time of day to burn because this gives fires more time to spread over a large area before being extinguished by evening dew (Russell-Smith et al. 1997a; Aboriginal, 2004).

Success or Failure? Perceptions of Fire Management in Kakadu

Ranger and Public Perceptions of Park Burning

Since its inception in the early 1990s, the helicopter burning program in Kakadu has been effective in shifting fire regimes from predominately large late-season fires towards earlier, smaller, and more heterogeneous fire regimes (Russell-Smith et al. 1997b). Price et al. (2005) show an increase in the heterogeneity (the number of unburned patches adjacent to burned patches) between 1980 and 2000, concomitant with the implementation of helicopter burning. However, there has been little change in fire frequency, which has remained consistent around 40–50% of the total area burned per year (Russell-Smith et al. 2003). A comparison with fire frequencies in neighboring Arnhem Land, where prior to the start of WALFA there was very little fire management in remote regions far from communities (Bowman et al. 2004), shows a stark difference in seasonality with a much greater proportion of fires in Kakadu occurring in the early dry season (Petty and Bowman 2007).

However, for all of its success in changing the seasonality and intensity of fires, the benefits of the Kakadu management program in terms of biodiversity impact, a key mandate of park management, remain equivocal. Fires early in the dry season may reduce plant flowering and fruiting success (Setterfield and Williams 1996) and the growth of dominant savanna eucalypts (Prior et al. 2004). Frequency also seems to have more impact than seasonality on the survival of most fauna (Andersen et al. 2005). Long-term monitoring plots in Kakadu have shown an overall reduction in fire frequency, yet little change in vegetation that

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can be attributed to fire (apart from significant stands of fire sensitive *Callitris* and *Allosyncarpia* vegetation that have declined due to fire) and a marked decline in mammal species (Russell-Smith et al. 2009b).

Concern over environmental management in the park has been coupled to a popular perception that there is too much fire management. This concern has found expression across many venues, particularly within the popular press, and has been well articulated on a prominent conservation blog:

> Another gob-smacking vista you'll get when travelling through Kakadu any time from April to December is that it's either been burnt, actively burning or targeted for burning. They burn the shit out of the place every year. No wonder the native mammals are having such a hard time (Bradshaw 2010).

However, critics of Kakadu's fire management program have not been able to articulate a plausible alternative fire management model for the park (Murphy et al. 2012).

Aboriginal Perceptions of Park Burning

Aboriginal people are also quite skeptical of the Park's burning program. Most Aboriginal people reported feeling disengaged from the process of burning, although they also had numerous criticisms related to specific undesirable ecological consequences.

The feeling of disengagement arose in part from reduced access to remote areas due to depopulation and forced removal from ancestral lands. All Aboriginal people interviewed in 2003 and 2004 expressed difficulty in accessing areas due to limited access to vehicles and poorly cleared roads. Some also stated frustration about their own lack of knowledge about some highly significant areas, particularly on the Arnhem Land Plateau. Many expressed concern that some places of high significance had not been burned by Aboriginal people for over ten years because they had not been able to get to them. One woman regretted the loss of feral buffalo from the park as she believed that grazing helped to do the job that Aboriginal people once did in keeping the landscape ''even,'' which was seen as a positive attribute: ''Buffalo keep the place even. [Now] some areas are too thick, others are too clear—trees are getting burnt'' (Aboriginal young female, 2004).

Many Aboriginal people, including some who have worked for the Park, also expressed a feeling of disengagement due to the scale and level of technology employed by the park (two Aboriginal elder females, 2003, 2004; three Aboriginal elder males, 2003, 2004; Aboriginal young male, 2004, 2007). The process of burning by helicopter was compared by Aboriginal people to ''buying chicken at the grocery store instead of hunting'' (Aboriginal young male, 2007), a quite significant statement in that it highlights the importance of fire as creating a personal relationship to the land, akin in significance to hunting and acquiring one's own food (Rose 1992). One man from southern Kakadu stated his dismay at the lack of control due to the imposition of a new technology:

> Parks mob is now burning the grass, not the Traditional Owners. Because in the Park, they've got the technology. The technology, it overrides our

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> way of doing things. Of course this is true, it's there you can see it. All of our information has to come through technology now: at the press of a button (Aboriginal elder male, 2004).

As with the public at large, there was near consensus among Aboriginal people that too much of the Park was being burned, and much of that incorrectly.[3] For instance, one woman would regularly burn around a special river location as soon as it could carry a fire to protect the riparian forest from park-started helicopter fires (Aboriginal young female, 2004). Three respondents from different clan groups (Aboriginal elder male, 2003; two Aboriginal elder females, 2004) complained about helicopter-started fires burning through riparian forests, a concern that is corroborated by scientific evidence that riparian areas make only marginal fire breaks (Price et al. 2007). Some Aboriginal people also explained subtle differences between burning along riparian forest by foot and by helicopter. Burning early was desirable, but fires should burn along the edge of the forest and outward (Aboriginal elder female, 2003). Most concurred with the Park practice of burning early, but felt that Park staff burned too often when it was dry and windy or at inappropriate times (two Aboriginal elder males, 2003; two Aboriginal elder females, 2004; Aboriginal young female, 2004; Aboriginal elder female, 2007).

A common sentiment among those Aboriginal people interviewed in 2003 and 2004, who reported that there was too much burning in the Park, was that Park fire management was conducted in an excessively routine manner and had insufficient regard for local plant conditions. Fire was thought to be too broad-scale and too removed from the fire itself, so that it was impossible to see the effects of fire on flora and fauna. These people felt that the Park should move away from helicopter burning and focus more on ground-based burning to facilitate Aboriginal access to remote areas.

Several Aboriginal people felt that park staff burning too frequently had caused specific detrimental ecological outcomes. One woman reported concern about fires impacting on flowering of native trees, particularly *Eucalyptus miniata* A.Cunn. ex Schauer and *Eucalyptus tetrodonta* F.Muell., which are important sources of nectar in the early dry season, and the impact this was having on native mammals:

> This place is not being managed properly with fire—there are fewer green plum [*Buchanania obovata* Engl.] than before and sugar gliders [*Petaurus breviceps* Waterhouse] are disappearing…Parks mob burn when the wind is blowing, when it's dry. Anrebel [*E. tetrodonta*] and andjalen [*E. miniata*] are suffering and can't make flowers, so fewer flying fox [*Pterapus alecto* Temminck]…They're burning all the flowers so there are fewer sugar gliders and bats (Aboriginal elder female, 2004).

Several people expressed concern over the decline of wattle trees (*Acacia* spp.), which also flower in the dry season, in the southern half of Kakadu (Mary River district):

> There used to be thick wattles in Mary River country, but now it is gone because of fires (Aboriginal young male, 2004).
> The tree that makes soap and can kill fish [*Acacia auriculiformis* A.Cunn. ex Benth. and other species] is reduced—they're burning so often that it's

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> now mainly spear grass [*Sorghum* spp.] and fewer acacias. There are fewer trees along the Sleisbeck Road [Mary River district] because of fire (Aboriginal elder male, 2003).

Too much fire in the southern half of Kakadu was also blamed for the decline of emus (*Dromaius novaehollandiae* Latham, a large flightless bird):

> Sleisbeck had emus—plenty of emu, but not now. About two years ago we saw two emus there when we were flying around by chopper. Maybe too many fires (Aboriginal elder male, 2003).

The Difficulty of Managing Fire in Kakadu

The difficult situation Kakadu finds itself in arises from the successful implementation of their fire management program. By using available resources and technology, the Park has been able to shift the seasonal timing of fire on a vast scale toward fires that are designed to reduce fuel loads and protect against hotter and more widespread late dry-season fires. Now, because park rangers are in charge of the park fire management program, they are responsible for the proliferation of widespread fires, while at the same time remaining responsible for not adequately ''controlling'' fire. Because very few people will entertain the idea of returning to a system of no fire management, which would in effect be a return to late dry-season fires, park rangers do not see an alternative to the current system even though the result of the program, apart from shifting the seasonality of fires, has been mixed.

Given that one of the explicit aims of the Kakadu fire management program is to reestablish the patterns of traditional Aboriginal burning, it is perhaps surprising that Aboriginal people express as much if not more concern about the park fire management program than the general public. Much of this is likely due to a feeling of disempowerment and marginalization by Aboriginal people; although there is a great deal of communication with Aboriginal people about fire management, there are fewer opportunities for input and participation in decision making and implementation. Indeed, several aspects of the fire management program are seen as nonnegotiable by park rangers, particularly putting fire breaks along the border and burning as much as possible before the end of July (which is mandated by the Northern Territory Bushfires Council as the cut-off date for fire breaks to be in place). From the park ranger point of view, the best way to implement these nonnegotiable aspects of fire management is through broad-scale burning by helicopter (a sentiment reported consistently by all rangers in 2003, 2004, and 2007).

Indigenous Fire Management in the Future—Can We Learn from Past Mistakes?

There has been increasing recognition of the need to engage with and promote Aboriginal community-based fire management across the Top End. Kakadu was an early and significant attempt and has long been seen as a positive development for meeting the aspirations of conservation, community development, and the recognition of Aboriginal heritage and culture (Press and

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Lawrence 1995). Despite arguably falling short of its ideals, Kakadu's implementation of landscape-scale fire management akin to precontact Aboriginal burning regimes has important implications for similar efforts in Arnhem Land and other Aboriginal freehold lands. These locations have become attractive as places where it is possible to engage with Aboriginal people in a seemingly more collaborative fashion, and to build environmental management programs potentially free from the constraints faced by Kakadu—especially legal obligations to protect boundaries and assets from fire.

The WALFA project is the first project outside of Kakadu to begin implementing large-scale fire management with substantive input from indigenous people (Cooke 2009 provides an excellent summary of its origins). It has become the model for other indigenous abatement projects that seek to facilitate fire management in Aboriginal communities using funding from emissions reduction agreements with private partners as well as government schemes such as the Australian Carbon Farming initiative. The WALFA project has been led by several individuals who have been closely involved with Kakadu fire management, making it well placed to learn from the shortcomings of Kakadu's fire management program from its inception. The project is highly collaborative, and there has been extensive discussion and collaboration with Aboriginal residents and particularly senior landowners to understand the geography and sociology of fire (Garde et al. 2009). There is also a strong emphasis on employment and facilitating Aboriginal people walking the land to burn (Cooke 2009).

The funding for WALFA comes from an arrangement with ConocoPhilips, which has paid an estimated forward price for carbon emissions that will be produced over the course of the development of several major gas projects in northern Australia. The agreement is that WALFA will reduce carbon and other greenhouse gas emissions by burning early in the dry season and through fuel reduction with early dry-season burns, and prevent more emissions-intensive late dry-season burns (Williams et al. 2004).

It is to be hoped that projects such as WALFA will facilitate a new era in Aboriginal fire management where Aboriginal values and aims for fire management are developed and run with strong input from Aboriginal communities. However, it remains to be seen how the aspirations of such grassroots fire management will articulate with the institutional goals and structures of programs such as WALFA, which must remain responsive to the requirements and constraints of national greenhouse gas emissions frameworks and corporate agreements for their funding base. Indeed, in terms of close consultation with senior Aboriginal leaders, coupled with an institutional mandate for early dry-season burning, WALFA is not significantly different from Kakadu during its first phase of fire management, when senior leaders were also widely consulted and respected for their expertise. It was only later, as that living knowledge became depersonalized and reinterpreted in an institutional context, that it was iterated back to a later generation of Aboriginal people as an essentialized and operationalized mechanism that favored one particular type of Aboriginal burning (e.g., ''the reinstatement of Aboriginal traditional approaches to savanna fire management—in particular a strategic, early dry-season burning

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program'' [Russell-Smith et al. 2013:55]). And worryingly, as Fache and Moizo (this volume) report for the Central Arnhem Land Fire Abatement (CALFA) program, a new program modeled on WALFA, there is already conflict between the indigenous ranger groups who see it as their job to burn as much of the land in the early dry season as possible to reduce greenhouse gas emissions, and the indigenous non-rangers, particularly elder Aboriginal people, who are worried by what they see as unsophisticated application of early-season burning by rangers coupled with increased use of broad-scale helicopter burning in their region.

The central question that remains is whether Aboriginal people in programs such as WALFA will be able to maintain control and some degree of autonomy over fire management programs and on-ground implementation, or if it is inevitable that outcomes and practices will ultimately be driven by the goals and aims of more powerful institutions that, even in cases such as WALFA, exert strong influence over burning programs through the structure and logic of legislative and funding regimes.

Discussion and Conclusion

European settlement of north Australia disrupted the social-ecological system that coevolved between Aboriginal people and biota over tens of thousands of years through the intentional management of the landscape by Aboriginal people. Attempts to emulate the precontact social-ecological system in Kakadu National Park have involved techno-bureaucratic solutions. The expediency of such solutions is clear, since Aboriginal settlement patterns and lifestyles have changed, and there is less walking than there used to be, and less incentive to walk great distances for subsistence and to interact with the landscape when travel by road is so much easier.

The most efficient tactic yet found is to burn as much as possible early in the dry season by helicopter. To do any less increases the risk of catastrophic late dry-season fires which may make Kakadu liable for fire-related damages outside the park, particularly to neighbors to the west, as well as damage to valuable biological and cultural assets. In terms of these aims, the Kakadu fire management program is a success, yet the results of the program in terms of protection of biodiversity, and public and Aboriginal perception, are mixed at best.

The WALFA project and other Aboriginal community-based projects hope to improve on the Kakadu model. However, despite the different history and land tenure that these projects enjoy, they still operate within techno-bureaucratic frameworks for natural resource management, which are themselves an integral part of the post-contact social-ecological system of the Top End. Critically, they are subject to the same constraints in funding and legislation that over time brought Kakadu toward the implementation of large-scale helicopter burning as an efficient way of putting in fire breaks across a vast landscape. Moreover, the funding model for the WALFA project creates an incentive to focus on following a complex emissions-accounting methodology (Russell-Smith et al. 2013) above all other concerns (Fache and Moizo, this volume). Rather than empowering Aboriginal people to look after their land, tying funding to accomplish these

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projects to shifting ''emissions accounting'' regimes ties the practice of burning very tightly to the accounting of burning. This forces a close registering and recording of burning, whose metrics are then tied to an external scheme, and represents a dramatic shift in the character of Aboriginal fire management, which is rooted in place-based knowledge, dynamic decision making, and attention to unique seasonal changes in vegetation. The Kakadu experience illustrates how, in institutional fire management, the logistics and costs of burning shape decisions about the practice of burning. The implication for WALFA and similar projects, then, is that the mandate to reduce emissions will have a similar effect on their burning programs, privileging particular types of burning over others simply by virtue of their costs and expediencies.

More subtly, the findings of Fache and Moizo (this volume) indicate that the act of becoming a ranger, particularly an indigenous ranger, invests a person with the power and the obligation to act on behalf of the aims of the institution. In CALFA, the indigenous rangers are not acting much differently from the non-indigenous rangers of Kakadu. In both places, the rangers are carrying out systematic fire management in the early dry season at the behest of the institutions they represent. Likewise, there is a striking similarity between the non-rangers' concerns about fire in both places—there is too much fire applied too carelessly and the resources employed are disempowering local knowledge and aspirations.

The constraints of cost, logistics, and power are inherent in any mandate-driven system, as no one mandate can reflect the full range and complexity of Aboriginal motives for fire management, which include increasing productivity and protection of resources, obligations to look after ancestral lands, and a deep and abiding aesthetic to ''clean'' the landscape through fire (Rose 1992). Indeed, it could be argued that preserving carbon on the landscape is antithetical to a clean landscape. Also, significantly, Aboriginal fire management rested on dispersed populations that travelled by foot throughout the landscape, and burned opportunistically rather than on pre-established plans. Nonetheless, the scientific and technocratic discourse of Aboriginal fire management strongly privileges one particular aspect of Aboriginal fire management: early dry-season burning to protect against late dry-season burning.

The discourse of protecting/abating renders Aboriginal fire management intelligible to land managers, scientists, and others who, usually unknowingly, advance the technocratic/bureaucratic solutions into the margins of state control (Pellizzoni 2011; Scott 1998). As there is growing interest in the potential of tropical savannas to store carbon (Parr and Andersen 2006), this is likely to continue. While such projects may achieve their aims in abating emissions, the Kakadu example shows that they may not achieve desirable social or ecological outcomes for the communities involved. Indeed, such projects almost inevitably result in the reduction of local knowledge and practice and their replacement with simplified solutions that are rarely fully successful (Scott 1998:335). To move toward a more holistic and inclusive program of Aboriginal fire management will require funding that is not tied to narrowly-focused aims, legislation that permits a wide range of types of fires rather than privileging one early-season fire regime over all others, and continuous engagement with Aboriginal people as experts in both the planning and execution of fire management.

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Notes

[1] As a jointly managed park, Kakadu employs several local Aboriginal people as park rangers, so there is not a neat dichotomy between ''rangers'' and ''Aboriginal people,'' although the vast majority of park rangers are of European descent. We have found from research conducted in Kakadu as well as research (not reported here) from Garig Gunak Barlu National Park that Aboriginal rangers express a tangible sense that they are living in ''two worlds''—between their working life and their personal life—and feel compelled to behave differently when acting in each role. In this paper, two of the Aboriginal people we interviewed were park rangers. These two were clearly representing themselves as members of the Aboriginal community, and their responses were similar to those of other Aboriginal people. However, we indicate where we report individual responses for Aboriginal rangers, and discuss where Aboriginal ranger responses or experiences differ from Aboriginal non-rangers.

[2] ''Traditional Owners'' is a term used throughout Australia to refer to Aboriginal people either with formal land rights to an area or the recognized authority to speak for an area.

[3] Twelve of the 16 Aboriginal people interviewed in 2003 and 2004 reported that the park was burning too much. These numbers were distributed evenly across the young/elder and male/female categories. In follow-up interviews in 2007, all three Aboriginal people interviewed reported that the Park was not doing a good job in managing fire.

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