Economic, social and ecological contexts of hunting, sharing and fire in the Western Desert of Australia.

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CHAPTER NINE

Economic, Social, and Ecological Contexts of Hunting, Sharing, and Fire in the Western Desert of Australia

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Introduction

In the remote desert regions of Australia, Aboriginal foragers continue to practice some of their traditional lifeways and livelihoods. Their practices include economic pursuits focused on hunting and gathering wild resources, activities that are intertwined with the maintenance of social relations and ritual obligations. Among Martu, Aboriginal inhabitants of the Great and Little Sandy Deserts and traditional owners of one of the largest native title regions in Australia, one of the most important foraging activities is also one that carries important social and environmental benefits: women’s sand monitor lizard (Varanus gouldii) hunting. Sand monitor hunting not only provides a reliable source of food, it brings people closer together in tight cooperative and sharing networks.

Women light fires while hunting sand monitors in the wintertime, and these have cascading trophic consequences in this fire-adapted landscape. Anthropogenic burning creates small-scale fire mosaics (patches of ground burned at different times) that buffer against lightning-caused wildfires and support a wide range of species. In this chapter, we expand on other economic explanations of why Martu continue to forage well into the twenty-first century (Codding et al., chapter 9, this volume) by showing how women’s burning practices are central to the continued productivity of hunting and gathering. Martu modify their environment with fire in order to create the network of economic, ecological, and social interactions that supports their foraging way of life.
ETHNOHISTORICAL BACKGROUND

In the arid center of Australia, human hunting and human fire may have been part of the landscape for the last thirty-six thousand years or more (M. A. Smith 2013; Smith et al. 2008). At contact, small to medium-sized mammals, lizards, and snakes, along with seed grasses, acacia beans, geophytes, and bush fruits, underwrote daily subsistence, with larger prey (hill kangaroo, *Macropus robustus*; plains kangaroo, *M. rufus*; and emu, *Dromiceius novaehollandiae*) providing an occasional feast (Cane 1987; Gould 1969, 1991; Kayberry 1939; Meggitt 1965; O’Connell et al. 1983). Throughout the desert, people used broadcast fires (fires intended to expose at least 1 ha of ground) in the cool dry season to clear areas of mature spinifex (*Triodia* spp.) in sand-plain and dune country and facilitate their search for burrowed prey, especially sand monitors and other lizards and snakes, but also small mammals such as bilby (*Macrotis lagotis*), mulgara (*Dasycercus cristicauda*), burrowing bettong (*Bettongia lesueur*), and rufous hare-wallaby (*Lgorchestes hirsutus*; Gould 1971; Jones 1969; Kimber 1983;
Latz and Green 1995). Smaller spot fires were used for flushing prey during hunts for larger monitors (*V. giganteus* and *V. panoptes*), brushtail possums (*Trichosurus vulpecula*), and feral cats (*Felis catus*).

Until about the mid-1960s, Martu moved across an extensive landscape, concentrating their hunting and burning around sources of water and moving on along established tracks to new camps when hunting returns declined. According to the reports of early explorers, precontact landscape-level fire mosaics were localized around heavily used campsites near springs, wells, and rockholes; such a pattern was so evident that European explorers linked the appearance of fire mosaics to the proximity of water (Gammage 2011).

In 1906, after Alfred Canning established the stock route linking Wiluna in the south with Halls Creek in the north and with the subsequent construction of the No. 1 Rabbit Proof Fence, Aboriginal depopulation of the western and central desert began, proceeding along with the spread of pastoralism around the desert’s margin from the south and east to the north and west. The Aboriginal exodus in the mid-twentieth century was driven both by the pull of resources available at settlements and by the push of an increasingly arid climate, made more difficult to endure by population loss. Several years of low and erratic rainfall had caused water sources to dry up, and without a large population present to maintain them, they gradually were disappearing under vegetation or filling with silt. Fire mosaics were breaking down, as fewer bands moved across the landscape burning and hunting. Invasive species were spreading into the arid interior: cats specializing in mice and small mammals, rabbits around clay pans and salt lakes, foxes in the southern regions, and, most recently, feral dromedaries. Atomic testing in the south left many poisoned and ill, contributing to increased social isolation. By 1960, fewer than two hundred mobile foragers were probably left in the northern half of the western desert, some of whom were first contacted during government patrols during the establishment of the Blue Streak missile testing range (Davenport et al. 2005; Peterson and Long 1986; Scelza and Bliege Bird 2008). By the mid-1970s, nearly all desert nomads had moved to centralized settlements such as Jigalong (Davenport et al. 2005), and although they continued forays into the desert margins, great expanses of the interior were entirely abandoned (see Codding et al., chapter 9, this volume, for additional ethnographic details).

In the mid-1980s, Martu returned to their homelands after a twenty-year exile in the missions and settlements on the desert fringe and took up permanent residence at the site of a uranium lease at Parnngurr Rockhole that was
owned by an Australian subsidiary of the international mining company Rio Tinto. This group of about sixty people included several families from the Kartuwarra, Manyjiljarra, and Warmman linguistic groups, who felt their claim to the area was quite strong. Unlike other parts of Australia, the Great and Little Sandy Deserts had been spared ecological degradation resulting from pastoralism, agriculture, and development; in their absence, the desert had been silent, the only visitors mining exploration teams intent on gold and uranium. Even so, Martu returned to an ecosystem far different from the one they had left, one in which most of their important subsistence resources, both plant and animal, had vanished. Paradoxically, the Martu hiatus from their homeland coincided with the local extinction of twenty-one species of native marsupial and the decline of forty-three more (Burbidge et al. 1988; Burrows et al. 2006; Finlayson 1961). Gone were several small marsupials that had been common prey—the rufous hare-wallaby (*Mala*), brushtail possum (*Wayuta*), burrowing bettong (*Jamparn*), and golden bandicoot (*Minkajurru*, *Isodon auratus*)—and in their place were feral housecats, camels, donkeys, and foxes. These new landscapes were dominated by extensive lightning fires that burned ten to one hundred times larger than the fires the Martu were used to (Burrows et al. 2006).

Martu coped with the extensive scale of these new landscapes by using vehicles to reduce the cost of travel, adapting to the new realities of settlement life by increasing their mobility across vast distances. As Martu continued to hunt and burn around camps, they reestablished fire mosaics (albeit in more restricted areas near vehicle tracks) and complaints about resource scarcity diminished.

To explain why Martu continue to forage today, we first need to understand their relationship with fire. The productivity of hunting and gathering is dependent upon Martu being able to use fire across the landscape in ways consistent with those of their long history. Unlike nearly all hunter-gatherer populations in other regions of the world, Martu in remote desert communities face no conflicts of interest with neighbors about burning; the region contains no pastoralism, no agriculture, no non-Aboriginal settlements, no developed infrastructure aside from their own communities, and very few tourists. Martu employ fire not to construct landscapes but as a hunting tool used in particular ecological contexts for particular kinds of animal prey.
Contemporary foraging among Martu is an important component of a hybrid economy (Altman 2010) that includes some wage labor, arts and crafts production, and social security payments. On any given day, 23 percent of community members are out foraging (Scelza et al. 2014). Contemporary foraging practices are shaped primarily by the search for five staple animal prey: hill kangaroos (*kirti-kirti*, 24.7 percent of total production by whole weight), bustards (*kipara, Ardeotis australis*, 24.1 percent), sand monitors (*parnajarpa*, 19.1 percent), large varanids (*maruntu* and *yalapara*, 2.7 percent), and feral house cats (1.5 percent; see Bird et al. 2009; Bliege Bird and Bird 2008; Bliege Bird et al. 2008; Codding et al. 2011; Veth and Walsh 1988).

Including all foraged foods, the average Martu forager acquires 2,842 ± 8,138 (s) kcal per foraging day. By far, the majority of daily calories come from sand-plain hunting, which targets mainly sand monitors. This primarily female activity provides an average of 73.2 percent of the daily foraging income, with a standard deviation across 368 camp days of 35 percent. Mean per capita harvest sizes per hunting day average 1,298 ± 1,251 kcal per person. Sand monitor is a staple resource primarily because harvests are reliable: out of 368 camp days, sand monitors were hunted on 166. There were only eight days when no hunter acquired any sand monitor, an additional twenty-one days when per capita returns were lower than 400 kcal per person per day, and thirty-two days when returns were greater than 2,000 kcal per person per day. But although sand monitor hunting is consistent, the chance of a very large harvest is low: daily returns exceeded 4,000 kcal per person only on two hunting days.

Contrasting with sand monitor hunting is kangaroo hunting, which is primarily a male activity. Men hunted kangaroos on seventy-two camp days, providing 2,127 ± 6,622 kcal per person per hunting day. On fifty-eight of those days, no one acquired any kangaroos, and on ten days the per capita return was greater than 4,000 kcal per person per day. But although sand monitor hunting is consistent, the chance of a very large harvest is low: daily returns exceeded 4,000 kcal per person only on two hunting days.

Sand monitor hunting is economically important both because it is reliable on a daily basis and because harvest sizes are predictable: the longer a forager hunts, the larger the harvest, which means harvests can be adjusted to need on a daily basis (Bliege Bird and Bird 2008; Codding et al. 2010). Variance discounting models show that sand monitor return rates have a higher utility than kangaroo returns for a forager who values meat primarily for its consumption benefits (as opposed to the benefits of sharing, storing, or sociopolitical gain;
Jones et al. 2013). Within the context of a hybrid economy, which includes reliance on purchased goods, sand monitor hunting responds to economic scarcity: more women hunt more often when money is short (Scelza et al. 2014). Hunting monitor lizards is also an important way for women, especially postmenopausal women, to invest in their grandchildren and other dependents (Bliege Bird and Bird 2008; Scelza 2009; Scelza and Bliege Bird 2008).

In order to achieve such high and consistent returns, foragers need to locate suitable hunting habitat. Burrowing prey are primarily found in long unburned spinifex grasslands on sand plains, dunes, and pockets of sand in upland areas. Foraging efficiency in the hunt for burrowing prey is constrained by den visibility, so foragers either target spinifex in the early stages of recovery following fire (early successional habitat) or set a broadcast fire in long unburned patches. Sand monitors enter a period of near dormancy during the cool dry season (May to September), remaining mostly underground and living off stored fat; most hunting fires are set at that time. Summer-season hunts when varanids are mobile target early successional habitats with good track visibility, to avoid the need to dig the animals out. Hunters (more often women) work alone or in small cooperative groups, probing areas around burrows with long, narrow digging sticks to search for the resting chambers, which lie 10–20 cm below the ground.

Hunters set broadcast fires primarily in the winter season because they significantly increase sand monitor foraging returns. In the winter, when pursuits involve mainly den spotting, foragers gain 348 kcal per hour of search and pursuit within late-successional patches of regrowth and 1,613 kcal per hour if they burn those patches (table 9.1). In the summer, when foragers pursue lizards by tracking, access to ground burned earlier in the season is critical: returns drop with more plant cover as tracks become more difficult to see. Although foragers do some burning when lizards are active, summer burns tend to be more difficult to control at the beginning of the season, when fuels are dry; more difficult to spread at the end of the season, when fuels are wet; and costlier to hunt in, as new fires drive lizards into their deep summer dens, which require extensive digging at high energetic cost. However, summer burns can be a fallback strategy if foragers are unable to find decent patches of early successional vegetation to hunt in. They can also return to a summer burn a few days later, when lizards have emerged from their dens to hunt again on the surface. The number of fires lit in regions where people are hunting cannot be predicted simply from where people travel on the landscape, nor by whether or not they are foraging in
Hunting, Sharing, and Fire in the Western Desert of Australia

These consistent and high returns from sand monitor hunting are dependent not just on the immediate use of fire, but on the history of fire and how it—along with other Martu subsistence activities—has shaped the structure of environmental variation.

The main fuel burned in desert sand-plain fires is highly flammable hummock grasses (mainly *Triodia schinzii* and *T. basedowii*) that dominate the sand-plain and sand-dune regions of the arid interior of Australia, covering 86 percent of the total land area. Spinifex hummock grass coexists with a dispersed overstory of shrubs and trees, mainly acacias (*A. pachycarpa*, *A. ligu-lata*, and *Cassia* spp.), with mulga (*A. aneura*) woodlands on lateritic uplands and clay-dominated soils (2.4 percent) and *Eucalyptus* (mainly *E. victrix* and *E. microthea*) in watercourse margins and floodplains (3.2 percent). Spinifex is slow growing but an excellent competitor, and it slowly crowds out most other species by about seven to ten years after a fire, depending upon rainfall (Burrows and Christensen 1990).

As burned ground recovers from fires, different plants and animals recolonize and grow at different rates. Martu classify these colonization and growth

<table>
<thead>
<tr>
<th>Type of Pursuit</th>
<th>Successional Stage</th>
<th>Mean LS kcal/h</th>
<th>SE</th>
<th>N</th>
<th>Lower 95% CI</th>
<th>Upper 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracking in Summer</td>
<td>Early</td>
<td>1,950</td>
<td>412</td>
<td>14</td>
<td>1,084</td>
<td>2,816</td>
</tr>
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<td></td>
<td>Mid</td>
<td>369</td>
<td>491</td>
<td>9</td>
<td>−636</td>
<td>1,374</td>
</tr>
<tr>
<td></td>
<td>Late</td>
<td>96</td>
<td>602</td>
<td>5</td>
<td>−1,111</td>
<td>1,304</td>
</tr>
<tr>
<td>Den Spotting in Winter</td>
<td>Early</td>
<td>343</td>
<td>513</td>
<td>8</td>
<td>−694</td>
<td>1,381</td>
</tr>
<tr>
<td></td>
<td>Mid</td>
<td>725</td>
<td>367</td>
<td>41</td>
<td>−101</td>
<td>1,552</td>
</tr>
<tr>
<td></td>
<td>Late</td>
<td>348</td>
<td>380</td>
<td>32</td>
<td>−488</td>
<td>1,185</td>
</tr>
<tr>
<td></td>
<td>Burn late</td>
<td>1,613</td>
<td>332</td>
<td>61</td>
<td>829</td>
<td>2,398</td>
</tr>
</tbody>
</table>

**Table 9.1. Least-squares mean and return rates by habitat type and season.**

*Note:* LS means derived from LS regression mixed model (forager random effect): *n* = 170 patches, model *r*² = .325, Pursuit Type (successional stage) effect test, F-ratio = 7.31, *p* < .0001. Return rates calculated as kcal/h in search and pursuit within each patch type.

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phases into five successional stages defined by their utility to humans and other animals. *Nyurnma* is a freshly burned area. *Waru-waru* is an early successional stage characterized by the presence of *yukuri*, or green shoots of new and diverse growth, which provides high-quality food for browsing and grazing animals. *Nyukura* is a mid-successional stage reached at approximately one to three years following rain, characterized by high densities of edible seed grasses, flowering shrubs, acacia seedlings, fruit, and other edible plants that are high-quality foods for graminivores and frugivores. *Nyukura* gradually fades into the late successional stage of *manguu*, or mature spinifex, as the slowly growing spinifex begins to crowd out edible plants, about five to seven years following the first rain. *Manguu* is important for animals that depend on woody shrubs and trees for nectar and seeds as well as shelter from predators. As the spinifex ages to *kunarka*, it begins to die in the center. Generally, only *manguu* and *kunarka* contain enough fuel to feed a broadcast fire.

Patches in different stages of regeneration following fire are associated with different community compositions (Latz and Green 1995; Pianka and Goodyear 2012). Plants like *Solanum diversiflorum* and other bush tomatoes, along with seed grasses like woolybutt (*Eragrostis eriopoda*) are most abundant in early and early to mid-successional stages (one to four years after fire), whereas late successional (ten or more years) shrubs and trees and spinifex grass increase in density over time (Parker et al. n.d.).

Animals, too, show differential fire responses: some animals move away after a fire, whereas others move in. Bustards come to freshly burned ground to feed and also enjoy the *Solanum* fruits so abundant in mid-successional patches. Termite specialists such as *Ctenophorus nuchalis*, the netted dragon, a 50–100 g slow-moving lizard, are more prevalent in recent burns, while *Ctenophorus isolepis*, which requires mature spinifex for refuge and thermoregulation, is more abundant in long unburned areas (Letnic et al. 2004; Masters 1996; Pianka and Goodyear 2012). Large insects may also show differential fire responses: scorpions may be larger and more abundant in mid-successional patches (Smith and Morton 1990), and large beetles may be disadvantaged by fire (Blanche et al. 2001). Thus, many different patches at different postfire stages (a fire mosaic) together make up a good indicator of both animal and plant species diversity at the landscape scale.

Sand monitor hunting is dependent upon an anthropogenic fire mosaic, which is created primarily through several years’ worth of hunting fires. Hunters use spot fires to pursue feral cats, bustards, and large monitors, but broadcast
fires set for hunting sand monitors have huge ecological effects across the landscape. In two Martu communities, Parnngurr and Punmu, anywhere from 60 to 240 individuals hunt. Hunters set a broadcast fire once every three to four days on average, producing about 360 hunting fires per year of about 100 ha in size across an area of nearly 500,000 ha (Bliege Bird et al. 2012a).

The hunting fires that people light are very different from lightning fires, which dominate this seasonally dry and climatically variable landscape. A comparison of landscapes marked by Martu hunting fires and those marked by lightning fires reveals that hunting fires are smaller and closer together: Martu hunting fires average 969 ± 723 m apart, whereas nearest neighbor distances in the lightning regime average 8.93 ± 11.41 km (Bliege Bird et al. 2012a). Seasonally, both mean and median hunting fire sizes are significantly smaller than lightning fires (table 9.2).

Hunting fires are smaller for a number of reasons. First, Martu light fires mostly under conditions when fire size can be more easily controlled—where downwind firebreaks are nearby, when winds are more consistent throughout the day, and when temperatures are lower. Under conditions unfavorable to control of fire, hunting fires tend to be larger. Lightning fires are large because they tend to start mainly when temperatures are high and winds are unpredictable. The size of lightning fires is limited mainly by the amount and contiguity of fuels, as measured by antecedent cumulative rainfall, which does not predict the size of Martu hunting fires (Bliege Bird et al. 2012a). When the grass is thick, Martu simply light a larger number of smaller fires because thick grass

<table>
<thead>
<tr>
<th></th>
<th>Median Size (ha)</th>
<th>Mean Size (ha)</th>
<th>Distance between Fires (m)</th>
<th>Number of Fires</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WET SEASON</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lightning</td>
<td>46.9</td>
<td>1,910 ± 325</td>
<td>5,400 ± 3,594</td>
<td>647</td>
</tr>
<tr>
<td>Martu</td>
<td>4.1</td>
<td>326 ± 83</td>
<td>1,248 ± 874</td>
<td>1,342</td>
</tr>
<tr>
<td><strong>DRY SEASON</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lightning</td>
<td>16.9</td>
<td>6,255 ± 3,099</td>
<td>12,832 ± 15,589</td>
<td>163</td>
</tr>
<tr>
<td>Martu</td>
<td>3.3</td>
<td>109 ± 41</td>
<td>661 ± 335</td>
<td>2,514</td>
</tr>
</tbody>
</table>
reduces lizard-hunting search efficiency. Because burned vegetation requires several years to regrow thickly enough to fuel a fire again, the small, patchy fires set throughout the landscape by Martu hunters have the incidental effect of creating firebreaks that prevent the spread of large lightning fires during seasons when they threaten.

Martu fires are also smaller because people light fires within social contexts as well as ecological and climatic ones. While the incentive to burn is supplied by the immediate boost to foraging returns, many of the disincentives to burn are socially imposed. Despite the fact that among Martu burning is an important signal of ownership and a demonstration of one's rights to manage Country, burning without foraging is considered wasteful and costly: it destroys resources others might want to collect and exposes animal dens to predators such as dingoes, who also take advantage of fire clearings to hunt. Being able to control a fire is important because the rights to burn Country for hunting are held collectively, but individual hunters are responsible for fires that burn areas to which they do not hold such rights. A hunter whose fire shifts with the wind and threatens a sacred site in an area where his or her burning rights are deemed less than legitimate is subject to severe punitive procedures governed by the collective body of owners, which today involve ritualized physical punishment and monetary compensation to owners.

A Martu fire regime produces a landscape significantly different from one that is burned primarily by lightning ignitions. In 1953, when several Martu bands still lived nomadically in the region, aerial photography taken near Kurta Kurta Soak revealed a tight vegetation mosaic created from 135 small fires that had burned that year or the year prior in an area of 119,236 ha. In this region, an area of sand dunes to the south of Karlamilyi River and to the west of Kurta Kurta Soak, fire size averaged $52.7 \pm 118$ (33–73, 95 percent CI) ha, with a median size of 15.9 ha. Only 14 percent of all fires were above 100 ha in size, and only 1 percent were above 1,000 ha. Today, the Kurta Kurta region is dominated by lightning fires and is not under a Martu fire regime. Between 2000 and 2009 the region had only 137 fires in total, averaging $798 \pm 3,568$ (604–992, 95 percent CI) ha, with a median size of 11 ha. Twenty-four percent of all fires were above 100 ha in size, and 9 percent were above 1,000 ha. The coefficient of variation in fire size doubled from 225 to 446.

The fire regime has shifted from one of small, consistent fires to one of quite variable fire size, with a mean skewed by extremely large fires (>3000 ha in size) that occur every few years. Similar patterns have been observed in other regions.
of the desert following Aboriginal population loss (Burrows et al. 2006). However, other regions visible in the 1953 aerial photography show no significant differences in mean fire size or number of fires per year compared to the present day. The Yulpul region (figure 9.2) has been intensively hunted ever since Martu returned to Parnngurr in 1984, and mean fire size in that region today is not significantly different. Between 1952 and 1953, there were 227 fires averaging 40.1 ± 218 (12–69, 95 percent CI) ha, with a median of 6.3 ha; 7.5 percent of all fires were above 100 ha (in a region covering 138,493 ha). Between 2000 and 2009, Yulpul saw 1,279 fires averaging 88 ± 706 (25–151, 95 percent CI) ha, with a median of 3.2 ha and 6.7 percent of all fires above 100 ha. While the coefficient of variation in mean fire size has increased, from 543 to 798, it has not increased to the same extent seen in the Kurta Kurta region.

Anthropogenic fires not only restructure the distribution of successional mosaics and attendant vegetation, but also the distribution of animals. Transect surveys show that sand monitor density is increased in regions with greater environmental heterogeneity. The higher the density of habitat edges—contrasts between new burns, regrowing vegetation, and old growth—the higher the density of sand monitors (Bliege Bird et al. 2013). Because Martu hunting fires increase the density of such contrasts, the mean percentage of plots with lizards present in unburned hummock grassland increases with human use. That is, lizards are more abundant in landscapes where they are more intensively hunted. This increase in abundance, in turn, increases Martu hunting returns. Mean returns of sand monitors are 1.6 times higher in more heavily hunted regions than they are in regions that are rarely visited by Martu hunters, and success rates are six times higher. An increase in patch diversity from one to two successional stages encountered per hour more than doubles foraging returns, from 541 ± 827 to 1,256 ± 675 kcal per hour (Bliege Bird et al. 2013).

The increase in lizard density with human use of landscapes is likely a function both of improvements to habitat through burning, which reduce the movement costs of foraging and predation and increase the availability of high-ranked prey, and of the effects of human predation on species that eat lizards. Monitor lizards in smaller-scale fire mosaics may be able to switch more easily to preying upon alternative high-ranked species in neighboring patches, thus increasing their overall return rates within the habitat. Increases in sand monitor density under higher human hunting pressure may be caused by interference-related competition (or direct predation) between humans and other predators of sand monitors, particularly the larger monitor lizards, which are actively hunted by
Figure 9.2. Recent fires (white) in a subset of the Yulpul region: in 1954, when Martu were nomadic foragers; in 1973, when all Martu had left the region seven years previously; and in 2000, when Martu had been hunting and burning since their return in 1985. Remote sensing analysis performed by Rebecca Bliege Bird.
Martu. *V. giganteus*, the perentie, is the largest varanid in Australia and reaches 2 m in length and 17 kg or more in weight (Pianka 1995).

Martu hunting fires also shape population distributions of other desert species that benefit from access to a more diverse set of successional stages at smaller spatial scales. Hill kangaroos (*Macropus robustus*) are more likely to be found in early successional patches characterized by newly emerging green shoots and in mid-successional patches, where they are able to target fruiting and herbaceous browse (Codding et al. 2014). Hill kangaroo scat density is linked significantly to successional-stage heterogeneity: scat counts increase both with remotely sensed measures of successional richness and with on-the-ground observations of successional edge density.

Characteristics of many of the animal species that disappeared or are in decline suggest that they, too, may have been advantaged by Martu fire mosaics. Hare-wallabies are browsers that rely on plants in many different successional stages and require mature spinifex hummocks for nesting and predator protection. Prior to the 1960s, they were abundant and widespread throughout the spinifex sand plains and were hunted frequently. The continued persistence of the population has been argued to be dependent on continued patch mosaic burning for access to early successional habitat adjacent to mature spinifex (Lundie-Jenkins 1993; Lundie-Jenkins et al. 1993a; Lundie-Jenkins et al. 1993b). The brushtail possum, which formerly was one of the most abundant small mammal prey for human hunters, seems to have been able to persist in more marginal desert regions only where its habitat, riparian eucalyptus woodlands, has been protected from extensive fire through Aboriginal patch mosaic burning (Kerle et al. 1992). In addition, access to a variety of successional stages appears to be important for possums, as they seem to prefer the same high-ranked early successional *Solanum* fruits that people do (Pickett et al. 2005).

**THE SOCIAL CONTEXT SUSTAINING HUNTING**

The landscape-level effects of fire sustain Martu social interactions via food sharing. Fire shapes a more productive anthropogenic landscape, but embedded in this productivity is a tradeoff: the more one acquires, the more one must give away. A sand monitor hunting bout is followed by sharing with another non-cooperating individuals 77 percent of the time (69/90 acquisitions; see Bliege Bird et al. 2012b for details of the sharing database). Hunters share whenever harvest size is over about 500 g; the average size of an unshared harvest is 401
± 186 g, and a shared one averages 1,309 ± 764 g. Sharing proceeds with each hunter distributing her harvest (after having divided it with her cooperation partner, if any) to all those sitting around the same hearth at the ngurra (camp or hearth), not just those who were unsuccessful, but those who were successful as well (Bliege Bird et al. 2012b). Women exchange lizards with other hunters, as if reluctant to consume their own, not in the form of immediate dyadic exchanges, in which two individuals pass each other lizards simultaneously, but in the form of sequential one-way distributions from each hunter to each member of the ngurra. Women must place their trust in the other members of the ngurra, that if they give up their own lizards, others will do so as well (a trust that is usually, but not always, rewarded, especially for better hunters, as we will describe). This form of reciprocity is not dyadic: a woman may receive from someone she did not even give to, and the goal is not to repay the hunter for her gift, but to ensure a roughly even distribution of meat among all consumers.

Shares of meat are distributed in ways that defuse the “power of the gift” (Mauss 1954). This power is muted in several ways typical of “immediate return economies” (Woodburn 1982) that disassociate the hunter with ownership of the food he or she has acquired, create egalitarian distributions of economic goods, promote tolerance of free riding, encourage cooperation, and discourage contingency in the sharing of food. First, any prey regardless of species that is larger than about 1–2 kg (including feral cats, perenties, and other small animals that can reach this size) is routinely given to another individual to cook and distribute. Second, with the temptation to benefit one’s self removed by lack of control over distribution, hunters receive no more than anyone else in the distribution of prey they have acquired (Bird and Bliege Bird 2010; Bliege Bird et al. 2012b). Those who acquire more than everyone else do not predictably benefit from their overproduction; in fact, better hunters share a larger proportion of their harvest and do so routinely (Bliege Bird et al. 2012b). Even for prey smaller than 1 kg, which is usually distributed by the hunter, the amount shared is a strongly linear function of the amount acquired: 89 percent of the variability in amount shared is predicted by amount acquired ($p < .0001$, $n = 153$ individuals). The proportion of a harvest given away increases with harvest size as well (figure 9.3). The successful small-game hunter does eat more but not at the expense of everyone else; a very successful hunter increases not only her own consumption portions, but those of everyone else at the ngurra equally (Bird and Bliege Bird 2010). Third, the power of the gift is also muted by sharing the opportunity to give. We have previously shown that better hunters
Figure 9.3. Panel A: The proportion of a sand monitor hunter’s harvest (whole weight) given to other dinner-camp members (with whom one did not cooperate). The best-fit line is estimated by a generalized linear model with a binomial logit link function, $\beta = .001$, $\chi^2 = 9.61$, $p = .0019$. The cluster of points at 0 and 1 represent harvests in which nothing was shared (most 500 g or less) and all was shared, respectively. While few harvests in this sample ($n = 153$ individuals in sand monitor hunting camps) were larger than 3 kg, proportions shared likely reach an asymptote at around 80–90 percent above that harvest size. Panel B: Sharing following cooperative sand monitor hunts ($n = 168$ cooperative, 126 solitary hunts) reveals that those who share more generously, that is, have a higher mean % given per day, $y = .06 + .22x$, $r^2 = .252$, $p = .0171$, $r = .50$, $p = .0019$. The cluster of points at 0 and 1 represent harvests in which nothing was shared (most 500 g or less) and all was shared, respectively. While few harvests in this sample ($n = 168$ cooperative, 126 solitary hunts) were larger than 3 kg, proportions shared likely reach an asymptote at around 80–90 percent above that harvest size.
cooperate more than expected (Bliege Bird et al. 2012b). They cooperate and split the resulting harvest evenly among group members, even though disparities in hunter ability or effort mean that better hunters tend to end up subsidizing the poorer ones, who contribute less to the common pot. But the better hunter has given the poorer hunter the opportunity to give, in effect sharing social capital and defusing the tensions that arise from being the “tall poppy.”

The costs sustained by the better hunters who eat little, share most, and cooperate extensively with poor hunters are compensated by the social benefits they receive. Martu say that the benefit of producing is the happiness created through sharing and kinship ties with people who are not necessarily closely related (pukurrpa). Although we cannot measure pukurrpa, we can measure the social networks of interaction—relationships of trust and cooperation that build family ties—that are created through sharing. Those who are more generous on average have higher centrality scores in the cooperative hunting network, meaning they cooperate more with more others who are also cooperative (see figure 9.2; see also Bliege Bird and Power 2015). More generous sharers are thus able to create a social network of strong ties between connected individuals. One may thus pay a cost to cooperate with a poor hunter, but one cooperates with a poor hunter who is also a more generous hunter, willing to share her poor harvest evenly with her partner. The benefit better hunters gain from looking after others in this way is a position on the hierarchy of virtue, rather than material accumulation (Bliege Bird et al. 2012b). Better hunters, mirtilya, signal their disinterest in pecuniary gain in order to convince others that they really do have the best interests of everyone at heart.

For Martu, the goal of mirtilya is generosity, and the benefits of generosity (pukurrpa) come indirectly from being at the center of a wide, cohesive social network. In sharing widely and generously, one supports an extensive family from which one might draw a variety of indirect benefits, including help in child rearing, protection from intergroup aggression, and improved health and well-being. Trust is also crucial in garnering support for meting out ritualized punishments, retaliating against sorcery, defending rights to land, and gaining access to higher levels of ritual knowledge. Where “generosity is the main measure of a man’s goodness” (Hiatt 1982:14), building and maintaining a reputation for virtue generates trust in many different dimensions of social life. Foragers share a greater percentage of their harvest the larger it is, feeding and holding those who cannot or will not forage for themselves. This is how Martu gain a measure of social prestige and become respected as those strong in the
Law: by disengaging with property (Tonkinson 1988) and fostering egalitarian material relationships in the “holding” of Country and family—by living the Dreaming (Bird and Bliege Bird 2010).

Conclusions: Why Martu Still Hunt and Gather

As Codding and colleagues (chapter 9, this volume) describe, the social, ecological, and metaphysical landscapes exist simultaneously for Martu, inextricably intertwined in a complex web of interaction. Sand monitor hunting is integral to the maintenance of Martu social networks and ultimately sustains both kinship and cooperation and structures gender relations. Martu today rely on hunting and gathering because it is economically efficient (Codding et al., chapter 9, this volume) and because hunting supplies both social and ritual benefits through sharing and the holding of Country and family. However, hunting and gathering is possible only within an environment where small animals flourish, which requires the intervention of human fire. Fire makes women’s hunting highly productive, increasing both predictability and return rates in the hunting of small animals, which gives women some measure of economic autonomy and enhances their importance in the subsistence economy. The foraging benefits supplied by fire-maintained habitats are invested into social relationships via food sharing. Fire sustains the generosity of the mirtilya, supports the kinship that emerges from generosity, and fosters stronger social ties between individuals, generating trust and facilitating cooperation. Anthropogenic fire links the realms of the economic, the social, the ritual, and the ecological.

The act of setting a broadcast fire not only binds family together, it also resonates with ecological implications. Martu serve as trophic regulators, both in their hunting of smaller predators, which prevents overexploitation of many prey species, and in their fire-mediated disturbance of plant communities. Their fires have widespread effects on the ecosystem, creating small-scale habitats that prevent the spread of very large fires and buffer small ground-dwelling mammals from both the effects of climate-driven fire and the heavy predation that ensues when animals are exposed in burnt areas. Martu burning creates more and smaller patches of unburned habitat that reduce the distance small animals must travel between food and shelter. In areas where traditional owners have returned to their homelands and actively hunt, burn, and share food, there is evidence of increased availability and diversity of habitat niches that favor endemic species, a reduction in climate-related variability in fire size and
predation risk, and an increase in density of critical plant and animal species that support both people and many other animals. Productive foraging and the egalitarian social relationships that underpin a foraging economy require that Martu continue to hunt and gather, burn and share, as they have for generations. That Martu are able to continue to maintain at least a part-time foraging economy today is due to some extent to their ability to burn: fire makes hunting and gathering sustainable in the western Australian desert.