Spinifex, sand and fire; Inaugural aerial patch burning in the Gibson Desert Nature Reserve, Western Australia

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Alex Robinson and I parked the Toyota Landcruiser on the Gunbarrel Highway in a vast sea of spinifex some 600 km north east of Wiluna. We were positioned at the southern end of flightline 1 of the first ever attempt at aerial patch burning of the seemingly endless spinifex plains of the Gibson Desert Nature Reserve (GDNR). Bruce Ward and Karen Maisey were parked some 25 km to our north-east on the other end of flightline 1. They were ready with a Very pistol to mark the northern boundary of GDNR burn 1.

Navigator Gerry van Didden came up on the vehicle's VHF radio, "South marker this is Number 1 aircraft, are you in position for flightline 1?" In a somewhat excited voice I responded, "Affirmative Number 1 aircraft, we are in position". Gerry had us spotted, so we didn't need to set off a flare from the Very pistol. Within minutes we caught a glint of Islander VH-ISA away to our south, approaching at about 100 knots and some 250 ft above the unsuspecting spinifex and mulga.

Pilot Sue Folkes skillfully guided the aircraft overhead on a bearing of 016^{o}. The Islander roared past then shrank away from us, swallowed by the endless plain. We strained our eyes for glimpses of thin wafts of smoke, the first tell-tail signs that the capsules dropped from the aircraft had actually ignited the spinifex. The first capsules should be on the ground by now – it's almost 45 seconds since the aircraft passed overhead and started its mission of dropping its fiery mixture of permanganate and glycol that would ignite the flammable spinifex. At least that was the plan. One minute later, and still no sign of smoke – what's gone wrong? Perhaps the fuel is too patchy to burn with point ignition after all? Perhaps all of the capsules landed on the bare red sand which makes up around 65% of the area? Was incendiary ignition using aircraft a failure in these fuel types? Had all the painstaking research that got us to this point been a waste of time?

Then Gerry called me on the radio and announced that they would have to abort this run and try again. He didn't elaborate over the airways, and I didn't enquire – I suspected it was probably a mildly embarrassing oversight on board the aircraft - perhaps a malfunction with the incendiary machine – perhaps they forgot to turn the glycol on or they didn't pack the capsules? Steve Dutton, the IMO, later revealed that in fact he had forgotten to turn on the glycol.

For a second time the Islander roared overhead, this time, it seemed, with more purpose. Again, standing on the back of the Toyota, we strained our eyes– desperately hoping to see a line of smoke plumes drifting up in the wake of the aeroplane. Thirty seconds passed, then forty seconds, forty five seconds - nothing. Then, "There's one", someone shouted. There's another, and another". With great relief, and a great sense of achievement, we stood on the back of the Toyota and flightline 1 of GDNR burn 1 materialised before us as a string of wispy black columns of smoke rising lazily above the spinifex plain.

For the first time in about 40 years, tongues of fire licked the sand and buckshot plains of the Gibson Desert Nature Reserve. Flames are not new to these ecosystems, but the way they were created was certainly new. For thousands of years, Aboriginal people dragged firesticks around with them, setting fire to the spinifex for a myriad of reasons. Spinifex is almost the perfect bushfire fuel – if only it was continuous rather than patchy, it would be perfectly flammable. Unlike the African savannas, the Australian hummock grasslands are designed to be eaten by fire and termites, not great herds of herbivores.

This, the first ever aircraft burn in the hummock grasslands was to meet prescription and exceed our expectations. The aim of prescribed burning in these vast landscapes is to return the landscape to a small-grain patchwork of a variety of fire-induced successional states, or fuel ages. The intention was that this would reduce the impact of large intense wildfires that ravaged these lands since the cessation of traditional Aboriginal burning and provide habitat diversity at fine rather than coarse scales. Altered fire regimes, together with predation by introduced predators, was thought to be the cause of the recent and alarming demise of medium size mammals in the Australian arid zone.

The aerial burning operation was the culmination of almost 30 experimental fires lit in the GDNR during 1987, just 13 months before this the first aircraft burn. From these experimental fires, we developed a Mk I fire behaviour guide. Using this guide, and after studying the seasonal wind patterns from historical meteorological data from Wiluna and Giles, we prepared a prescription for aero-burning such that we would achieve a mosaic of burnt and unburnt patches. We were relying on variation in the diurnal winds to regulate the size of the burnt patches – the historical data showed that in September, there was a good (66%) chance of wind speeds during the day being sufficient to sustain moderate fire spread, but dropping to below the threshold for spread by late afternoon such that the fires self-extinguished. For this first burn, everything went according to plan – I guess luck plays its role, despite the science.

We conducted four more aerial patch-burning operations in the subsequent days, varying the ignition pattern to vary the resulting burn mosaic. Not all were as successful as we had planned; the main problem being sub-threshold wind speeds (<15 kph) which meant few of the ignitions developed into sustained fires. Even though the spinifex was about forty years old, fuel cover and load were low as the spinifex had begun to senesce - the clumps had developed the classic large diameter hollow donut or crescent shape typical of long unburnt spinifex. While these fuels would readily burn under more severe weather conditions, they were reluctant to burn under low wind conditions in September. Obtaining reliable wind speed forecasts for remote areas is problematic, so prescribed burning can be hit and miss in terms of weather (wind) conditions.

Each prescription was designed to provide a different configuration of burnt patches ranging from long narrow strips to larger burnt patches up to 2,000 ha. For a given set of fuel conditions, lighting pattern, wind speed, wind speed duration (wind run), variation in wind direction, temperature and relative humidity are the key variables in determining the final burnt mosaic and patch configuration. For example, one of the prescriptions was as follows:

Burn objective:

- Burnt patches < 2,000 ha.
- Maximal perimeter-to-area (habitat boundary) ratio i.e., burnt-unburnt boundary, or edge. Burnt patches to have high length-to-width ratio, with many narrow tongues to increase habitat boundary.
- Within burnt patches, 5-10% of the area to comprise unburnt pockets.
- 20%-50% of the burn unit to be burnt.

Lighting pattern:

- Lines 300 m apart, incendiaries 100 m apart. Thirty flight lines, each 16 km long. Flight lines aligned with prevailing wind direction. Ignition time 1300 hrs.

Weather:

Temperature 28^{o}-32^{o}; relative humidity 15%-25%, wind speed @ 2m above ground 15-25 kph; wind duration at this speed (burning time) 3 hours, then winds to decrease <15 kph.

In the GDNR, there are no reserve boundary tracks or breaks and very few other tracks from which to work. Fire control and fire size is determined by natural fire breaks such as rocky ranges, playas and other low fuel areas, and by the prevailing weather conditions. In these environments, and for achieving a burn mosaic, an understanding of fire behaviour, especially thresholds for spread – when fires will run and when they will self extinguish, is more important than being able to predict actual rate of spread.

Burning in the desert, it is necessary to understand fuel conditions (cover, load, moisture content) and importantly, seasonal and diurnal wind patterns. In the Gibson Desert, prevailing winds and natural barriers to spread replace tracks, firebreaks, heavy duties, gangs, spotters and all of the other paraphernalia normally associated with prescribed burning in south-west forests.

Over the 8 days that the aircraft operated in the GDNR, we successfully patch-burnt a total of 75,000 ha, of which about 20% actually burnt. The total cost was 15 cents per ha. An analysis of aerial photography and satellite imagery will ultimately reveal just how successful we were. I am confident that we have developed a relatively inexpensive technique for broad-area patch-burning in spinifex fuels in remote areas. In its simplest form, aero-patch burning over large areas should be able to be done with just a pilot, a navigator, an IMO and a ground support crew of 2 people.