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HOPPING INTO A BRIGHT FUTURE - THE WOYLIE SANDALWOOD STORY

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AT the time of European settlement the woylie or brush-tailed bettong was extremely common and occurred in large numbers across the southern third of the continent. Indeed, accounts from the 1880s reported woylies "swarming" over large areas of the landscape.

Tragically, in just 100 years the woylie had declined to the point that it existed in only three small remnant patches of woodland in the south-west of Western Australia and was on the brink of extinction. The good news is that recent conservation efforts by the Department of Conservation and Land Management has seen a remarkable come back of the woylie, so much so that in 1996 the woylie was reclassified to non-threatened. Since the recovery of the woylie, it has become possible to study their ecology in some detail and it has been shown that woylies are important ecosystem 'engineers'. For example, the woylie can create in excess of 100 small diggings per night as they forage for underground fungi, or truffles, and a variety of bulbs. These diggings have a positive impact on the soil by allowing rainwater to infiltrate the normally water repellent soil. Woylie diggings also affect soil properties such as bulk density and the behaviour of soil nutrients.

Woylies have another very important role in the ecosystem, which has been largely over looked until recently. They are very efficient seed dispersers. For the past 30 years anecdotal evidence suggested that woylies disperse and cache seeds from a variety of plants including *Gastrolobium* species, quandong (*Santalum acuminatum*) and Western Australian sandalwood (*S. spicatum*); however, this behaviour was not examined in any detail until recently. In a study carried out in Dryandra Woodland it was shown for the first time how important woylies are to the ecology of sandalwood regeneration through dispersing and caching their seeds.

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Sandalwood has been harvested for many years in both Western Australia and South Australia and is a profitable industry yielding export earnings of approximately 11 million dollars annually. The heartwood and roots contain the valuable, strongly aromatic oil-containing santalols, which are used in the manufacture of sandalwood scented products. Sandalwood is a root hemi-parasite and commonly grows with nitrogen fixing plants such as *Acacia* or *Allocasuarina.* The tree has pendulous fruit, with red-brown leathery exocarp encasing a large seed; it is the nature of this seed that hints at the intriguing relationship that has evolved between sandalwood and the woylie.

In recent years, natural regeneration of sandalwood has been poor. Habitat fragmentation, its parasitic nature, grazing and poor seed dispersal have all been implicated in these poor rates of recruitment; however, this is not the case in habitats in which woylies are still present. The woylie sandalwood story began in a sandalwood stand just outside the main block of Dryandra Woodland where it was noted that many new sandalwood recruits were springing up across the road from the main plantation. This fascinating development sparked the interest of sandalwood managers and so, in collaboration with scientists from the Forest Products Commission, the investigation into how the recruits got there began.

Throughout this sandalwood site there was extensive regeneration of all age classes of sandalwood, and the young plants are spreading up hill away from the parent trees. Clearly some animal was removing the seeds from where they fell under the adult trees and dispersing them in all directions. In striking contrast, sandalwood stands in Wickepin, 54 km east of Dryandra, showed no regeneration at all and there were literally hundreds of seeds lying beneath the parent, the vast majority of which will perish. Trapping sessions were conducted at the Wickepin site to determine if there were any woylies, but it was

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completely devoid of native mammals. These findings pretty much confirmed the theory that woylies were a significant dispersal agent for sandalwood. The question was... how do we prove it?

We decided to set up bait stations at the Dryandra village where woylie numbers were relatively high. To enable us to determine the fate of the sandalwood seed once it was removed by the woylie, cotton bobbins were used; the end of the thread was glued to the seed and the bobbin was staked into the ground. This allowed the thread to unwind freely if the seed was removed. We then sat and waited. Sure enough, after a short while a woylie appeared at our bait station to investigate the seeds. After a few moments the woylie picked up the seed in its fore paws, put the seed in its mouth and left the area at some speed. The cotton thread unwound rapidly as the woylie hopped away with its prize. A few moments later the cotton stopped unwinding and the woylie returned to the bait station and repeated the procedure.

The trail left by the cotton was clearly visible and was easy to follow around, under and through vegetation. Finally, the trail stopped and disappeared into a small hole in the ground. There at the bottom was the sandalwood seed, pressed hard into the soil. Surprisingly, the cache was not covered by soil in the majority of cases, but after a couple of days the caches were almost completely covered with leaf litter that had fallen into the cache. The distance of the caches from the bait station ranged from 8 m to 81 m and occurred in a scatterhoarded pattern (one seed per cache). So for the first time ever it was shown that woylies do disperse and cache sandalwood seeds and as a result, woylies have an important role to play in the regeneration of at least one woodland plant species.

The study was the first of its kind to link directly the conservation of a mammal to the regeneration and management of an important plant species. Future studies plan to expand our knowledge on the important role some endangered native mammals play in the regeneration of plant species through caching behaviour. For instance, the boodie or burrowing bettong, a relative of the woylie, is believed to have cached sandalwood seeds prior to its extinction from the mainland. The western mouse is also reported to have relationship with sandalwood, although at this stage it is unclear whether this particular species is a seed disperser or primarily a seed predator. It is hoped that this will become clearer as the research progresses.

The implications of these findings for conservation of biodiversity are clear. The discovery of the link between the woylie and sandalwood provides an 'icon' for the many functional relationships that exist in our landscapes. Over the millennia, many plants and animals have co-evolved, forming close and intimate relationships. The woylie sandalwood story is one example of such a relationship and is a prime example of how biodiverse ecosystems can function; indeed, the woylie sandalwood story can give us a 'functional icon' to drive the conservation of plant and animal biodiversity as a whole. For the first time we have the opportunity to demonstrate to all Australians the relationships, complexity and beauty of the ecology of Australia and hopefully, we can change our current view of degraded systems to one of high functional biodiversity.

Marie is starting a PhD on this topic. She would greatly appreciate it if readers who may know of any field sites containing sandalwood and native mammals could pass this information on to her as this would be of immense help with her research.

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