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DEAD WOOD IN THE ARID ZONE
SOME DATA FROM THE T.G.B. OSBORN VEGETATION RESERVE, KOONAMORE

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ABSTRACT

Very little information is available about how long dead trees remain standing, or fallen logs persist, in the Australian arid zone. Some Information about dead timber is available from the records of the T.G.B. Osborn Vegetation Reserve on Koonamore Station, South Australia. Two species were examined , *Acacia aneura* (mulga) and *Myoporum platycarpum* (false sandalwood, sugarwood). Data were extracted from records of both permanent quadrats and photopoints. Standing dead Myoporum trees had a mean age of 31.2 $\pm$ 5.7 years, fallen trunks 38.4 $\pm$ 3.7 years. Mean age of standing dead *A. aneura* was 40.0 $\pm$ 3.7 years, fallen trunks 22.4$\pm$ 6.3 years. These figures are almost certainly underestimates. The reasons why are discussed and some comparisons made with temperate forests. Some individuals of mulga are capable of standing dead for over 75 years , while dead *Myoporum platycarpum* may stand for over 60 years.

INTRODUCTION

Long term vegetation monitoring tends to concentrate on living plants; records of standing dead trees are often not maintained, and data on fallen timber is even less common. Biomass estimates of standing dead trees (snags) and coarse woody debris (CWD) are most commonly available for northern hemisphere temperate or tropical forests, and even there, decay rates are not common. Very little data appear to be available for arid, semi-arid or savannah ecosystems, yet standing dead trees and fallen wood are important as habitat for many animals, a store of potential nutrients and carbon. The decay rates and hence rates of release of these nutrients and carbon are significant for modelling ecological processes and atmospheric CO_2 balance models. Standing dead trees in the landscape may give an impression of recent dieback, which may be quite false if the trees have been standing for many years.

Some information about the longevity of dead wood in an arid environment can be extracted from the records of the T.G.B. Osborn Vegetation Reserve at Koonamore, South Australia. This 4 km^2 reserve was set up in 1926 to follow changes in vegetation after the exclusion of sheep and rabbits. The country is chenopod shrubland, with scattered trees, including mulga (*Acacia aneura*), false sandalwood or sugarwood (*Myoporum platycarpum*), blackoak (*Casuarina pauper*) and bullock-bush (*Alectryon oleifolium*). Sheep were brought into the area in about 1863, and rabbits are believed to have arrived there about the early 1880s, and reached plague proportions not long afterwards. For further details of the reserve, see Hall *et al.* (1964).

The Reserve is maintained by the University of Adelaide, and now has 75 years of records of permanent quadrats and photopoints. Quadrat maps include dead trees when these are still standing. Fallen trees and dead branches have also been mapped, although less consistently. Quadrats were read annually for the first few years, but more infrequently since, with some gaps of several years.

Consequently it is possible to obtain from the records an indication of when a tree died, how long it remained standing dead, and how long dead wood has persisted on the ground. In this paper results will be presented for two of the most common tree species occurring on the Reserve, namely *Acacia aneura* (mulga) and *Myoporum platycarpum* (false sandalwood, sugarwood). Comparisons are made with data for standing dead tree decay rates in some northern temperate forests.

METHODS

Quadrat records

The five large quadrats have been used in this study. Four of these, namely Q100, Q200, Q300 & Q400 are 1 ha squares. The fifth, Q6-80, is rectangular, 60x80m, so that the total area mapped was 4.48 ha. The two species occur at different density on different quadrats, and neither is present on all. Quadrat data are originally recorded on printed chart cards, but have now also been transferred to an Access database. The methods of recording data have varied over time and more detail is now recorded than in the early years. Initially presence only of a plant was mapped, with canopy size of larger plants indicated by a circle. A standing dead tree was indicated by a dotted circle, or sometimes by an exclamation mark by the species symbol. Fallen dead wood was not usually indicated. In more recent years, plant height and canopy dimensions have been measured and recorded, and the larger fallen dead wood also mapped, if not always consistently. Fallen wood has not been included in the Access database.

To extract the data on dead trees from the database, the coordinates were selected of all trees of one of the species that were present on the earliest chart of one quadrat. For each of these trees, records were searched through time for presence of the tree, the dates if and when the tree was first recorded as dead, and the date if and when the record ceased, indicating that the tree had fallen. The original charts were then checked for presence of dead wood at the coordinates of the original tree, and the presence of this dead wood traced forwards through time until it was no longer mapped, or (more usually) until the last reading of the quadrat.

Photopoint records.

Photopoint photos are filed on index cards with accompanying comments. To avoid duplication only photopoints with fields of view that did not include a quadrat were considered. Those that showed unequivocally identifiable trees were examined. Photo-sequences were examined for trees originally alive, which died and/or fell during the course of the recordings. In some cases trees disappeared from view in undergrowth when they fell. These fallen logs were located on a recent visit to the reserve.

Data were compiled as: mean time (years) dead trees were standing
mean time (years) dead trees were fallen but distinguishable
For standing dead, the means were of two categories:

1. Incomplete: individuals for which the first and/or last dates were unknown, either because the tree was already dead in the earliest record, or the tree was still standing dead in the most recent record. All fallen trunks were still identifiable, hence are classed as incomplete.
2. Complete: individuals for which first and last dates were approximately known, that is, the date at which a live tree died or a dead tree fell.

Most trees were included in the first group.

Data were also displayed as frequency distributions in 10-year age classes, distinguishing between complete and incomplete records in each case.

RESULTS

The average ages of standing dead trees and fallen trunks of each species are summarised in Tables 1 and 2 below. These data include both quadrat and photopoint records.

Table 1. *Myoporum platycarpum* mean ages.

		mean age	standard error	no. of trees	total number
standing dead	incomplete	31.2	5.7	14	42
	complete	16.9	3.0	28	
fallen trunk	incomplete	38.4	3.7	34	34

Table 2. *Acacia aneura* mean ages.

		mean age	standard error	no. of trees	total number
standing dead	incomplete	40.0	3.7	39	45
	complete	11.7	4.3	6	
fallen trunk	incomplete	22.4	6.3	12	12

Frequency distributions, showing the number of dead trees standing or fallen in each 10-year interval, are presented below (Figures 1 to 4). Here again incomplete records are distinguished from complete ones.

Figure 1.

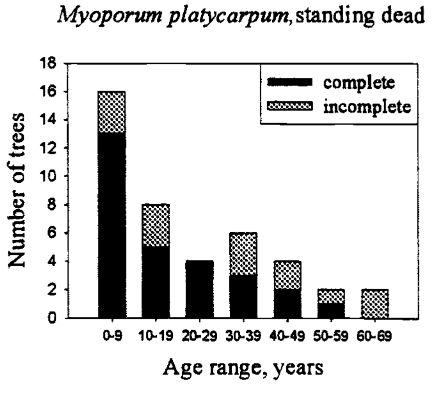


Figure 2.

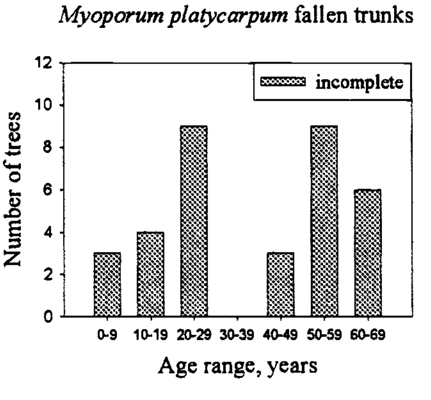


Figure 3.

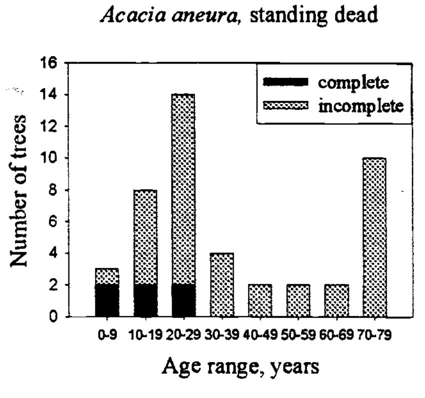
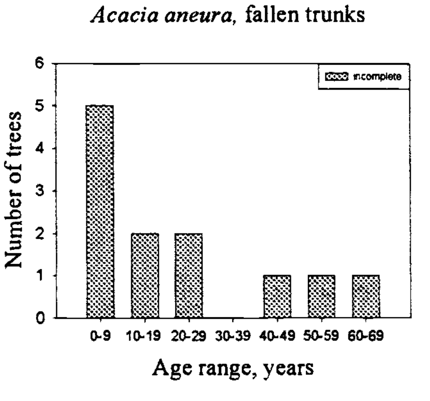


Figure 4.



Figures 1-4. Frequency distributions of ages of dead standing trees or dead fallen trunks in 10-year age classes. *Myoporum platycarpum*, Figs 1 & 2; *Acacia aneura*, Figs 3 & 4. Solid bars, complete records: ie beginning and end of the time interval recorded, at least approximately. Grey bars, incomplete records: beginning or end of the time interval unknown- tree was already standing dead when records began, and/or was still standing dead, or fallen trunk still identifiable, at most recent record.

DISCUSSION

It can be seen from the data that *M. platycarpum* trees have a shorter mean lifespan as standing dead (31.2 years) than do *A. aneura* (40.0 years), for the incomplete records. It is likely that the age underestimate of these means is greater for the mulga, as a higher proportion of the mulga total sample is incomplete (39 out of 45) compared with *Myoporum* (14 out of 42). No trees from the 46 recorded as fallen have yet disappeared. Consequently the fallen time-spans are even more underestimated. *Myoporum* appeared to have a longer lifespan as fallen dead wood (38.4 years) compared to mulga (22.4 years), but this is almost certainly because less mulga standing dead trees fell during the observation period, and more of these were at more recent dates.

The data as presented must be treated with caution, and for several reasons should be regarded as estimates only, and almost certainly underestimates. Both *M. platycarpum* and *A. aneura* may senesce gradually before dying completely. They were sometimes recorded as dead one year, but alive subsequently. Trees may drop foliage in dry seasons, but later re-sprout, although the bulk of the trunk remains dead. Hence it was sometimes difficult to estimate the exact date on which the tree should be taken as dead.

The quadrats were read annually or more frequently for the first few years of the project, but less frequently after about 1935, with gaps of several years in some cases. Hence there were often uncertainties of a few years in date of death or falling, if this occurred in one of these gaps in the records. Dates used were always the first date a tree was recorded as dead, or the last it was recorded as present and dead, so when a tree died or fell during a gap in records, the age was underestimated.
More serious is the fact that most of the records are incomplete. That is, many trees, especially *A. aneura*, were still standing dead at the most recent reading, (2000 or 2001), and nearly all of the fallen dead-wood was still identifiably present at the most recent readings. Some trees were recorded as present but dead when the quadrats were first read in 1926, and three mulgas and one *Myoporum* have remained standing dead from their first to last recording. Seventy-five years of records are not nearly enough to capture the entire life and death cycle of these trees.

Although many of the records are incomplete, some of the trees, especially *M. platycarpum*, fell over within one of two years of death. Because these short times were easily captured within the time-span of the experiment, the means of the "complete" categories are shorter than those of the "incomplete" categories, which at first seems counter-intuitive.

No comparable data could be found for arid zone trees either in Australia or overseas. Data are available for Northern Hemisphere temperate or tropical forests, but even these are not numerous. Some figures were found for fall-down rates for standing dead trees, or snags. These are often quoted as % per year. From these figures, half-lives of snags have been calculated, assuming an exponential decrease, and shown in Table 3.

Table 3. Fall-down rates and half-lives of snags (standing dead trees) in Northern Hemisphere forests

vegetation type	snag fall-down rate, % per year	decay rate constant	half-life, years	source of data
deciduous/conifer S. Appalachian Mts, USA	3.6 - 11	0.0367 - 0.1165	18.9 - 5.9	Harmon (1982)
Mt. pine forest, Swiss Nat. Park	0.7	0.00726	98.7	Dobbertin et al. (2001)
Aspen-dominated boreal, Alberta, Canada	9 - 21	0.0943 - 0.2357	7.3 - 2.9	Lee (1998)
Myoporum platycarpum		0.0597	11.6	This study

An exponential decay curve was fitted to the "complete" data for *Myoporum platycarpum* standing dead trees, yielding a decay constant of 0.0597 and a half-life of 11.6 years. For the reasons given above this is almost certainly an underestimate, but from Table 3 it appears to be comparable to rates in mixed deciduous and conifer forests in the S.E. of the USA, slower than the Canadian boreal forest, but much faster than the Swiss mountain pine forest.

Although the exponential fit to the *Myoporum* data is quite good (r^2 = 0.950), there is no obvious reason why this should be the case. Figure 1 does not represent an initial population of dead trees that gradually fell over time. Rather it is a data-set of trees which died at many different times over a 75 year period. There is no a priori reason why the smallest age cohort (0 - 10 years) should be the largest. The calculated half-life for *Myoporum* does not mean quite the same thing as that derived from percentage decreases in standing dead trees in Table 3.

The *A. aneura* data do not show an exponential decay; the observation time is too short and sample size too small. There is evidence that these mulgas occur in approximately even-aged stands, which is not the case further north where stands are more extensive and recruitment patterns different (Crisp, 1978). Many trees within one stand died within a short time period (Sinclair, 1996). This has contributed to the unevenness of the age distribution in Figure 3. The fallen dead-wood data (Figures 2 and 4) are also too incomplete to be compared with decay rates for logs or woody debris in forests.

Further work on the Reserve could reveal biomass of standing and fallen wood, for comparison with forest estimates and to place the decay rates in context. Perhaps the most interesting conclusion from this study so far is that some individuals of mulga are capable of standing dead for over 75 years , while dead *Myoporum platycarpum* may stand for over 60 years. Dead wood in the arid zone, if not collected for firewood, may last for a very long time, and standing dead trees are not necessarily due to recent dieback. They may indicate events long past. Nevertheless if there is no sign of young trees of seedlings to replace them, the dead wood may be a good indicator of long-term gradual loss of trees.

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