Distribution and Habitats of the Thick-Billed Grasswren *Amytornis textilis*, subspecies *myall*

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Abstract

The Thick-billed Grasswren Amytornis textilis, subspecies myall, occurs in semi-arid South Australia, between Whyalla and the Gawler Ranges. Its distribution is largely unchanged since its discovery in August 1902. Its present status in the Yellabinna region, where it was recorded once in 1909, is unknown. Searches in 2006 were successful at 76% of 62 located sites of previous records. The main habitats of A. t. myall are Blackbush low shrubland (40% of sites), Australian Boxthorn low shrubland (21%) and Western Myall low woodland (19%) along drainage lines, with a mean shrub cover of 30.6%. Other semi-arid low woodlands and shrublands are also frequented, even low rocky hills if shrub cover is sufficient. The total cover of Blackbush, Australian Boxthorn, other spiny shrubs, Ruby Saltbush and taller shrubs (>75 cm high) differed between sites with A. t. myall and unoccupied control sites: occupied sites had greater dense shrub cover with a mean density score of 10.8 compared with 4.3 at controls.

Most of the habitat of A. t. myall is unconserved and within pastoral lands, particularly in areas where stock congregate. Careful management is therefore required to ensure that areas of dense shrub cover persist.

INTRODUCTION

Three subspecies of the Thick-billed Grasswren *Amytornis textilis* are currently recognised: *A. t. textilis* in Western Australia, now restricted to the Shark Bay area, *A. t. modestus* in northern South Australia and formerly central Australia and New South Wales, and *A. t. myall* (Schodde and Mason 1999). The last named is known from a restricted area of the eastern Gawler Ranges and adjacent plains of north eastern Eyre Peninsula. Two intriguing outlying specimens that most closely match A. t. myall were taken by R. C. Chandler in 1909 between Barton and Bates in the Yellabinna region, over 400 km to the west, but they have not been reported from that region since (Black 2004). Another outlying report from southern Eyre Peninsula (Hall 1910) is considered doubtful (Schodde 1982).

The habitats of *A. textilis* are chenopod and other arid shrublands, particularly where larger and denser shrubs and vegetative debris provide shelter down to ground level (Schodde 1982; Brooker 2000; Higgins, Peter and Steele 2001). Those of *A. t. myall* have been variously described as "salt-bush near a dry watercourse" (White 1913), "very prickly bushes about three to four feet high" (Sutton 1924), "country covered in a bluebush (*Kochia [=Maireana] pyramidata*), which grows to a height of four to five feet, and covers any flat-lying ground" (Sutton 1926), "saltbush and bluebush higher and larger than that ordinarily in the locality" (Bryant 1937), "thick Blackbush and Nitraria shubland along a creek line" (Reimanis 1987) and "dense stands of Dead Finish *Acacia tetragonophylla* surrounding dams or drainage lines" (Matthew and Carpenter 1993).

The aim of the present study is to assess the distribution and habitats of A. t. myall in detail, as part of a larger project to clarify the status, distribution and habitats of *A. textilis* in South Australia.

METHODS

Previous records of *A. t. myall* were collated from museum specimens (South Australian Museum, Museum Victoria and Australian National Wildlife Collection), data in the S. A. Department for Environment and Heritage Biological Survey, published reports, records kept by the South Australian Ornithological Association, our own unpublished observations and those of other ornithologists.

Localities where *A. t. myall* had been reported were revisited in 2006 and habitat measured. Most sites were accessible by vehicle. To increase the likelihood of detecting grasswrens, the surveys were undertaken during the presumed breeding season, as follows:

30 July - 4 August: south of the Port Augusta to Iron Knob road;

27 August - 1 September: east and south of the Gawler Ranges;
17-22 September: eastern Gawler Ranges;
22-27 October: central Gawler Ranges (Mount Ive Station and west).

At each locality we searched up to 5 ha on foot over a 30-minute period. Grasswrens were detected by contact calls, flushing birds from cover, observation of birds "hopping" ahead of the observer, and responses to play-back of taped grasswren calls and mimicking whistles. The presence of grasswrens was confirmed in all cases by observation and not by calls alone. In most cases grasswrens, if present, were seen within a few minutes of starting a search. The location of all sites was recorded with a hand-held GPS unit.

If grasswrens were found at the site of a previous record it was considered verified,

Typical habitat of *Amytornis textilis myall*

Thick-billed Grasswren, *Amytornis textilis myall*
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otherwise it was deemed unconfirmed. Two methods were used to establish new sites. First, at each verified site a control site was sought 500 metres away, its locality determined entirely on the basis of distance from the verified site and irrespective of habitat. If no grasswrens were found another attempt was made to find a control site a further 500 metres away. If Grasswrens were found at a control site it was recorded as a new site. (A "control" site was selected 500 metres away from each verified site, its locality determined entirely on the basis of distance from the verified site and irrespective of habitat. The control site was thus an unselected one and was adopted as such only if after a thorough search no grasswrens were found,; otherwise another attempt was made to find a control site a further 500 m away. If grasswrens were found the site was recorded as a "new" site. Occasionally grasswrens were distributed continuously, in which case no control site was established). Secondly, "new" sites were also established through searches at the edge of known distribution or within gaps. Previous records without specific locality information were not re-assessed.

At 61 sites where *A. t. myall* occurred, other bird species were recorded and interactions noted.

Habitat measurements

Ground cover vegetation was identified and its cover and height measured at verified, new and control survey sites (Table 1). Percentage cover was calculated from the plant species present at each 1 m point along a 100 m transect laid in a straight line over the habitat. At sites where grasswrens were located, the transect was placed where the birds were first seen and laid in the direction that the birds travelled. The heights of ground cover plants were recorded in 25 cm categories at each point using a range pole. Vegetation types were described at each site based on the estimated cover and species in the highest stratum or storey (after Specht 1972). Any vegetation cover above 4 m high was recorded as canopy. Canopy species with 2% or less cover were considered emergent and the vegetation type was defined by the next highest stratum. During the survey it became evident that the foliage density of shrubs along the transect might also be an important habitat characteristic. We therefore devised a simple measure of shrub density or "density score" by counting the number of times along each transect that the step on the range pole 12.5 cm above the ground was hidden from the person doing the sampling by shrub foliage.

Data analysis

Sites with cover data where grasswrens were observed were compared with control sites. Habitat variables were first compared individually between sites with and without grasswrens. Student's t test was used to compare the more abundant habitat variables, while those plants providing limited cover were compared using the Mann-Whitney non-parametric test. Chi-square (χ^2) analysis was used to determine whether the presence of other features (e.g. canopy) and the presence of grasswrens were correlated.

Multivariate statistical analysis (logistic regression) was then used to seek a relationship between the main habitat variables and the presence of grasswrens, following the procedure

Table 1. Habitat variables used in the multivariate analysis. See Appendix 2 for scientific names of plants.

Habitat variable	Description
Barerock	% cover of bare ground and rock
Litter	% cover of leaf litter or other dead vegetation
Blackbush 0-25 cm	% cover of Blackbush 0-25 cm
Blackbush 26-50cm	% cover of Blackbush 26-50 cm
Blackbush 51-75 cm	% cover of Blackbush 51-75 cm
Blackbush >75 cm	% cover of Blackbush over 75 cm
Blackbush total	% cover of Blackbush (all heights)
Weeds	% cover of all introduced annuals (Ward's Weed, medics etc)
Australian Boxthorn	% cover of Australian Boxthorn (all heights)
Spiny shrubs	% cover of all spiny shrubs except Australian Boxthorn (i.e. Veined Wait-a-while, Dead Finish, Spiny Saltbush, Nitre-bush, Nitre Goosefoot, Spiny Fan-flower) (all heights)
Pearl Bluebush	% cover of Pearl Bluebush (all heights)
Copperburrs	% cover of ll Copperburrs and other low chenopods (e.g. Ball Bindyi).
Ruby Saltbush	% cover of Ruby Saltbush (all heights)
Saltbush	% cover of Bladder Saltbush and Bitter Saltbush (all heights)
Shrubs 0-25 cm	% cover of all shrubs 0-25 cm excluding Blackbush
Shrubs 26-50cm	% cover of all shrubs 26-50 cm excluding Blackbush
Shrubs 51-75 cm	% cover of all shrubs 51-75 cm excluding Blackbush
Shrubs >75 cm	% cover of all shrubs over 75cm excluding Blackbush

of Pearce, Burgman and Franklin (1994) and Pearce (1996). Values greater than 0.5 indicate that grasswrens are more likely to be present than absent. Such an analysis allows all of the habitat variables to be considered together rather than individually. Because of the great variety of cover categories recorded (species and heights), habitat variables within the dataset were simplified by combining similar or related plant species of low incidence (see Table 1 for definitions).

Three habitat variables ("Barerock", "Blackbush 51-75 cm" and "Blackbush>75 cm" – Table 1) were removed from further analysis because they were highly correlated with other variables. A computer-operated stepwise logistic regression analysis (STATISTICA 1995 version) was then performed to determine which habitat variables were important indicators at survey sites with grasswrens, and what combination of these variables could be used to predict grasswren presence at a site. A measure of the usefuLNEess of the logistic regression is the proportion of sites that are correctly predicted to have grasswrens present or absent. The regression equation can also be used to predict whether a new area may be suitable for grasswrens based on measured habitat variables. Note however that prediction values will be biased upwards as explained by Keating and Cherry (2004).

RESULTS

Distribution

The review identified 87 previous localities for *A. t. myall* (Figure 1, Appendix 1). Distributional limits were:

Southern - northern edge of Munyaroo Conservation Park (CP) (Cox and Carpenter 2003) and Ash Hall near Sinclair Gap (Ragless 1969);

Eastern - Murninnie Beach (Cox 1974a and pers. comm.), Eight Mile Creek, south of Whyalla (Cox 1974a), Myall Creek near its crossing of the Port Augusta - Whyalla road (Bryant 1937), and Port Augusta - Iron Knob road (P. Langdon pers. comm.);

Northern - Gunter's Dam, Cariewerloo Station (P. Langdon pers. comm.) and Scrubby Outstation, Nonning Station (Matthew and Carpenter 1993.);

Western - Mount Ive Homestead (SAM B7360, P. Langdon pers.comm.); and

South-western - Wilcherry (c. 30 km north of Kimba) (J. Cox pers. comm.), the north-eastern extremity of Lake Gilles CP (T. Cox pers. comm.), 15 km south-west of Iron Knob (J. Cooper pers. comm.) and the Iron Knob-Iron Baron road (J. Cox pers. comm.).

We were unable to locate any records west of Mount Ive Station other than that of R. C. Chandler from the Yellabinna region, over 400 km further west, in 1909 (Black 2004). This area was not visited during the survey. Of the previous grasswren localities 62 had sufficient details for the record to be relocated accurately. Of these, *A. t. myall* was verified from 47 sites (76%) and unconfirmed at 15 (Appendix 1, Figure 1). We also found grasswrens at 65 new localities (bringing total presence sites to 112) and established 51 control sites. The greatest concentration of records was in the south-east in an area bounded by Whyalla, Iron Baron, Iron Knob and the Port Augusta to Iron Knob road.

Evidence of breeding was found throughout the 2006 survey period, as follows:

8 August - partly built nest in a Spiny Fanflower near Middleback HS (Site 72);
27 August - dependent young in Lignum with Australian Boxthorn and Spiny Saltbush south of the Eyre Highway near Myall Creek (Site 47);
1 September - a nest with three eggs in Ruby Saltbush growing in a dead Blackbush at Gunter's Dam, Cariewerloo Station (Site 76);
1 September - dependent young and an old nest about one km N of Site 76 (=Site 77);
19 September - a nest with two eggs in an Australian Boxthorn south of Rockwater Hill, Nonning Station (Site 90);
20 September - a recently used nest in a dead Australian Boxthorn north of Larry's Dam, Nonning Station (Site 91 - collected for the SA Museum);
21 September - a nest with young in a Spiny Saltbush at Cocoa Dam, Nonning Station (Site 93); and
26 October - a nest of grasses including Feather Spear-grass Austrostipa elegantissima in a Blackbush containing two eggs about five km W of Mt Ive Homestead (Site 109).

Associated birds

A total of 74 species (excluding waterbirds) was recorded, the most frequent being Singing Honeyeater *Lichenostomus virescens* (52% of sites), Spiny-cheeked Honeyeater *Acanthagenys rufogularis* (49%), White-browed Babbler *Pomatostomus superciliosus* (49%), Redthroat *Pyrrholaemus brunneus* (48%), White-winged Fairy-wren *Malurus leucopterus* (36%), Variegated Fairy-wren *M. lamberti* (36%) and Southern Whiteface *Aphelocephala leucopsis* (25%). Other species of note were Slender-billed Thornbill *Acanthiza iredalei* (13%), Chestnut Quail-thrush *Cinclosoma castanotum* (8%) and Rufous Fieldwren *Calamanthus campestris* (8%). Only wrens *Malurus spp.*, Redthroat and Rufous Fieldwren were seen in company with *A. t. myall*,

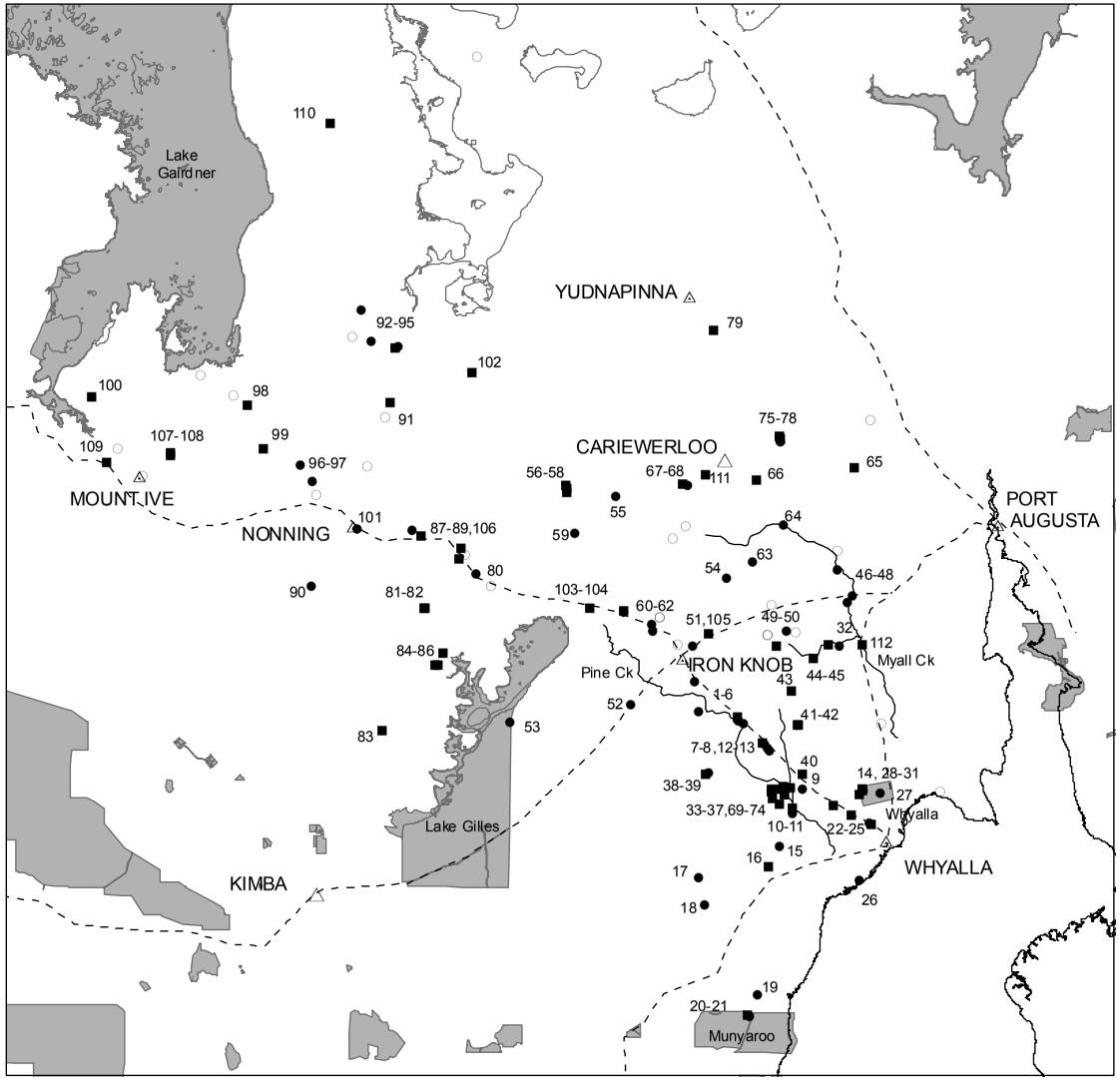

Figure 1. Records of *Amytornis textilis myall* showing verified previous reports, previous reports unconfirmed during this study and new localities. Note that records from the Yellabinna in 1909 (Black 2004) are not shown, being located about 600 km WNW of Port Augusta.

but no behavioural interactions were observed.

Habitats

Habitat data were collected from 91 of the 112 sites where grasswrens were found during the survey. *A. t. myall* was recorded in a variety of vegetation types (Table 2), 28% being low woodland and the remainder shrubland. Most were recorded in Blackbush low shrubland (40% of sites), Western Myall low woodland (19%) or Australian Boxthorn low shrubland (21%) that were concentrated along drainage lines and depressions. Compared with control sites, Australian Boxthorn low shrubland was found more often and Pearl Bluebush low shrubland less often at sites with grasswrens. Blackbush (78% of sites), Spiny Saltbush (54%) and Australian Boxthorn (51%) were prominent shrubs along transects with grasswrens (Table 3). A full list of plant species recorded at sites with *A. t. myall* is given in Appendix 2.

The average shrub cover at sites with grasswrens was 30.6 +/- 10.5% (mean +/- standard deviation), including 12.4 +/- 10.7% Blackbush cover (Table 3). These sites also had significantly higher density scores, total cover of Blackbush, Blackbush above 50 cm, Ruby Saltbush, Australian Boxthorn, spiny shrubs

Table 2. Vegetation types at sites used by *A. t. myall* and at control sites

Vegetation type (canopy height)	Sites with grasswrens N=112 (%)	Controls N=51 (%)
Low Woodlands (5-10 m)		
Western Myall	19	20
Bullock-Bush and/or False Sandalwood	7	6
Mulga	1	0
Weeping Emubush	1	0
Red Mallee	0	2
TOTAL	28	28
Shrublands (2-5 m)		
Sandhill Wattle	2	0
Veined Wait-a-while	1	0
Nitre Goosefoot	2	0
Sheep Bush	1	0
Nitre-bush	2	0
TOTAL	8	0
Low Shrublands (0-2 m)		
Nealie	1	0
Australian Boxthorn Lycium australe	21	2
Bladder Saltbush	0	2
Lobed-leaf Hopbush	2	0
Blackbush	40	54
Low Bluebush	0	4
Pearl Bluebush	0	10
TOTAL	**64**	**72**

Table 3. Individual comparison of habitat variables between sites with grasswrens and controls. See Table 1 for details of habitat variables in bold print. [1] Standard deviation is provided only for habitat variables that are present at most sites, probability tested with t-test. Other variables were compared using the Mann-Whitney non-parametric test or (for Canopy) Chi-square test. [2] Significance levels P=0.01-0.05 = *; P=0.001-0.01 = **; P<0.001 = ***.

Habitat variable	[1] No. Grasswrens present (N=91) mean± SD (range)	Number of sites (%)	Controls (N=51) mean+/-SD (range)	No sites (%)	[2]Signif. Level
Density score	10.8+/-4.4 (3-22)	-	4.3+/-2.5 (1-11)		***
Bare	50.8+/-16.0 (5-78)	-	65.5+/-13.0 (31-84)		***
Rock		14 (15)		8 (16)	NS
Barerock	52.5+/-14.0 (5-81)		65.8+/-13.2 (31-84)		***
Litter	10.6+/-6.0 (0-31)		9.9+/-6.6 (2-33)		NS
Canopy		57 (63)		26 (51)	NS
Blackbush 0-25 cm	1.2	49 (54)	1	26 (51)	NS
Blackbush 26-50 cm	4.4	69 (76)	3.3	32 (63)	NS
Blackbush 51-75 cm	4.9	68 (75)	2	30 (59)	***
Blackbush >75 cm	2	51 (56)	0.2	8 (16)	***
Blackbush total	12.4 +/- 10.7 (0-42)	71 (78)	6.6 +/- 5.8 (0-17)	36 (71)	**
Pearl Bluebush	1.5	24 (26)	4.1	26 (51)	NS
Copperburrs	0.4	14 (15)	1	28 (55)	***
Ruby Saltbush	0.4	25 (27)	0.1	4 (8)	*
Saltbush	3.4	43 (47)	3.6	35 (69)	NS
Australian Boxthorn	5.5	46 (51)	0.7	5 (10)	***
Spiny shrubs	3.1	71 (78)	0.3	8 (16)	***
Weeds	5.1	45 (49)	5.4	24 (47)	NS
Shrubs 0-25 cm	3.2 +/- 3.2 (0-14)	76 (84)	4.5 +/- 3.4(0-13)	46 (90)	**
Shrubs 26-50 cm	5.3 +/- 4.3 (0-20)	82 (90)	3.9 +/- 3.3 (0-13)	41 (80)	NS
Shrubs 51-75 cm	4.3	66 (73)	2.5	27 (53)	*
Shrubs 75 cm	5.4	60 (66)	1	16 (31)	***
All shrubs	30.6 +/- 10.5		18.5 +/- 5.7		***

and tall shrubs (over 75 cm), and significantly less low shrubs (especially copperburrs.) than control sites. The presence of a tree canopy and the amount of annual weed growth, litter, Pearl Bluebush or saltbushes did not differ significantly between grasswren sites and controls (Table 3).

DISCUSSION

Distribution and status

This survey presents the first systematic assessment of the distribution and habitat of *A. t. myall*. It confirmed the presence of grasswrens at over 75% of sites where they had been

recorded previously. The highest proportion of confirmed sites was in the southern area of distribution, while unconfirmed sites were more prevalent in the north and in the Gawler Ranges. Major concentrations of grasswrens are present today along two of the largest drainage systems in the study region, namely Myall and Pine Creeks (Figure 1). The latter approaches the Whyalla-Iron Knob road and rail corridor, where the distribution of grasswrens is almost continuous.

The known range of *A. t. myall* was extended slightly during the survey. In the north-east new localities were found both east and north of Cariewerloo Woolshed and about 8 km south-east of Yudnapinna Homestead. In the Gawler Ranges a new locality extended known range north from near Old Siam Homestead to north of Rankin Outstation, about 10 km south of Lake Macfarlane. In the west several new sites were discovered around Mt. Ive Homestead but grasswrens were not found further west on Yardea and Thurlga Stations, despite intensive searching over three days in apparently suitable habitat. In the east, further survey work east of the Port Augusta – Whyalla road failed to locate any new sites (GC pers. obs). However two additional records north of the Gawler Ranges came to our attention after the field study was completed: south of Island Lagoon on Yalymboo Station, 6 February 1999 (H. Ehmann pers. comm.) and Mahanewo Station November 2006 (H. Stewart pers. comm.) We searched both sites unsuccessfully but on 13 December 2006 located two grasswrens that appeared typical of *A. t. myall* about 2.3 km west of the latter site and 13 km south of Mahanewo Homestead (Site 110).

Assuming that most of the current distribution of *A. t. myall* was assessed during this survey, its total range covers less than 10,000 square km. Within much of this area suitable habitat is confined to small areas, particularly drainage lines. Assuming that a pair occupies a territory of four to five hectares (Schodde 1982), we estimate that the total population is unlikely to exceed a few thousand individuals.

The ease of finding grasswrens during the first survey may have been related to significant rainfall in the region from 13 to 16 July, when falls of 25 – 50 mm were widespread. The responsiveness then of the grasswrens to both imitated and taped calls suggested that they were establishing breeding territories at the time. On subsequent trips grasswrens were less active and there was no further significant rain. The breeding season in 2006 corresponded to that recorded for *A. t. textilis* at Shark Bay (WA), where nesting is driven by winter rainfall (Brooker 2000). Surveys over several years and in all seasons are needed to provide more information on the breeding of A. t. myall.

Habitat

A. t. myall occurs mainly in low-lying areas of Blackbush (mean cover = 12.4%) and spiny shrubs, particularly Australian Boxthorn (total mean cover = 8.6%; Table 3), either as a shrubland or as an understorey of Western Myall low open woodland. Such areas are concentrated along drainage lines, particularly the Myall and Pine Creek catchments. The cover of perennial vegetation from 0-1 m high at grasswren sites in this study (30.6 +/- 10.5%; N=91) compares closely with that found for *A. t. textilis* (34.4 +/- 2.4%; N=27) at Shark Bay in Western Australia (Brooker 2000). In contrast however was the greater abundance of taller shrubs (especially recumbent shrubs with branches extending to the ground, mostly wattles Acacia spp.) at Shark Bay, with more than 20% cover over 1m high compared to 7.4% above 75 cm high (from Table 3) in the northern Eyre Peninsula-Gawler Ranges study area. Recumbent shrubs were not a feature in this study and the loss of Western Myall and Bullock-Bush foliage below browse line was noteworthy, although less palatable species such as Dead Finish and Elegant Wattle were present at some sites.

Grasswrens were also found in atypical habitats, such as rocky hills on Wild Dog Hill at Whyalla Conservation Park (Sites 29 and 30, Figure 1) and near the summit of Mt Miccollo on Nonning Station (Site 89), in Lobed-leaf Hopbush and Curry Bush shrubland and Nealie shrubland over Spinifex, respectively. The latter habitat is more typical for the Short-tailed Grasswren *A. merrotsyi*, a species only recently discovered in the region (Baxter and Paton 1998). In both cases *A. t. myall* was also recorded in more characteristic habitats, Blackbush and Australian Boxthorn shrublands, at the base of the hills. At three localities *A. t. myall* extended to the mallee open scrubs on the sandier soils of northern Eyre Peninsula. At Ash they were seen within 100 m of mallee woodland (Site 18), at Munyaroo Conservation Park they were found in shrublands associated with and immediately adjacent to mallee (Sites 20 and 21), and east of Wilcherry they were in a small open area within the mallee (Site 83). In each case there was a high cover of dense spiny shrubs, particularly Spiny Saltbush, Australian Boxthorn and, near Wilcherry, Veined Wait-a-while. The grasswren also occurred in Dead Finish on Nonning Station (Site 95), which, though of limited extent in the survey area, is a common habitat of *A. t. textilis* in Western Australia (Brooker 2000, Higgins, Peter and Steele 2001).

The significantly higher "density scores" at sites with grasswrens (mean 10.8 versus 4.3 at controls) also highlight the importance of a dense shrub cover extending to the ground. Such habitat provided important nesting sites for *A. t. textilis* in Western Australia (Brooker 2000). The presence of grasswrens was not influenced by introduced annual species such as Ward's Weed.

The logistic regression habitat analysis showed that the presence of grasswrens could largely be predicted by the total cover of Blackbush, Australian Boxthorn, spiny shrubs, Ruby Saltbush and taller shrubs (over 0.75 m). Although Blackbush shrubland occurred at a similar proportion of occupied and control sites (Table 2), the analysis indicates that it is the percentage cover of Blackbush that is important. Moreover, sites with a combination of Blackbush and Australian Boxthorn (and/or other spiny shrubs of similar structure) provided the most likely sites for finding grasswrens.

The habitat prediction equation proved highly discriminating, grasswrens being recorded at few sites with prediction values < 0.5 and at most sites with values > 0.5 (Table 4). The large difference in prediction values between occupied and control sites (mean 0.88 vs. 0.21) reflects the considerable variation in shrub cover in the study area. Occupied sites had denser and taller cover and were generally confined to drainage lines, while control sites were mostly at a distance from them. To better discern habitat use, future studies could consider confining control sites to drainage lines.

Brooker (2000) found that the distribution of *A. t. textilis* at Shark Bay, Western Australia, was influenced by the abundance of climbing or scrambling plants that provided favoured nest sites. Similar species present in our survey included Ruby Saltbush (included in the analysis), Climbing Twinleaf, Feather Spear-grass, Cottony Goosefoot and Climbing Saltbush. These species were not prominent but contributed to the density scores and Feather Spear-grass was present in most grasswren nests.

Table 4. Precision of the logistic regression analysis for predicting presence or absence of grasswrens.

Grasswrens	Probability >0.5	Probability <0.5	% Correctly predicted
Present	84	7	92
Absent	5	46	90

Conservation

A. textilis myall occurs throughout most of its former range. However, they are chiefly found on unprotected pastoral land; the only reserves with grasswrens are the small (1980 ha) Whyalla Conservation Park, and the northern edges Lake Gilles and Munyaroo Conservation Parks. The absence of grasswrens from about one quarter of their previously identified localities could be due to a number of factors. The habitat at some sites may have become less suitable due to drought and grazing by stock, mainly sheep and cattle, and rabbits. The year 2006 was particularly dry and followed a succession of years of below average rainfall. During this time it is likely that grasswren populations contracted into refuge areas of optimal habitat. Prolonged drought had reduced the cover and density of many plant species, causing dieback or leaf-drop in Blackbush and Bladder Saltbush independently of grazing intensity (D. Michael pers. comm. and pers. obs.). Stock grazing reduces the cover of more palatable species such as Low Bluebush, Ruby Saltbush, and other scrambling species that may be important for nesting sites (Brooker 2000). On the other hand, Blackbush and spiny shrubs are generally more resilient and may increase under light to moderate grazing pressure or following a reduction in rabbit numbers (Cunningham et al. 1992). It is also possible that the release of Rabbit Haemorrhagic Disease in 1995 led to a secondary reduction in fox numbers and facilitated a recovery of grasswren populations. Further studies are required to determine changes in site occupancy over time.

It might appear paradoxical that many records of *A. t. myall* were near dams, where impacts from stock are greatest. Explanations include the greater observer effort near dams and the preference of grasswrens for the enhanced shrub cover and density associated with watercourses. Furthermore, the concentration of nutrients and soil disturbance caused by stock around dams has promoted dense growth of Blackbush and spiny shrubs such as Nitre-bush. Over the last few years many dams in the study area have been dry and stock impacts in their vicinity will have been low.

Pastoral practices will continue to evolve as dictated by markets and new management. The decline in the wool industry has led to a change from wool-producing sheep to cattle and sheep breeds such as Damara and Dorper, whose different feeding habits may have different impacts on native vegetation. Careful management will be required to ensure that the density of Blackbush and spiny shrubs remains across the landscape.

There is a concentration of records along the Whyalla – Iron Knob road and, to a lesser extent the Eyre Highway near Iron Knob, where increased run off from the road surface and lack of stock grazing have led to the growth of dense stands of Blackbush. Such areas provide important links between drainage systems; yet the survival of vegetation along transport corridors is often tenuous, for example where clearance has occurred along the highway west of Iron Knob to make way for a new water pipeline. On the coast south of Whyalla at Eight Mile Creek (Site 26), grasswrens were relatively common in the 1970s (e.g. Cox 1974a) but habitat loss from sandmining and use by off-road vehicles in recent years may have contributed to their scarcity (only one bird located after a thorough search) during the survey. Another potential threat throughout the region is the mistaken destruction of Australian Boxthorn or Nitrebush due to their similarity to African Boxthorn Lycium ferocissimum, a serious weed throughout southern Australia. There is also a proposal for the transfer of several pastoral properties covering the core distribution of *A. t. myall* to the Australian Military. Changes in land use at this scale have potential for significant impacts on habitat but also present opportunities for directed conservation management and exemplify the need for close documentation and monitoring.

Our 2006 survey established that *A. t. myall* still occurs throughout its limited distribution on north-eastern Eyre Peninsula and the eastern Gawler Ranges, being present at 765% of historic sites. Once familiar with the species our targeted searches doubled the number of recorded sites. The survey has also identified key habitat features, particularly the combination of Blackbush cover and presence of spiny shrubs.

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Appendix 1. Previous records of *Amytornis textilis myall,* indicating sites that were revisited in 2006. U = records that were unconfirmed in 2006. Site locations are shown in Fig. 1.

No	Day	Month	Year	Location	Source	Site
1	6	8	1902	Nonning, Fly Camp	Chenery (1903), SAM B7359	
1	10	8	1902	Mt Ive	Chenery (1903), SAM B7360	
2	16	1	1909	Near Bates siding, Yellabinna	Black (2004)	
1+2juvs		8	1912	Myall Creek (=Myall Creek HS)	White (1913), Mathews (1916)	
1	12	8	1923	Nonning, 1km N	Sutton (1924)	101
1	30	8	1923	Roopena, 7m NNE Wertigo Dam	Sutton (1924)	11
nest+3 eggs	30	8	1923	Wertigo Dam	Sutton (1924), SAM B14023	15
1	29	8	1925	Myall Creek Reservoir (=Govt Dam)	Sutton (1926)	64
6	8	9	1925	Middleback Stn, 3km N Randell Tank	Sutton (1926)	
4	11	9	1925	Middleback HS to Iron Knob	Sutton (1926)	
2	28	8	1925	Myall Creek Reservoir, 4m W	Sutton (1926)	
several +nest		11	1936	Roopena (=8km E Roopena HS)	Bryant (1937), SAM B31341	32
numerous	5	9	1969	Nonning	Ragless, G. (SAOA records)	101
breeding	7	9	1970	Whyalla, near	Ragless in Glover (1973)	
1			1970	Wartaka Stn, Govt Paddock	Langdon, P. (pers. comm.)	U
eggs	28	6	1971	Iron Knob, 17m (=28km) SE	SAM B42818, B42819	
	4	1	1972	Wartaka	Langdon, P. (pers. comm.)	
several			1972	Whyalla, 8m S (=Eight Mile Creek)	Cox (1974a), SAM B27931-4	26
1	14	9	1972	Wartaka HS	Langdon, P. (pers. comm.)	U
			1972	Whyalla Saltfields	Cox (1974a)	
			1972	Corunna	Cox (1974a)	
			1972	Iron Baron, N of	Cox (1974a, pers. comm.)	
			1972	Mount Laura	Cox (1974a)	24
			1972	Murninnie, near	Cox (1974a)	
			1972	Uno, near	Cox (1974a)	80
1	29	8	1973	Nonning, Rockwater Hill	Paton (1975)	
3 eggs	13	9	1973	Iron Knob, 17m SE	SAM B42820	
2	30	12	1973	Nonning HS, 10m NW (=16km NW)	Cox (1974b)	97
	18	12	1973	Whyalla, 13m N	Cox, J. (pers. comm.)	U
	30	12	1973	Wilcherry, 30km N Kimba	Cox, J. (pers. comm.)	
2	30	12	1973	Nonning, 15km NW	Cox, J. (pers. comm.)	96
2	15	4	1974	Sinclair's Gap	Swaby (1975)	17
8, breeding	12	9	1974	Ash, SW of Whyalla	Ragless (1969)	18
2	21	12	1975	False Bay	Cox, J. (pers. comm.)	
3, breeding	10	10	1976	Cariewerloo Stn	Reid (1980)	55
1	29	8	1977	Iron Knob, 15km SW	Cooper, J. (pers. comm.)	52
1	24	4	1978	Corunna to Iron Knob	Joseph and Black (1983)	U
3+	18	3	1979	Middleback Stn	Bransbury (1984)	9
			1981	Corunna, SE of White Dam	LP (pers. obs.)	60
			1981	Corunna HS, 9km WNW	LP (pers. obs.)	61
			1981	Corunna, NW of White Dam	LP (pers. obs.)	62
2 eggs	28	8	1982	Kolendo	SAM B50447	
1 gp	22	5	1985	Eight Mile Creek	R. Allen (pers. comm.)	26
2	6	6	1985	Nonning HS, 40km N (3km E Scrubby Hill)	Allen (1985)	95
2	30	8	1985	Nonning, 5km NNE Scrubby OS	Matthew and Carpenter (1993)	95
1	20	10	1985	Kolendo Stn, 3km E Shinnock Dam	Robinson et al. (1988), SAM B39446, B39441	U
		10	1985	Kolendo Stn, 7km NW Shinnock Dam	Robinson et al. (1988)	U
		10	1985	Nonning Stn, Larry Dam	Robinson et al. (1988)	U

No	Day	Month	Year	Location	Source	Site
		10	1985	Nonning Stn, Nonning Reservoir	Robinson et al. (1988)	96
		10	1985	Nonning Stn, Sisters Dam	Robinson et al. (1988)	U
		10	1985	Wartaka Woolshed, 4km SW	Robinson et al. (1988)	59
		10	1985	Coralbignie Outstation, 4km E	Robinson et al. (1988)	90
			1985	Unalla Stn, Francis Dam	LP pers. obs.	U
20	7	11	1987	Kolendo Stn, Shinnock Dam	Reimanis (1987)	U
2			1990	Whyalla CP, S boundary	M. de Jong (pers. comm.)	27
1	8	10	1991	Munyaroo CP, 3km N	Sacchi, Harper and Harper (1991)	19
6	6	11	1991	Whyalla, 24km SW	GC and J. Matthew (pers. obs.)	
2	7	11	1991	Iron Knob, 9km SSE	GC and J. Matthew (pers. obs.)	6
2	7	11	1991	Nonning Stn, 1km E Mt Nonning	Matthew and Carpenter (1993)	U
4	8	11	1991	Nonning Stn, Cocoa Dam	Matthew and Carpenter (1993)	92
5	9	11	1991	Nonning Stn, Blue Spec Dam	Matthew and Carpenter (1993)	94
2	9	11	1991	Nonning Stn, 3km E Blue Spec Dam	Matthew and Carpenter (1993)	
5	9	11	1991	Scrubby Outstation, 1km SW	Matthew and Carpenter (1993)	U
1	9	11	1991	Nonning Stn, 1km SE Nonning Reservoir	Matthew and Carpenter (1993)	97
1	9	11	1991	Siam Stn, 3km W East Well Dam	GC and J. Matthew (pers. obs.)	U
1	10	11	1992	Carriewerloo Stn, Sandy Dam	Langdon, P. (pers. comm.)	68
1	15	1	1993	Carriewerloo Stn, Gunter Dam	Langdon, P. (pers. comm.)	75
1	13	9	1996	Pandurra Stn, Block Dam	Langdon, P. (pers. comm.)	63
1			1998-9	Pandurra Stn, Claypan Dam	Langdon, P. (pers. comm.)	U
1			1998	Mt Micollo, Nonning Stn	LP (pers. obs.)	89
1	6	2	1999	Yalymboo Stn, W of Bryant Dam	H. Ehmann (pers. comm.)	U
1		8-Sep	1999	Pandurra Stn, Trig Dam	Langdon, P. (pers. comm.)	49
1	24	8	1999	Pandurra Stn, Dienoff Dam	Langdon, P. (pers. comm.)	U
	17	9	1999	Pandurra Stn, Tank Hill	Birds Australia Atlas data	U
	4	11	1999	Iron Knob	Birds Australia Atlas data	5
1	4	3	2000	Pandurra Stn, Woolly (Paddock) Dam	Langdon, P. (pers. comm.)	48
2	4	9	2000	Iron-Knob to Whyalla	Pascoe, E. (pers. comm.)	7, 12
	5	9	2000	Whyalla CP, Wild Dog Hill	Birds Australia Atlas	28
1	10	12	2000	Pandurra Stn, Double(=Keane) Dams	Langdon, P. (pers. comm.)	54
1			2000	Siam HS, 5km SSE	LP (pers. obs.)	80
1			2000	Siam HS, 1km NW	LP (pers. obs.)	87
1			2000	Siam HS, 1km S	LP (pers. obs.)	U
1	27	10	2001	Pandurra Stn, Lake Paddock	Langdon, P. (pers. comm.)	47
1	4	2	2002	LincoLNE Gap Stn, Pt Augusta paddock	Langdon, P. (pers. comm.)	46
1	17	6	2002	Pandurra Stn, East Bing Paddock	Langdon, P. (pers. comm.)	U
3	2	10	2002	Munyaroo CP, N boundary	Cox and Carpenter (2003)	20
2	3	10	2003	Iron Knob to Whyalla	Pascoe, E. (pers. comm.)	1,2
1	16	8	2003	Corunna HS, 3km NW	LP and Langdon, P. (pers. obs.)	U
1	19	1	2004	Iron Knob, 2km NE	GC (pers. obs.)	51
		10	2004	Lake Gilles CP, E boundary	Cox, T. (pers. comm.)	53
4	27	7	2005	Middleback Stn, Yanaby Dam	AB (pers. obs.)	38
1		10	2005	Mt Ive HS	Langdon, P. (pers. comm.)	U
1		10	2005	Mt Ive Stn, S of Some Quality Bore	Langdon, P. (pers. comm.)	
			2005	Moonabie HS, 9 km E	Stead, C. (pers. comm.)	19
1		8	2006	Old Siam HS, 1km NW	Langdon, P. (pers. comm.)	

Appendix 2. Plant species recorded at sites with *Amytornis textilis myall*. Abundance: +++ = prominent at many sites; ++ = present at several sites; + = present at few sites; * = introduced species

Species	Common Name	Abundance
Acacia aneura	Mulga	+
Acacia burkittii	Pin-bush Wattle	+
Acacia colletioides	Veined Wait-a-while	++
Acacia continua	Thorn Wattle	+
Acacia ligulata	Sandhill Wattle	++
Acacia oswaldii	Umbrella Wattle	++
Acacia papyrocarpa	Western Myall	+++
Acacia rigens	Nealie	+
Acacia tetragonophylla	Dead Finish	++
Acacia victoriae	Elegant Wattle	++
Alectryon oleifolius	Bullock Bush	++
**Asphodelus fistulosus*	Onion Weed	+
Atriplex stipitata	Bitter Saltbush	+
Atriplex vesicaria	Bladder Saltbush	+++
Austrodanthonia caespitosa	Common Wallaby-grass	+
Austrostipa elegantissima	Feather Spear-grass	++
Austrostipa sp.	Spear-grass	+
Carpobrotus modestus	Inland Pigface	+
**Carrichtera annua*	Ward's Weed	++
**Carthamus lanatus*	Saffron Thistle	+
Cassinia laevis	Curry Bush	+
Casuarina pauper	Black Oak	+
Chenopodium curvispicatum	Cottony Goosefoot	+
Chenopodium nitrariaceum	Nitre Goosefoot	++
Cratystylis conocephala	Bluebush Daisy	+
Crinum flaccidum	Murray Lily	+
Disphyma crassifolium	Round-leaf Pigface	+
Dissocarpus paradoxus	Ball Bindyi	+
Dodonaea lobulata	Lobed-leaf Hop-bush	+
Dodonaea viscosa ssp. angustissima	Narrow-leaf Hop-bush	+
**Echium plantagineum*	Salvation Jane	+
Enchylaena tomentosa	Ruby Saltbush	++
Einadia nutans	Climbing Saltbush	+
Eremophila alternifolia	Narrow-leaf Emubush	+
Eremophila longifolia	Weeping Emubush	+
Eremophila maculata	Spotted Emubush	+
Eremophila oppositifolia	Opposite-leaved Emubush	+
Eremophila scoparia	Broom Emubush	+
Eucalyptus gracilis	Yorrell	+
Eucalyptus oleosa	Red Mallee	+
Eucalyptus porosa	Mallee Box	+
Exocarpos aphyllus	Leafless Cherry	+

Species	Common Name	Abundance
Frankenia pauciflora	Southern Sea-heath	+
Geijera linearifolia	Sheep Bush	+
Grevillea huegelii	Comb Grevillea	+
Halosarcia indica	Brown-head Samphire	+
Lomandra effusa	Scented Mat-rush	+
Lycium australe	Australian Boxthorn	+++
Maireana aphylla	Cotton-bush	++
Maireana appressa	Pale-fruit Bluebush	+
Maireana astrotricha	Low Bluebush	+
Maireana brevifolia	Short-leaf Bluebush	+
Maireana erioclada	Rosy Bluebush	+
Maireana georgei	Satiny Bluebush	++
Maireana pyramidata	Blackbush	+++
Maireana sedifolia	Pearl Bluebush	++
Maireana trichoptera	Hairy-fruit Bluebush	++
Maireana triptera	Three-wing Bluebush	+
**Marrubium vulgare*	Horehound	+
**Medicago sp.*	medic	++
Minuria leptophylla	Minnie Daisy	++
Muehlenbeckia florulenta	Lignum	++
Myoporum platycarpum	False Sandalwood	++
Nitraria billardierei	Nitre-bush	++
Olearia decurrens	Winged Daisy-bush	+
Pimelea microcephala	Shrubby Riceflower	+
Pittosporum angustifolium	Native Apricot	+
Ptilotus obovatus	Silver Mulla mulla	+
Rhagodia crassifolia	Fleshy Saltbush	+
Rhagodia parabolica	Mealy Saltbush	+
Rhagodia spinescens	Spiny Saltbush	+++
Rhagodia ulicina	Intricate Saltbush	++
Sarcozona praecox	Sarcozona	+
Scaevola spinescens	Spiny Fanflower	++
Sclerolaena diacantha	Grey Copperburr	+
Sclerolaena obliquicuspis	Oblique-spined Copperburr	++
Sclerolaena sp.	Copperburr	++
Sclerostegia tenuis	Slender Samphire	+
Senna artemisioides ssp. coriacea	Broad-leaf Desert Senna	++
Senna cardiosperma ssp. gawlerensis	Gawler Ranges Senna	+
Sida petrophila	Rock Sida	+
Tetragonia implexicoma	Bower Spinach	+
Threlkeldia diffusa	Coast Bonefruit	+
Triodia irritans	Spinifex	+
Vittadinia sp.	New Holland daisy	+
Zygophyllum apiculatum	Pointed Twinleaf	+
Zygophyllum eremaeum	Climbing Twinleaf	++