Monitoring grassland earless dragons at Jerrabomberra East Grassland Reserve 2009 - 2018

An update on ten years monitoring

Photo: W. Dimond

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Introduction

The grassland earless dragon (*Tympanocryptis pinguicolla*) is a nationally endangered species with populations located only near Canberra and in parts of the Monaro region south of Cooma. A recent genetic study (Carlson *et al.* 2016) indicates that the ACT region population is an important evolutionary significant management unit (ESU) and that the genetic differences are at a level where the ACT region population could be classified as a new species. The study required to describe the population from the ACT region as a new species is now underway at the Museum of Victoria (Jane Melville, Museum Victoria, pers. comm.). Conservation of all populations of this very restricted new species will be a high priority for land managers.

In the ACT region the species has been found in the Majura and Jerrabomberra Valleys (Bonshaw, Jerrabomberra Grassland Reserve West, Jerrabomberra Grassland Reserve East, and in the Symonston area) (ACT Government 2005; Biosis 2012). Several populations also occur near Queanbeyan (Queanbeyan Nature Reserve and The Poplars) (Robertson and Evans 2012). Populations in the Jerrabomberra Valley comprise an extremely important component of the ACT – Queanbeyan region population of this endangered species (Robertson and Cooper 2012).

The grassland earless dragon has suffered a very serious decline in population size in the ACT. The decline commenced in 2006-2007 (Dimond *et al*. 2012) and at that time the region was experiencing severe drought and increased herbivore pressure on the grasslands. The specific reasons for actual losses to populations are still not known. The two main hypotheses relate to drought: (1) eggs and/or hatchlings may have died as a result of dehydration and excessive heat; and (2) with the greatly reduced ground cover there may have been increased predation on juveniles (most likely by magpies, raptors and snakes).

To help test the possibility that grassland condition is influencing the recovery of populations of grassland earless dragons in the ACT, staff of Canberra Nature Park arranged for the construction, in 2010, of paddock-sized kangaroo exclosures at two locations in natural temperate grassland (Jerrabomberra East and Jerrabomberra West) (Figure 1). Both locations were known to contain high quality native grassland that previously supported populations of grassland earless dragons (Dimond et al. 2012 and Nelson *et al*. 1998). Extensive areas of grassland suitable for the species also occur outside of the exclosures at each of these locations.

In 2010, Canberra had above average rainfall and this led to the establishment of a tall, dense grass sward at sites that were not grazed. In the absence of grazing by kangaroos in the kangaroo exclosure at Jerrabomberra East, this tall, thick grassland persisted until the exclosure was opened to kangaroo grazing in 2017. As a result, the exclosure treatments at Jerrabomberra East have provided a comparison between grids that are grazed by a large local population of kangaroos (grids P and O) and grids that, until recently, supported tall dense grasslands that were not grazed (grids U and Y) (Figure 1). To reduce the cover of grass in the kangaroo exclosure, approximately half of each of the two monitoring grids was burnt in large patches in 2015, (the results of these management actions on grassland condition has not been documented yet; M. Gilbert and B. Howland pers. comm).

Monitoring the effects of these adaptive management actions and other management activities, such as weed control, requires a strong commitment to ongoing monitoring of the relative abundance of the lizards and the condition of their habitat. During the past decade the ACT Parks and Conservation Service has made such a commitment. Annual monitoring of populations of grassland earless dragons is one component of the conservation program for the species in the ACT (ACT Government 2017).

Aims

The longer-term aims of the monitoring program are to: (1) determine whether populations of grassland earless dragon are recovering from the recent population decline (caused by the prolonged drought culminating in population crashes in 2006 and 2007); (2) examine the response by the lizards (and their habitat) to the removal of large herbivores; and (3) in the longer term, help to determine the response of the lizards to a return to controlled levels of kangaroo grazing as a means for reducing vegetation biomass.

This report summarizes the monitoring results from four grids at Jerrabomberra East grassland reserve for ten years (2009-2018). In 2014, 2015 and 2016 additional surveys were undertaken to supplement the annual monitoring program (for example to confirm that grassland earless dragons occur within dispersal distance of grids in the kangaroo exclosure). These results are not presented here but are summarised in an earlier report (Osborne 2017).

Methods

In 2009 the University of Canberra established two monitoring grids for grassland earless dragons in natural temperate grassland near the southern boundary of Jerrabomberra East grassland reserve (Grids O and P; Figure 1). Later, in 2011, with support from ACT Parks and Conservation Service, two grids were established in the kangaroo exclosure at Jerrabomberra East (Grids U and Y; Figure 1). Each grid was located at least 100m from all other grids to maintain 'trapping' independence between grids (Figure 3); 100m was chosen because it was considered to be unlikely that lizards would move over this distance during a sampling period (Evans & Ormay 2002; Stevens et al 2010). Grids were established authoritatively within areas already known to have had dragons in the past and which appeared to support suitable habitat (i.e. higher well drained ground that contained open patches dominated by *Rytidosperma carphoides* and other low ground cover species characteristic of natural temperate grassland).

In October 2015 the tall, dense grass cover on grids U and Y in the kangaroo enclosure was reduced by the burning of large patches (up to 20 m diameter) within the grid (this work was carried out by staff of ACTPCS) . This reduced the extent of dense grass cover by about 50 percent. Exactly half of the artificial shelter tubes were located in the burnt patches and the remainder were in unburnt grassland. In 2017 the exclosure was re-opened to kangaroo grazing (M. Gilbert pers. comm.) and this has continued to 2018.

Grassland earless dragons were detected on the monitoring grids by using artificial burrows made from PVC drain pipe (31mm diameter x 142mm deep), lined with brown paint and sand, slipped inside an outer sleeve that remains in the ground (Figure 2), to facilitate checking for any sheltering specimens and to enable the tubes to be cleaned (Fletcher *et al*. 2009; Nelson 2004; Nelson *et al.* 2004). The artificial burrows do not actually trap individuals; lizards are able to enter and leave these burrows at will. Any dense or tall vegetation around each shelter tube was cut back to ground level within a radius of 20 cm. This was done to facilitate access to the shelter tubes by the lizards.

At each monitoring site, a single grid of artificial burrows (shelter tubes) was established comprising seven rows of eight (7 X 8) artificial burrows (in total 56 burrows) with a ten metre spacing between each burrow (Figure 3). From 2009 to 2011 all artificial burrows were shaded by a flat metal shelter (200 x 200 mm). However, in 2012 and 2013 the use of the shelters was discontinued because of the presence of tall, dense grass growth at most of the ACT monitoring sites. Shelters were reinstated in 2014 to further examine the influence of the shelters on detection. Between 2014 and 2018 a standard approach was adopted across the ACT monitoring sites (Dr M. Evans pers. comm.); this involved alternating artificial burrows set with shelters with burrows set without shelters (i.e. four shelters used per row of eight artificial burrows).

Monitoring was undertaken from early to mid-February to late March or early April of each year (depending on start date and allowing for days lost to poor weather conditions and total fire bans when the reserve was closed) (Table 1). This period overlaps the time when juveniles will emerge and enter the trappable population (Dimond 2009). During the survey period the artificial burrows were checked three times a week for lizards – for a total of 18 checks. When captured, grassland earless dragons were measured for snout-vent length (SVL) (to help determine age and growth), tail length, and weight; an estimation of sex in larger individuals was made and details of breeding colours and general body condition noted.

Following Dimond (2009), juveniles were considered to be individuals smaller that 28.0 mm SVL, subadults 28 - 38 mm SVL and adults greater than 38 mm SVL. Repeated captures of the same individual allow for analysis of survival; therefore individuals were also marked ventrally with a sharpie pen (non toxic) and photographed for identification (from dorsal and throat colour pattern). Once all data was recorded from an individual it was released immediately back into the shelter tube in which it was discovered.

Figure 1 removed to protect sensitive species location data.

Figure 1 - Species Location Data – approximate locations of long-term grassland earless dragon monitoring grids within the Jerrabomberra East site.

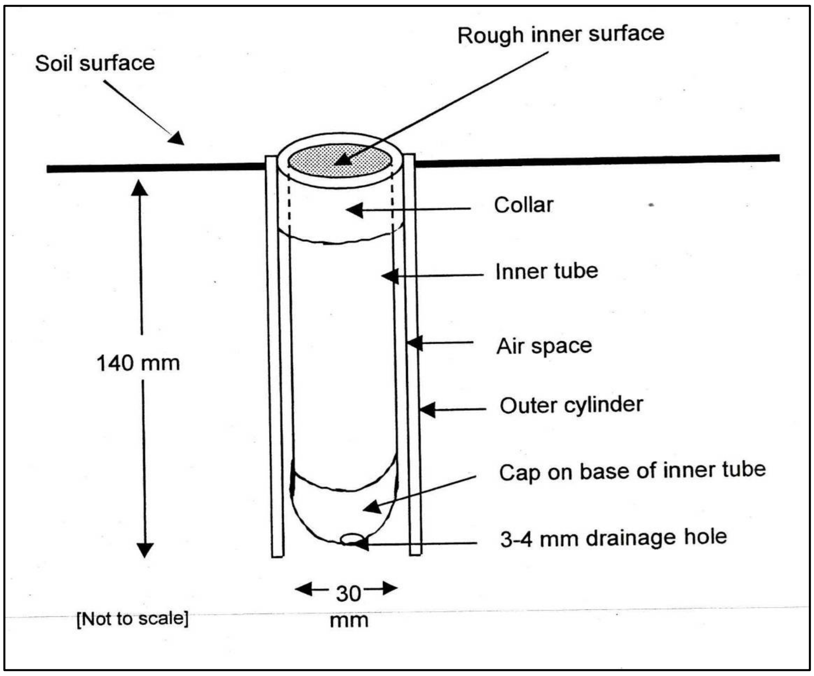

Figure 2 - Artificial burrows used to capture grassland earless dragons (Diagram from Nelson 2004)

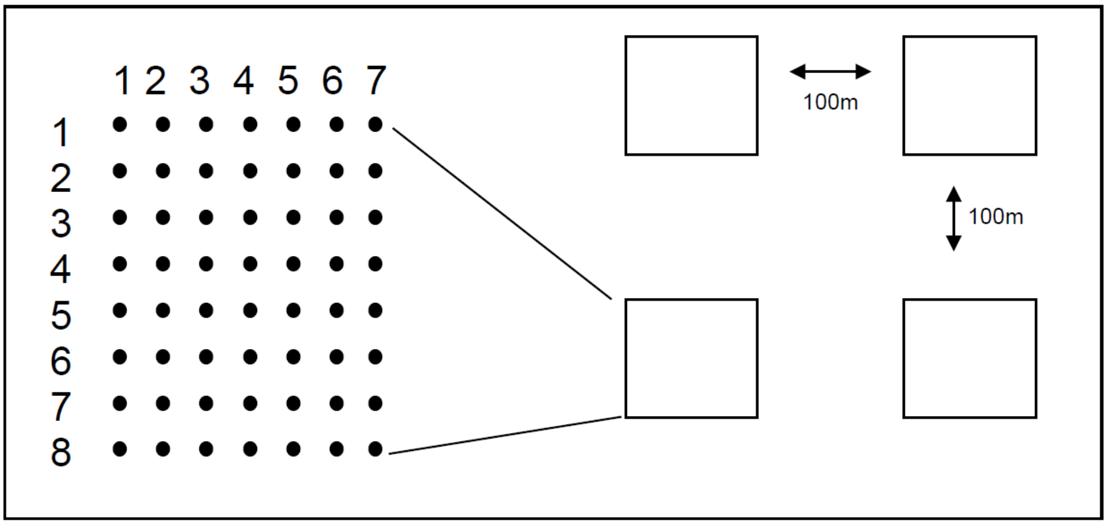

Figure 3 - Layout of individual grids, located at least 100m apart. Black dots represent the artificial burrows, spaced 10m apart.

Table 1 - Monitoring dates for monitoring locations. This table shows the dates that monitoring was conducted at each monitoring location between 2009 and 2015 at Jerrabomberra east grassland reserve. Data from 2009 and 2010 were collected by W. Osborne as a part of another study.

Year	Grid code	No. of grids	Sampling dates
2009	Grids 0 and P	2	February - March
2010	Grids O and P	2	February - March
2011	Grids O P U Y	4	February – April
2012	Grids O P U Y	4	13 Feb - 26 April (21 checks)
2013	Grids O P U Y	4	11 Feb – 25 March (20 checks)
2014	Grids O P U Y	4	10 Feb – 9 April (19 checks)
2015	Grids O P U Y	4	9 Feb - 20 April (18 checks)
2016	Grids O P U Y	4	8 Feb – 19 April (18 checks)
2017	Grids O P U Y	4	6 Feb – 27 March (20 checks)
2018	Grids O P U Y	4	21 Feb – 29 March (18 checks)

Counts of naturally occurring burrows

The density of naturally occurring arthropod burrows within each monitoring grid was determined by undertaking a single visual count along seven, 2 m wide, strip transects established across each grid. These transects were 70 m long and corresponded to the seven lines of artificial burrows. All natural burrows larger than 8 mm that were seen within the strip transect were counted and the occupants of the burrow noted if they could be seen. Two counts were made on each grid (23 February and 21 March 2018).

Grassland condition photographs

Photographs of ten 1 X 1 m plots were taken at 10 metre intervals along a single line transect set diagonally across each grid in a straight line between shelter tube positions 1,1 and 7,8 (Figure 4). If quadrat positions were located near shelter tubes or on the internal grid access tracks the quadrat was moved to the nearest undisturbed position. A single photograph was taken vertically above each quadrat. These photographs are available for future reference as an indicator of grassland condition at the time of the survey.

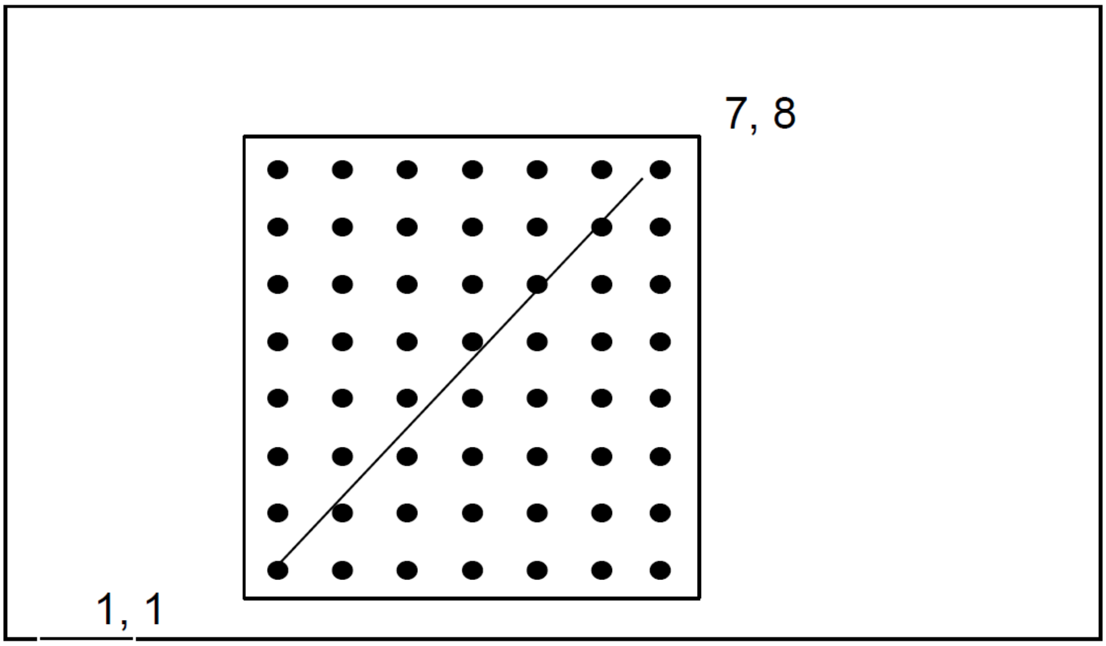

Figure 4 - Location within the grids of a single transect used to determine the position of the photo monitoring plots. Ten 1 by 1 metre plots were spaced at 10m intervals along the transect. A single photograph was taken vertically above each quadrant. Black dots represent the artificial burrows.

Results

Grassland earless dragon monitoring

Grassland earless dragons were detected across the four monitoring grids in 2018 (Table 2 a through 2 e). However, the number of individuals (unique individuals) recorded was quite low with only 14 individuals being captured. The total number of captures (including recaptures) was 17. Most individuals captured were juveniles or subadults (73 %) indicating that there has been successful breeding in or near all grids. The highest number of captures and detections was recorded at Grid P. Very few individuals were recorded at the other three grids (O, U and Y).

Low numbers of grassland earless dragons were recorded on grids O and P at Jerrabomberra East between 2009 and 2015, however the numbers detected increased markedly in 2016 and remained high in 2017. In 2018 the number of individuals detected dropped by approximately one half (Figure 5; Table 3). The increase in numbers was comprised mainly of juveniles.

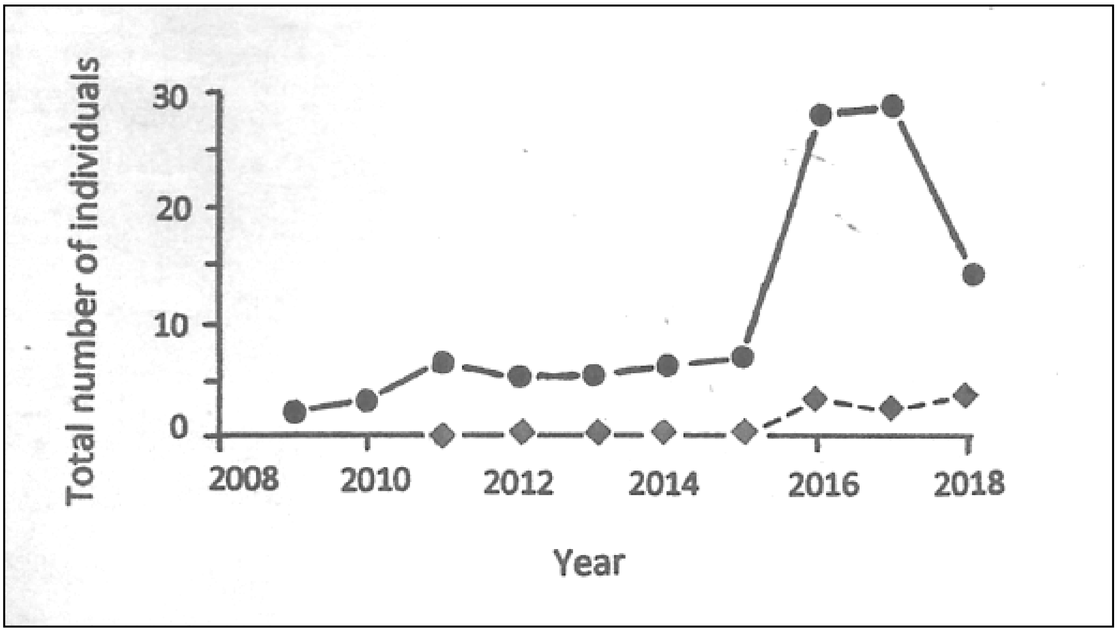

Figure 5 - Total numbes of unique individuals detected at Jerrabomberra East grassland reserve between 2009 and 2016. The graph shows combined totals from all grids (closed circles) and totals for the two grids in the kangaroo exclosure (closed diamonds). See Table 2.a through 2.e, and Table 3 for details of individual grids.

Table 2.a - Grid P summary capture data for Jerrabomberra East long-term monitoring grids in 2018

Grid P	**Detections (Unique individuals)**	**Detections (including recaptures)**
Adult males	1	1
Adult females	1	2
Sub-adults	2	2
Juveniles	3	5
Total	7	10

Table 2.b - Grid O summary capture data for Jerrabomberra East long-term monitoring grids in 2018

Grid O	**Detections (Unique individuals)**	**Detections (including recaptures)**
Adult males	1	1
Adult females	0	0
Sub-adults	0	0
Juveniles	2	2
Total	3	3

Table 2.c - Grid U summary capture data for Jerrabomberra East long-term monitoring grids in 2018

Grid U	**Detections (Unique individuals)**	**Detections (including recaptures)**
Adult males	0	0
Adult females	0	0
Sub-adults	1	1
Juveniles	1	1
Total	2	2

Table 2.d - Grid P summary capture data for Jerrabomberra East long-term monitoring grids in 2018

Grid Y	**Detections (Unique individuals)**	**Detections (including recaptures)**
Adult males	0	0
Adult females	0	0
Sub-adults	1	1
Juveniles	1	1
Total	2	2

Table 2.e - Total Summary Data for all grids

Over totals	Detections (Unique individuals)	Detections (including recaptures)
All Grids	14	17

Individuals were captured on Grids O and P of each year except in 2014 when no individuals were captured on Grid P. By contrast, no individuals were detected on grids within the kangaroo exclosure during the first seven years of monitoring. This situation changed following the burning of large patches within each of the grids in 2016. Three large sub-adult dragons were detected in the burnt patches in grid U in 2016. Then in 2017 two small juvenile dragons were detected in the same burnt patches. In 2018 two larger juveniles were captured at Grid U (these were not the same individuals that were photographed in 2017). No individuals were detected at Grid Y until 2018 when two individuals (a juvenile and subadult) were captured.

Table 3 - Results of annual monitoring of Grasslands Earless Dragons on long-term monitoring grids at Jerrabomberra East grassland between 2009 and 2018. The numbers are the numbers of unique individuals. This data is available as an Excel file.

	Grid O	Grid P	Grid U	Grid Y	**Total**
2009			Not yet established	Not yet established	**2**
Adult males	1				
Adult females					
Juveniles/subadults	1				
2010			Not yet established	Not yet established	**3**
Adult males					
Adult females					
Juveniles/subadults	3				
2011					**6**
Adult males	4				
Adult females		1			
Juveniles/subadults	1				
2012					**5**
Adult males	3				
Adult females		2			
Juveniles/subadults					
2013					**5**
Adult males*	1	1			
Adult females*	1	1			
Juveniles/subadults*	1				

	Grid O	Grid P	Grid U	Grid Y	**Total**
2014					**6**
Adult males	1				
Adult females	2				
Juveniles/subadults	3				
2015					**7**
Adult males					
Adult females	1				
Juveniles/subadults	4	2			
2016					**28**
Adult males	1	2			
Adult females	1	2			
Juveniles/subadults	10	15	3		
2017					**29**
Adult males		3			
Adult females		1			
Juveniles/subadults	7	16	2		
2018					
Adult males	1	1			
Adult females		1			
Juveniles/subadults	2	5	2	2	14

* In 2013 four of the five individuals recorded were obtained earlier than the monitoring period by Dr L. Doucette (University of Canberra), in December and January when the tubes were opened to obtain specimens for a radio-tracking study. Surprisingly these individuals were not detected during the following monitoring period four weeks later, although one specimen was found to be sheltering in a natural burrow and one new adult male was detected (Table 5).

The influence of artificial shelters on detection

The 2016 and 2018 data are summarized in the text below. Note that shelters were not used in used in 2017 to fit in with another research study (B. Howland pers. comm.) and counts in other years were very low and were not included.

Ninety-one detections of grassland earless dragons were made on Grids O and P which supported a low and comparatively sparse vegetation cover at the time of sampling. Sixty of the detections (66 %) were of individuals in artificial burrows under shelters and 31 detections (34 %) were of individuals found in artificial burrows without shelters.

To address the question as to whether any particular individual was detected at tubes with only one shelter type (either no shelter or shelter) it is necessary to consider recaptures. The results are shown in Table 4 below.

Table 4 - Preference for shelter type

Individuals detected in both sheltered and unsheltered tubes	Individuals detected only in sheltered tubes	Individuals detected only in unsheltered tubes
14	20	10

These data indicate a clear preference for sheltered burrows. Over the course of six weeks sampling about a third of the individuals that chose unsheltered tubes had not been detected under sheltered tubes. It is not known if the 20 individuals detected only under shelters would also have been detected if there were no shelters available. Given the apparent preference for shelters, I recommend that monitoring be done with tubes set with shelters (at least at every second trap position) as this may slightly increase the number of unique individuals sampled. Note that the archived raw data is available as an EXCEL file accompanying this report.

Counts of natural arthropod burrows

Counts of natural arthropod burrows are shown in Table 5. The highest density of naturally occurring arthropod burrows was found in grid O (total count 32 burrows; mean/transect = 8.9) followed by Grid P (total count 32; mean/transect = 4.6). Fourteen burrows (mean/transect = 1.9) were recorded within the transects in Grid U and three burrows (mean/transect 0.5) were recorded in Grid Y.

Table 5 - Counts of natural burrows made on two dates at each long-term monitoring grid

Grid	Date	T 1	T 2	T 3	T 4	T 5	T 6	T 7	Total
O	23-2-2018	9	6	6	7	2	3	4	37
O	21-3-2018	7	3	7	1	3	2	3	26
P	23-2-2018	2	11	10	6	2	8	6	45
P	21-3-2018	7	3	4	7	4	4	3	32
U	23-2-2018	2	2	7	1	1	1	0	14
U	21-3-2018	3	1	1	0	0	0	0	0
Y	23-2-2018	3	0	4	1	2	0	0	10
Y	21-3-2018	0	0	0	0	0	0	1	1

Discussion

The results presented here highlight the importance of collecting long-term data on threatened species. Without monitoring the responses of species to processes such as grazing, drought and fire, the impact of human management actions can be very difficult to interpret. In the present study, we detected two main trends in earless dragon populations. First, a clear recovery of the grassland earless dragon population (Figure 5) has occurred at sites that have been grazed by eastern grey kangaroos throughout the ten years of the study. This appears to represent a post-drought recovery phase, however in the last year of monitoring (2018) a decline of about 50 percent was detected. This may reflect year-to-year variation in abundance but more likely is a result of the very dry summer of 2017/18 which may have affected survival of juveniles. This requires further analysis and involves the inclusion of monitoring data from all ACT region sites (including the recent monitoring data for Mikes Hill, where a similar drop in detection occurred this year; Brett Howland ACT Government, pers. comm.). The second finding that is obvious is the prolonged lack of detection of the species at formerly occupied sites in tall dense grassland within the kangaroo exclosure. It was not until large patches were burnt within the monitoring grids in the enclosure in the spring of 2015 that grassland earless dragons were detected in the exclosure. It is very unlikely that these individuals were living at grid U before the patch burning occurred. It is reassuring that in 2018, for the first time during the ten years of monitoring, individuals were captured on both grids in the kangaroo exclosure (U and Y).

It could be argued that grassland earless dragons were actually present within the monitoring grids in the exclosure, and that they were simply not detected because the excessive cover would make it unlikely that they would use the artificial burrows. However, this view is not supported by the findings here. Despite the very close proximity of Grids U and Y in the exclosure to an existing population of grasslands earless dragons (occupied habitat occurs within 50 m of both grids in the exclosure) there has not been a detection of the species on Grid Y in seven years of monitoring until the detections this year (2018) – even following the removal of about half the cover of grass by patch burning in 2016. By contrast, at Grid U there was no detection of individuals for five years, but then three individuals were detected in the first summer season after burning occurred on that grid (2016; Table 3). This would appear to support the view that the lizards could occur in the denser grasslands. However, these three individuals (two males and a female) were all almost adult in size and were found only in a burnt patch on the far eastern side of the grid that connected with more-open habitat on the nearby Mike's Hill. In the 2017 monitoring of this grid two small juveniles were detected in this same burnt patch indicating that breeding occurred within or very near the grid. Examination of the trends at nearby Jerrabomberra West Nature Reserve, where patch burning has also occurred, should help to improve our understanding of the importance of maintaining a more-open and patchy ground cover.

Over a two-year period (2016 and 2018) a clear preference was shown by the lizards for artificial burrows that had a shelter set over them (66 % of detections were of lizards in sheltered tubes. When the data was reduced to the detection of unique animals this preference was less obvious but potentially represented up to a third of the unique individuals recorded (20 individuals were only ever caught in burrows that were sheltered compared to 10 individuals only ever caught in burrows that were not sheltered). A similar finding was found by the Conservation Research Unit (ACT Government) after analysing a larger set of data from all monitoring sites in the ACT (Dr Murray Evans pers. comm.). This is important given that some monitoring and survey programs for this species do not use shelters.

Counts of naturally occurring arthropod burrows indicated some variability in their availability, both spatially and temporally. The considerably lower (55 %) number of burrows observed during the second count was surprising. However, it is a feature that we have noticed in some previous years and it most likely is a result of dry conditions preventing soil dwelling arthropods from excavating new burrows (new burrows tend to appear after rainfall when the soil is softer). In addition, the old burrows gradually get filled in with soil and other surface debris unless they are being used. The results also indicate that the soil arthropod fauna that makes these burrows is still very depleted in the kangaroo exclosure. This is likely to have been a direct result of the dense and rank ground cover that persisted from 2010 to 2016. The reduced availability of burrows is likely to impede the ability of the population in this area to recover.

Trials involving the provision of artificial burrows for the endangered pygmy bluetongue lizard have been very successful (Souter *et al.* 2004), and past research in the ACT has determined that simple burrows constructed by hammering a suitable-sized piece of dowel or piping into the ground, and then removing it, successfully creates an artificial burrow (W. Osborne unpublished data). In the past, burrows constructed by using this technique have been rapidly occupied by overwintering dragons (W. Osborne unpublished data). To facilitate recovery of the lizard population in the exclosure (and at other occupied sites where burrows appear to be limited in availability such as at Jerrabomberra West) I recommend, as a management strategy, the establishment of experiments involving artificial burrows (suitable-sized holes made in the soil) in October (when adults start to search for burrows to lay eggs in) and then again in mid March (when lizards start to search for over-wintering burrows). The numbers of burrows to be constructed at a site has not been determined. It will depend on the size of the patch and will be guided by the density of naturally occurring burrows at sites occupied by moderate to high densities of grassland earless dragons.

Burrow construction to assist with protection of individuals could also be conducted at sites where recovery is still occurring and where potentially harmful management interventions are planned (for example at sites that are going to be mown or burnt). In such situations, I would recommend, as a management strategy, the establishment of artificial burrows at least four weeks before the mowing or burning is implemented (this would ensure that the lizard's are familiar with the location of all burrows in their home range).

Recommendations

1. Continue grid-based monitoring of Grids P, O, Y, and U to determine effect of the manipulated changes in grass cover (patch burning and kangaroo grazing). Monitoring should continue to determine whether grids Y and U eventually become recolonized by the lizards.
2. Continue the program of patch burning on the monitoring grids and in the surrounding parts of the kangaroo enclosure until a suitable level of habitat structure (open patches mixed with taller denser patches) is achieved throughout the enclosure. It may be possible to maintain a more open structure with the use of controlled levels of kangaroo grazing.
3. Until the soil arthropod fauna recovers, use artificial burrows to provide shelter sites in burnt patches that lack a suitable number of naturally occurring burrows.
4. Continue to use alternating shelters with the artificial burrows used in monitoring until the usefulness of using them has been determined by follow-up analysis.
5. Undertake a broader analysis of the ACT monitoring data for Majura, Cookanalla, Jerrabomberra West and Jerrabomberra East to help determine and interpret the relationship between population trends and habitat condition, and weather.
6. Instate a program of habitat condition measurement that accompanies the annual monitoring program. This should include counts of arthropod burrows and some record of grass height, density and composition (for example through use of photographic plots).
7. Increase the effectiveness of the weed control program by including saffron thistle in the list of species to be controlled and by better targeting of Saint Johns Wort and Serrated tussock which have spread rapidly in

recent years. In addition a concerted effort should be made to control phalaris within the reserve, particularly within low lying areas that occur between areas of potential grassland earless dragon habitat. If invasion by phalaris is left unchecked it will compromise the potential for movement by the lizards between occupied patches.

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