Diet, nest sites and breeding success of the Wedge-tailed Eagle *Aquila audax,* during 2012 at Lorna Glen Conservation Reserve, Western Australia.

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February 2013

EXECUTIVE SUMMARY

This report details the findings of wedge-tailed eagle research conducted by Insight Ornithology at Lorna Glen Proposed Conservation Reserve during late 2012. Fieldwork carried out in August 2012 identified numerous wedge-tailed eagle nests, many of which were active containing eggs or chicks. This survey therefore aimed to gather information on wedge-tailed eagle productivity by revisiting these nests, assessing their status, and collecting prey remains from them to determine eagle diet. It also aimed to expand current nesting data by searching for new breeding territories in locations as yet unvisited.

Fourteen new wedge-tailed eagle nests were located at Lorna Glen during December 2012. Together with information from previous field surveys, this brings the nest total to 52 and the number of breeding territories present in the study area to at least 24. All 14 new nests were built in *Acacia pruinocarpa* trees, usually on ridges or at the top of breakaways, a result which complimented previous findings in the study area. Despite many suitable nest sites, no nests were located in the spinifex/sandplain habitat, or along drainage lines, probably because wedge-tails prefer higher ground where tall trees provide a commanding view over their territory.

During the 2012 breeding season, 16 of the 24 wedge-tailed eagle territories (67%) were confirmed as occupied, each containing one active nest. Seven nests (44%) were lined partly or wholly with fresh sprigs (mostly *Acacia* or *Eucalyptus*), and nine (56%) were fully lined and had eggs laid in them.

No wedge-tailed eagles bred successfully in 2012. In August only one of the nine nests (Nest 2) was observed to have hatched chicks: 2 eaglets aged less than one week were photographed on this nest on 11th August. By 16th August one eaglet had disappeared, and on 9th December this eaglet was found dead under a perch tree near the nest, aged 6-7 weeks. None of the remaining nests in which eggs were laid contained evidence that chicks had hatched, or developed on their nest for more than one week. Such breeding failure was attributed to erratic rainfall and failure of eagle food to reach the minimum density threshold required for survival of young.

Eight-hundred and sixty-six prey fragments and 39 pellets collected from nests and associated perch trees yielded 20 species of vertebrate animal taken by wedge-tailed eagles at Lorna Glen. These comprised seven mammal, ten bird and four reptile species. The most frequently eaten prey animals were large macropods (euros *Macropus robustus* and red kangaroos *M. rufus*), emu *Dromaius novaehollandiae* chicks, Australian bustards *Ardeotis australis* and large Varanids (yellow-spotted monitor *Varanus panoptes* and Gould's monitor *V. gouldii*). One reintroduced mammal, a bilby *Macrotis lagotis*, was identified by a skull found at Nest 33. This is the first known record of eagles preying on a reintroduced mammal outside the fenced enclosure.

Further fieldwork is planned for mid-March 2013. This will include conducting more nest surveys in unsearched areas, and preparation of cage traps to be used for eagle capture and subsequent satellite telemetry in June.

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1 INTRODUCTION

In 2011, Insight Ornithology was commissioned by the Department of Environment and Conservation (DEC) to conduct an investigation into the ecology of the wedge-tailed eagle at Lorna Glen Conservation Reserve, situated across the border of the Murchison and Gascoyne regions in Western Australia. This (planned long-term) study has the following aims:

- To determine and monitor the status (whether breeding resident, visitor, vagrant, etc) of the wedge-tailed eagle at Lorna Glen;
- To quantify the diet of the wedge-tailed eagle at Lorna Glen;
- To relate eagle diet to the reintroduction of Threatened mammal species present at Lorna Glen, both in the 1100ha fenced enclosure, and across the broader landscape;
- To gather detailed information on eagle home range and habitat use via satellite telemetry, and relate this to Threatened mammals.

Findings of this research can then be used to assist with future management decisions regarding Threatened mammal translocations (for more information see Cherriman 2012*a*; 2012*b*).

Wedge-tailed eagles were confirmed as a breeding resident and a total of 38 eagle nests were located during previous field work, most of which being carried out in August 2012. At this time breeding was reported in 7 of 12 active nests. In order to assess the breeding success and gain further information on eagle diet, a second 2012 field trip was planned for the end of the breeding season. The aims of this trip which were:

- To revisit active wedge-tailed eagle nests located during August 2012 and obtain data on breeding success and diet in 2012;
- To conduct further surveys in as yet unvisited areas, locate as many new eagle nests as possible and determine their status;
- To supplement previously collected data on the number breeding pairs of eagles present at Lorna Glen;
- To supplement existing data on eagle diet at Lorna Glen.

This report details the findings of the third field survey conducted in December 2012.

2 METHODS

2.1 Study Area

Lorna Glen Proposed Conservation Reserve is located approximately 150 km east north-east of Wiluna in Western Australia.

2.2 Personnel

The following personnel were involved in the preparation of this report:

- Mr Simon Cherriman *BSc. Hons (Env. Biol.), MSciComm. (Nat. Hist. Film.)*
- Mr Michael McDonnell *Dip. Marine Science.*

The field surveys were undertaken by Simon Cherriman and Michael McDonnell and the report was prepared by Simon Cherriman.

2.3 Field Survey

The field survey was conducted on 8th – 16th December 2012. Weather conditions were usually fine or partly cloudy with daily maxima around 35˚C. Activities undertaken during the field survey included the following:

2.3.1 Breeding Status/Nest Searching

Known nests located during previous fieldwork were revisited to check their status and to collect prey remains. Searches for new eagle nests were conducted in areas not previously visited in August 2012. These were conducted by systematically driving internal roads and access tracks, and walking and/or driving ridge-lines on a quad-bike, to search all visible vegetation for wedge-tailed eagle nests.

2.3.2 Breeding Territory Mapping

The locations of all wedge-tailed eagle nests identified during the field survey were mapped using Google Earth software. Spatial information together with eagle nest activity data was used to estimate the approximate territory boundaries of breeding eagles.

2.3.3 Diet Analysis

Prey remains (e.g. bones, fur and feathers) and regurgitated pellets were collected from all located wedge-tailed eagle nest sites (nests + nearby perch trees) to acquire information on diet. Some pellets were also collected from a tall, well used perched tree located about 2.6 km from Nest 7, most likely associated with this nest. Eagle dietary material from both August and December 2012 field surveys was analysed in the laboratory at DEC's Science Division in Woodvale following the methods of Cherriman (2007), which involved:

1) Identification of prey remains to genus, and if possible, to species, using a reference collection of animal skeletal material and bird feathers.
2) Quantification of a minimum number of individual prey animals using the prey remains.
3) Analysis and identification of material in regurgitated pellets using the skeletal reference collection for bones/feathers, and the Hair ID Interactive CD (Triggs and Brunner 2002) for mammalian hair.

4) Combining data from prey remains and pellets *only* when material in pellets could be used to reliably quantify numbers of animals within a pellet, and when animal parts could be considered in context of prey remains data to eliminate any possibility of 'double-counting' individuals.

2.3.4 Opportunistic Observations

Observations of wedge-tailed eagles were made at all times. Notes were made on the location, number and behaviour of birds sighted. Where possible, wedge-tailed eagles were aged using plumage colour (see Ridpath and Brooker 1986). Observations of adult eagles, especially those seen in pairs during the breeding season, can often indicate the location of a breeding territory containing nests. Thus, thorough searches for eagle nests were initiated in areas where sightings of such adult pairs were made.

3 RESULTS

3.1.1 Nests and Territories

Fourteen new wedge-tailed eagle nests were located at Lorna Glen during December 2012. Together with information from previous field surveys, this brings the nest total to 52 and the number of breeding territories present in the study area to at least 24. Characteristics of all new nests are shown in Table 1 and maps of nests and breeding territories are shown in Figure 1.

3.1.2 Breeding Status

Four of the 14 new nests were active during 2012: Nests 45 and 49 had been heavily lined with fresh Mulga leaves and fragments of eggshell present on a depressed cavity provided strong indication that laying had occurred earlier in the year. Fresh lining in Nests 46 and 52 indicated eagles had visited these nests but not laid eggs.

All twelve eagle nests reported as active during the August 2012 field survey were revisited. No eagles bred successfully. Nest 2, which when last visited on 16th August 2012 contained a small chick aged *c.* 1 week, had numerous juvenile eagle wing feathers in the nest cavity. A dead nestling eaglet aged 6-7 weeks (Figure 2) was located beneath a perch tree *c.* 20 m from the nest, suggesting it had died on the nest cavity and been removed and taken to the perch by an adult eagle. The six other nests on which eggs were observed in August were all empty and contained no evidence (i.e. newly added eucalypt leaves, build up of prey remains, fresh scats) that young had been reared.

3.1.3 Diet

Analysis of 866 prey fragments and 39 pellets collected from nests and associated perch trees yielded 20 species of vertebrate animal taken by wedge-tailed eagles at Lorna Glen (see Table 2). These comprised seven mammal, ten bird and four reptile species. Many bird bone fragments were unable to be identified past the family level. The most frequently eaten prey animals were large macropods (euros *Macropus robustus* and red kangaroos *M. rufus*), emu *Dromaius novaehollandiae* chicks, Australian bustards *Ardeotis australis* and large Varanids (yellow-spotted monitor *Varanus panoptes* and Gould's monitor *V. gouldii*). The only reintroduced mammal taken was a bilby *Macrotis lagotis* identified by a skull found at Nest 33 (see Figure 3). Figure 4 shows a typical example of a prey fragment collection from one nest.

Table 1. Characteristics, location and status of new wedge-tailed eagle nests located during the field survey carried out at Lorna Glen in December 2012.

Nest No.	Easting	Northing	Tree Species	Ht. (m)	2012 Status	Content	Notes
39	328527	7114524	*Acacia pruinocarpa*	10	inactive		Nest in good condition but no recent lining.
40	357227	7087542	*A. pruinocarpa*	5	inactive		Old nest partially collapsed, not used for many years.
41	356358	7094416	*A. pruinocarpa*	5	inactive		Old and deteriorated, not used for at least 5 years.
42	356077	7094425	*A. pruinocarpa*	9	inactive		Old and deteriorated, not used for many years.
43	355944	7094282	*A. pruinocarpa*	7	inactive		Old nest in dead tree, not recently used.
44	355744	7094548	*A. pruinocarpa*	9	inactive		Nest in good condition, a few fresh Eucalypt sprigs placed in last 1-2 months.
45	356536	7095255	*A. pruinocarpa*	4	**ACTIVE**	eggshell	Nest very recently lined, eggshell fragments suggesting breeding attempt.
46	341313	7118131	*A. pruinocarpa*	7	**ACTIVE**	Fresh leaves	Nest in good condition with several fresh sprigs placed in last 1-2 months.
47	354182	7121477	*A. pruinocarpa*	8	inactive		Very old, small nest, may old be used as feeding platform.
48	337882	7119614	*A. pruinocarpa*	8	inactive		Good condition but no lining.
49	338315	7120123	*A. pruinocarpa*	3	**ACTIVE**	eggshell	Nest very recently lined, eggshell fragments suggesting breeding attempt.
50	322742	7114939	*A. pruinocarpa*	5	inactive		Very old nest partially collapsed.
51	318660	7117275	*A. pruinocarpa*	8	inactive		Good condition with some signs of refurbishment, several scats below nest.
52	313807	7105028	*A. pruinocarpa*	11	**ACTIVE**	Fresh leaves	Good condition with fresh lining and several scats below.

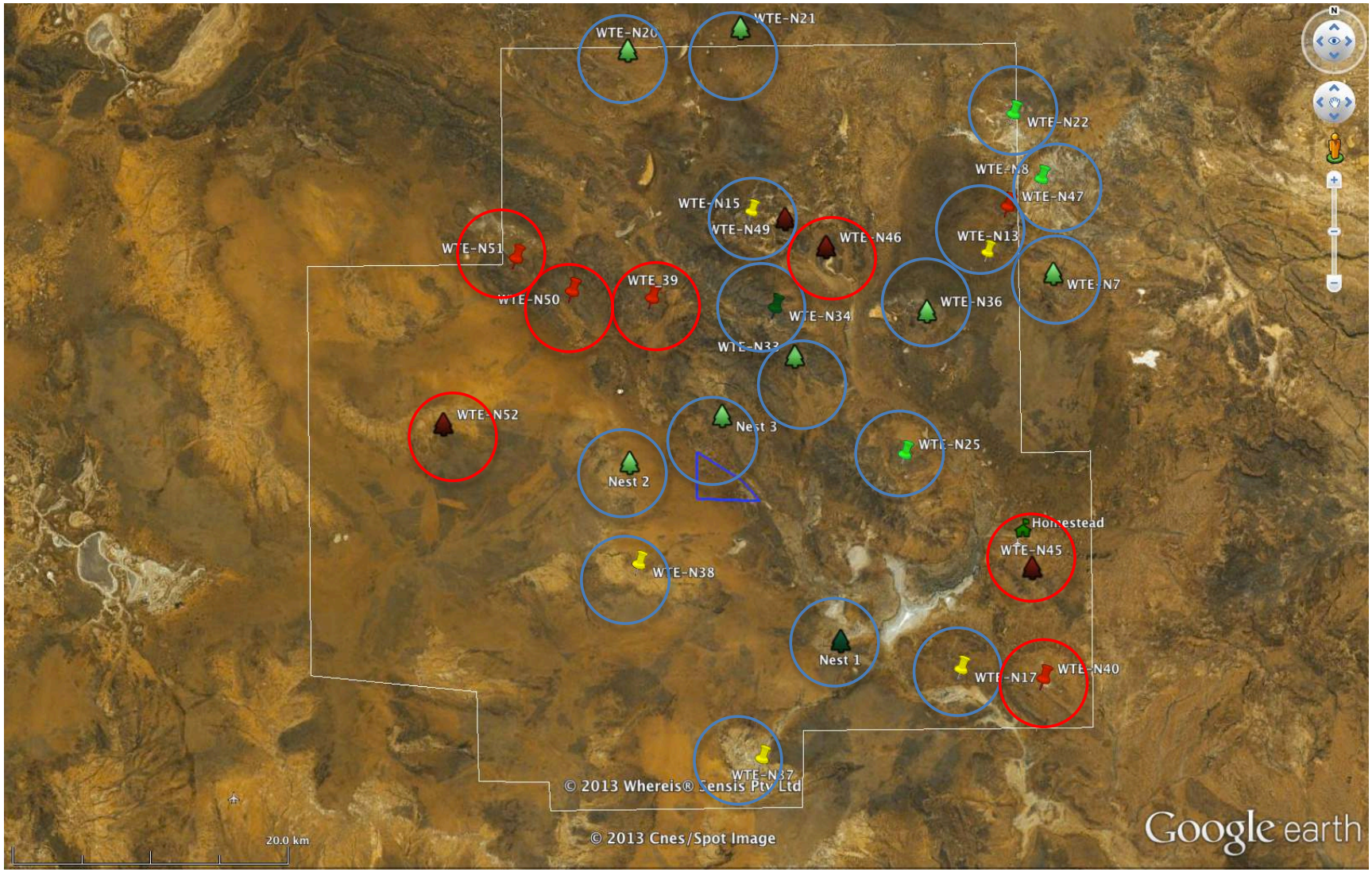

Figure 1. Map of Lorna Glen Proposed Conservation Reserve showing locations of 24 wedge-tailed eagle breeding territories and most recently active nests within each. Red circles indicate territories newly discovered in December 2012. Tree symbol = active nests containing eggs/chicks; green pin = active nests lined but not bred in; yellow pin = inactive nest; red pin = new nest; blue triangle = fenced enclosure. Note that eagle territories are unlikely uniform in shape – circles used for demonstrative purposes only.

Table 2. Number of vertebrate animals identified from prey remains and pellets at various wedge-tailed eagle nests at Lorna Glen during 2012 field surveys.

Prey Species		NEST NUMBER																									TOTAL:
		2	3	7	8	11	13	17	18	20	21	22	23	24	29	31	32	33	36	39	42	45	49	50	51	52	
MAMMALS:																											
Bilby	*Macrotis lagotis*																	1									**1**
Golden Bandicoot	*Isoodon auratus*		1																								**1**
Red Kangaroo (juv.)	*Macropus rufus*				1						1								2		2		3				**9**
Unidentified Kangaroo	*Macropus sp.*	3	1	2	7	4	1	4	1	1		0	1	2	9	2	2	4	1		1	1	2	1	1	1	**52**
	Total Macropods	***3***	***1***	***2***	***8***	***4***	***1***	***4***	***1***	***1***	***1***	***0***	***1***	***2***	***9***	***2***	***2***	***4***	***3***	***0***	***3***	***1***	***5***	***1***	***1***		***60***
*Feral Cat	*Felis catus*	1		1																							**2**
*Rabbit	*Oryctolagus cuniculus*				1			10	3			1	1					1	1				2				**20**
Unidentified Mammal												1															**1**
	Total Mammals:	**4**	**2**	**3**	**9**	**4**	**1**	**14**	**4**	**1**	**1**	**2**	**2**	**2**	**9**	**2**	**2**	**6**	**4**	**0**	**3**	**1**	**7**	**1**	**1**		**85**
BIRDS:																											
Emu (juv.)	*Dromaius novaehollandiae*	7	1				1																				**9**
Emu (eggshell)	*Dromaius novaehollandiae*			1														1									**2**
Australian Bustard	*Ardeotis australis*	1	1	2		1				1								1							1	1	**9**
Button Quail	*Turnix sp.*	1									1																**2**
Crested Pigeon	*Ocyphaps lophetes*	1		1	1	1														1							**5**
Galah	*Eolophus roseicapillus*	2																									**2**
Australian Ringneck	*Barnardius zonarius*																						1				**1**
Tawny Frogmouth	*Podargus strigoides*	1							1			1															**3**
Barn Owl	*Tyto javanica*	1	1																								**2**
Grey Butcherbird	*Cracticus torquatus*																					1					**1**
Little Crow	*Corvus bennetti*	2																1									**3**
Unidentified Large Bird					1			3							3			2					1				**10**
Unidentified Medium Bird																			1				1	1			**3**
Unidentified Small Bird								1										1					1	1			**4**
	Total Birds:	**17**	**3**	**4**	**2**	**2**	**1**	**5**	**1**	**1**	**1**	**1**	**0**	**0**	**3**	**0**	**0**	**6**	**1**	**1**	**0**	**1**	**4**	**2**	**1**		**57**
REPTILES:																											
Centralian Bluetongue	*Tiliqua multifasciata*	3	1					1																			**5**
Thorny Devil	*Moloch horridus*	1						1																			**2**
Yellow-spotted Monitor	*Varanus panoptes*	1		1			2	2										1		3		3					**13**
Unidentified Goanna	*Varanus sp.*		1		1	2			2	1	2	1	1		2		1	5	1		2		2	1	1		**26**
Total Varanids		***1***	***1***	***1***	***1***	***2***	***2***	***2***	***2***	***1***	***2***	***1***	***1***	***0***	***2***	***0***	***1***	***6***	***1***	***3***	***2***	***3***	***2***	***1***	***1***		***39***
	Total Reptiles:	**5**	**2**	**1**	**1**	**2**	**2**	**4**	**2**	**1**	**2**	**1**	**1**	**0**	**2**	**0**	**1**	**6**	**1**	**3**	**2**	**3**	**2**	**1**	**1**		**46**
	TOTAL ANIMALS:	**26**	**7**	**8**	**12**	**8**	**4**	**23**	**7**	**3**	**4**	**4**	**3**	**2**	**14**	**2**	**3**	**18**	**6**	**4**	**5**	**5**	**13**	**4**	**3**		**188**

Figure 2. Dead nestling wedge-tailed eaglet aged 6-7 weeks found under a perch tree near Nest 2 at Lorna Glen in December 2012.

Figure 3. Skull of bilby *Macrotis lagotis* found in prey remains sample from wedge-tailed eagle Nest 33, collected during field survey at Lorna Glen during December 2012.

Figure 4. Typical same of prey remains collected from wedge-tailed eagle nests at Lorna Glen. These remains were found at Nest 2 and represent macropod (3), cat (1), Australian bustard (1), galah (1), tawny frogmouth (1), barn owl (1), little crow (2), Centralian bluetongue (2), thorny devil (1) and varanid (1).

3.1.4 Opportunistic Observations

Eleven opportunistic records were made of wedge-tailed eagles during the field survey at Lorna Glen; these are presented in Table 2. As with records made during the August field trip, all eagles observed were adults with easily recognisable dark plumage.

Table 3. Opportunistic records of wedge-tailed eagles made during field survey at Lorna Glen, December 2012.

Sighting	Date	Time	Easting	Northing	Notes
1	10/12/12	7:50	327309	7102443	Single adult eagle perched in tree above Nest 2.
2	10/12/12	10:04	328527	7114524	Adult pair circling above ridge near Nest 39.
3	10/12/12	10:46	328138	7116696	Single adult flying low over road.
4	11/12/12	8:55	352788	7096053	Single adult perched in tall Eucalypt along creekline.
5	11/12/12	10:05	351066	7092376	Single adult eagle, probably female, flying low over road.
6	11/12/12	17:00	352788	7096053	Single adult eagle soaring above plain east of creekline.
7	12/12/12	13:25	355979	7123551	Single adult eagle soaring low over breakaway.
8	13/12/12	13:15	354903	7120499	Adult pair perched in live Gidgee, fresh pellets below.
9	13/12/12	14:20	339474	7110979	Single adult perched in live Gidgee, previously identified as eagle perch, near Nest 32.
10	14/12/12	1	319408	7117557	Single adult eagle flying low over road.
11	14/12/12	9	327652	7109622	Three adult eagles soaring very high, 2 engaged in grappling and rolling fight, one then began performing territorial display.

4 DISCUSSION

4.1.1 Nests and Territories

The site, situation and characteristics of new wedge-tailed eagle nests found during the field survey were consistent with those recorded previously at Lorna Glen (see Cherriman 2012*b*), and other studies in arid regions (Ridpath and Brooker 1987). New information on sites and spacing of eagle nests across the landscape provides further evidence that nest areas are confined to rockier Mulga habitat dominant in the northern section of the property, where tall gidgee *Acacia pruinocarpa* trees provide ample nest sites. Despite detailed searches among sandplain/spinifex habitat in the western and south-western portions of the study area, only one new nest was located in this habitat. This nest (Nest 52; see Figure 1) was situated on an 'island' of rocky, breakaway country with Mulga shrubland surrounded by sandplain, a feature shared with Nests 2, 37 and 38.

No wedge-tailed eagle nests were located along major drainage lines, despite this habitat having many tall trees suitable as sites. This finding is contrary to that of Silva and Croft (2007), who found wedge-tails to build nests in both ridge and creek habitats in arid New South Wales. Along creeks at Lorna Glen, there were many nests of other raptor species, including black-breasted buzzard *Hamirostra melanosternon*, whistling kite and little eagle *Hieraeetus morphnoides*. There is a possibility that this complex of potential competitor species deters eagles. Though it is more likely that wedge-tails prefer the ridges because higher ground affords nesting adults the commanding view over the surrounding landscape they require (Olsen 2005), more so than that offered from tall eucalypts along creeks.

That eagles select higher ground with taller vegetation and varying topography, and avoid drainage lines and sandplain/spinifex habitat when establishing breeding territories, may also be because (in the Murchison/Gascoyne region) it supports the highest density of favoured prey. Many of the animals identified as eagle food (see below) are found seeking shelter or foraging around breakaways. The isolation of the four 'outlying' nests/territories mentioned above also suggests wedge-tails are capable of breeding on such 'islands' of suitable habitat in an otherwise marginal landscape.

Where suitable habitat occurs (i.e. the north-eastern portion of Lorna Glen), eagle breeding density appears fairly uniformly distributed, with territories containing one or more clustered nests occurring every 4-6km (see Figure 1). Such spacing is consistent with Ridpath and Brooker (1987), who reported clusters of nests belonging to the same breeding pair occurring within *c.* 5km in arid Western Australia. If this pattern is consistent, those areas in between identified territories shown in Figure 1 (in the northern, southern-central and central-eastern sections) probably contain more nest clusters.

4.1.2 Eagle diet

It should first be noted that there was a large variation in the amount of prey remains collected from different eagle nests in this study. Although the 866 individual prey remain items from Lorna Glen yielded 188 prey animals, there was significant variation the number of animals identified at each nest (range = 2 to 26; mean = 7.8 per nest; Table 2). The quantity of food samples available for collection by researchers can be influenced by several factors, including the degree of removal by scavenging animals, the individual nest-cleaning behaviour of adult eagles, and the frequency of visits to nests. Furthermore, many prey fragments collected in 2012 represent prey taken over an unknown period. For

some nests (e.g. Nest 2), fragments gathered were representative of 2012 diet only, but for most other old nests not in use when located, the remains represent animals taken over a much longer timeframe. Such samples usually overestimate the number of mammals because mammal bones are more resistant to weathering than the fragile bones of birds and reptiles (Brooker and Ridpath 1980). Information presented in this report therefore only offers insight into eagle diet at Lorna Glen, and cannot be used to accurately quantify differences in diet between territories.

Overall, wedge-tailed eagle diet at Lorna Glen consisted mainly of mammals (45% by number), with macropod species (i.e. euro and red kangaroo) being taken most frequently. This finding is consistent with previous research. For example, Brooker and Ridpath (1980) found red kangaroos and euros to contribute significantly to eagle food at their Dry West Coast study site near Carnarvon. In south-west Western Australia, immature western grey kangaroos *Macropus fuliginosus* were frequently preyed on in the Perth region (Cherriman 2007), and tammar wallabies *Macropus eugeneii* were the most favoured prey animal at bush reserves near Narrogin (Cherriman 2008). At two locations near Canberra in New South Wales, macropods contributed to more than half of wedge-tailed eagle diet biomass (Olsen *et al.* 2006; Fuentes *et al.* 2007). Sharp (1997) also found macropods to be dominant in a nest diet sample from Idalia National Park in south-central Queensland. Such dominance of red kangaroos and euros as eagle food is probably a reflection of these species being the most abundant suitable-sized mammals at Lorna Glen. In a study in Shark Bay, Richards and Short (1998) found wedge-tailed eagles ate burrowing bettongs and banded hare-wallabies in proportion to their relative occurrence in the environment.

Most Australian studies on wedge-tailed eagle diet have reported introduced rabbits *Oryctolagus cuniculus* as the main prey species. The relative scarcity of rabbit prey at Lorna Glen (10.6% by number *cf*. 90%+ in other arid WA sites, Brooker and Ridpath 1980) is probably due to their low abundance within the study site. Except for in the fenced enclosure where water is reliable in artificial watering stations, rabbits have been almost absent from the landscape since bores ceased to operate when DEC assumed management of the property in 2000 (J. Dunlop pers. comm.).

Despite its proximity to the fenced enclosure, Nest 2 contained no evidence that the eagles occupying it took reintroduced Threatened mammals surviving there. This was contrary to the pair breeding in Nest 3 during 2011 which preyed on several reintroduced boodies, mala and golden bandicoots (see Cherriman 2012*a*). Although the diet sample from Nest 2 in 2012 was limited and the number of prey items collected was reduced by the nest's failure (i.e. death of eaglet), this may indicate that the distance (Nest 2 *c.* 4.9km from pen *cf*. Nest 3 *c.* 2.4km) is too great for this pair to forage in the pen, or that eagle territoriality prevents this. Perhaps a combination of these factors is true. Further research into the diets of these neighbouring pairs will shed light on this situation.

One bilby skull was identified in the prey remains sample collected from Nest 33. This is the first known record of eagles preying on a reintroduced mammal outside of the fenced enclosure, and is one case where a natural predator-prey relationship has been restored. Bilbies were released at several locations in the broader Lorna Glen landscape and are known to have become well established throughout (Miller *et al.* 2010), but it is interesting to confirm that eagles are capable of hunting them. It is possible the bilby was killed by another predator and taken as carrion, although when breeding, eagles usually

prefer live prey (Olsen 2005). Other studies (e.g. Richards and Short 1998, Cherriman 2007) have shown wedge-tailed eagles are capable of regularly taking nocturnal animals.

The remaining diet sample consisted of 30% birds and 25% reptiles by number, respectively. Birds taken included emu chicks, Australian bustards (both large and small individuals), galah *Eolophus roseicapillus*, crested pigeon *Ocyphaps lophotes*, Australian ringneck *Barnardius zonarius* and little crow *Corvus bennetti*, all species which have been previously recorded as wedge-tailed eagle food (Brooker and Ridpath 1980). Each of these species are common at Lorna Glen, and known to feed on the ground making them vulnerable to eagle attack. The barn owl *Tyto javanica* and tawny frogmouth *Podargus strigoides* recorded at Nests 2 and 3 were probably taken on dusk. Wedge-tails are known to wait on perch trees at sunset and ambush nocturnal species emerging to forage (S. Cherriman pers. obs.). Varanids were the most commonly eaten reptiles, probably because once again these are an abundant large vertebrate in the arid zone. These species, as well as Centralian bluetongues *Tiliqua multifasciata* and thorny devils *Moloch horridus* have also been recorded as eagle food in other parts of WA (Brooker and Ridpath 1980).

4.1.3 Breeding Status

During the 2012 breeding season, 16 of the 24 wedge-tailed eagle territories (67%) were confirmed as occupied, each containing one active nest. It should be noted that the proportion of territory occupancy may be higher as in some areas only one old nest was located, and newer active nests may have been present nearby. Seven nests (44%) were lined partly or wholly with fresh sprigs (mostly *Acacia* or *Eucalyptus*), and nine (56%) were fully lined and had eggs laid in them. This was confirmed either by observing eggs during August (in seven nests), or by locating a freshly lined, depressed nest cavity containing eggshell fragments in December (two nests). In August only one of the nine nests (Nest 2) was observed to have hatched chicks: 2 eaglets aged less than one week were photographed on this nest on 11th August. By 16th August one eaglet had disappeared, and on 9th December this eaglet was found dead under a perch tree near the nest, aged 6-7 weeks.

None of the eight other nests in which eggs were laid contained evidence that chicks had hatched, or developed on their nest for more than one week. This was clear because the lined cavity of these nests remained compressed into a concave cup, which had subsequently become faded by the sun. The continuous addition of fresh leaves by parent birds during eaglet development soon turns the concave cup into a flat platform. Therefore, one expects to find the nest cavity transformed significantly during a successful breeding event. Conversely, the nest cavity remains relatively unchanged when breeding has failed. This ‘before and after’ scenario is shown in Figures 5 and 6, where on Nest 20 eggs were present in August 2012, but had disappeared four months later in December.

Figure 5. Wedge-tailed eagle Nest 20 at Lorna Glen, photographed in August 2012 when it contained 2 eggs. The freshly lined, depressed nest cavity is visible.

Figure 6. Wedge-tailed eagle Nest 20 at Lorna Glen, photographed in December 2012 when it contained 2 eggs. The faded lining is obvious and the depressed nest cavity is visible. Eggshell fragments were collected from this nest.

Such high failure rate in wedge-tailed eagle breeding in one particular year is not unusual. In a long-term study in south-east Western Australia, and on the west coast near Carnarvon, Ridpath and Brooker (1986*b*) determined that eagle breeding success was related directly to food supply. Pairs remained in their territory and each year either partly or fully lined an existing nest, or attempted to breed by laying eggs. In years where the food supply reached or exceeded a minimum threshold density of prey animals, breeding usually succeeded. However, breeding often failed when this threshold was not met, especially in areas of erratic rainfall. Such breeding failures (or lack of attempts) sometimes occurred for up to four consecutive years. Based on this information it is likely that 2012 was a lean year for wedge-tailed eagle breeding at Lorna Glen, with prey not reaching the minimum threshold required for success across most of the landscape. The rapid failure of Nest 2, with the second chick dying after 6-7 weeks, provides some evidence for this. Low prey density may be a result of low rainfall during 2011-12, as well as a lag in the time taken for native mammal numbers to replace introduced species removed as a result of different land management. It is unusual, however, that the breeding attempt by eagles in Nest 3 failed, seeing as this nest is situated very close to the fenced enclosure containing densities of boodies and golden bandicoots which are presumably quite high. This nest succeeded in producing one young in 2011 (Cherriman 2012*a*).

It should be clarified that researcher-induced failures are unlikely to have influenced eagle breeding in this study. In cases where incubating adults were disturbed, all nests were observed with binoculars from a distance of more than 500 m to ensure the birds returned to their nest. At Nest 2, a brooding female eagle flushed as researchers approached in August, but was observed to return about half an hour later just as the researchers returned to their car *c.* 2 km away. Breeding failures for many raptors can be attributed to nest predation (e.g. by cats and goannas), but this is highly unlikely with a dominant predator such as the wedge-tailed eagle.

Eggshell fragments were collected in December from active nests that failed. These were further evidence that hatching had not occurred because adult eagles remove the two halves of eggshell soon after the eggs hatch, often dropping it below a nearby perch (S. Cherriman pers. obs.). Small rocks were located on the cavity of two nests which had contained eggs in December. It is possible that these were brought by black-breasted buzzards and used to break into abandoned eagle eggs; buzzards are known to use this technique to feed on emu eggs (Olsen 1995).

5 CONCLUSIONS AND RECOMMENDATIONS

The field study conducted in December 2012 gave a further insight into wedge-tailed eagle ecology at Lorna Glen. Locations and site characteristics of known nests provide important information for future work.

In light of the above information, the following recommendations are noteworthy:

- Conduct further field surveys in the northern, southern-central and central-eastern sections of the reserve to locate more eagle nests (planned for March 2013).
- Trap and monitor (through satellite-telemetry) the movements of adult eagles to gain information on habitat use, including visitations to the fenced enclosure (planned for June 2013).
- If breeding is successful in 2013, band any nestling wedge-tailed eagles at age 60 days (prior to fledging) to record possible movements within Lorna Glen.
- Revisit known eagle nests to monitor breeding and subsequent success/failure to gather more information about eagle productivity at Lorna Glen (August 2013).

6 REFERENCES

Cherriman, S. C. 2007. Territory size and diet throughout the year of the wedge-tailed eagle *Aquila audax* in the Perth region, Western Australia. BSc Honours Thesis, Curtin University, Perth.

Cherriman, S. C. 2008. Diet of the wedge-tailed eagle *Aquila audax* at some DEC reserves near Narrogin, Western Australia. Unpublished report prepared for the Department of Environment and Conservation by Insight Ornithology, Parkerville, Western Australia.

Cherriman, S. C. 2012*a*. Diet and status of the wedge-tailed eagle *Aquila audax* at Lorna Glen Conservation Reserve, Western Australia. Unpublished report prepared for the Department of Environment and Conservation by Insight Ornithology, Parkerville, Western Australia.

Cherriman, S. C. 2012*b*. Breeding of the wedge-tailed eagle *Aquila audax* during 2012 at Lorna Glen Conservation Reserve, Western Australia. Unpublished report prepared for the Department of Environment and Conservation by Insight Ornithology, Parkerville, Western Australia.

Friend, T. and Beecham, B. 2004. Return to Dryandra: Western Shield Review – February 2003. *Conservation Science Western Australia* **5 (2)**, 174-193.

Fuentes, E., Olsen, J. and Rose, A. B. 2007. Diet, occupancy and breeding performance of wedge-tailed eagles *Aquila audax* near Canberra: four decades after Leopold and Wolfe. *Corella* **31**(3/4), 65-72.

Miller, E., Dunlop, J. and Morris, K. 2010. Rangelands Restoration: Fauna recovery at Lorna Glen, Western Australia. Unpublished report by the Department of Environment and Conservation, Science Division, Woodvale, Western Australia.

Olsen, P. 1995. Australian Birds of Prey: The Biology and Ecology of Raptors. University of New South Wales Press, Sydney.

Olsen, P. 2005. Wedge-tailed Eagle. CSIRO Publishing, Australia.

Olsen, J., Feuentes, E. and Rose, A. B. 2006. Trophic relationships between neighbouring white-bellied sea-eagles *Haliaeetus leucogaster* and wedge-tailed eagles *Aquila audax* breeding on rivers and dams near Canberra. *Emu* **106**, 193-201.

Richards, J.D. and Short, J. 1998. Wedge-tailed eagle (*Aquila audax*) predation on endangered mammals and rabbits at Shark Bay, Western Australia. *Emu* **98**, 23-31.

Ridpath, M. G. and Brooker, M. G. 1986*a*. Age, movements and management of the wedge-tailed eagle *Aquila audax* in arid Western Australia. *Australian Wildlife Research* **13**, 245-260.

Ridpath, M. G. and Brooker, M. G. 1986b. The breeding of the wedge-tailed eagle *Aquila audax* in relation to its food supply in arid Western Australia. *Ibis* **128**, 177-194.

Ridpath, M. G. and Brooker, M. G. 1987. Sites and spacing as determinants of wedge-tailed eagle breeding in Arid Western Australia. *Emu* **87**, 143-149.

Sharp, A. 1997. Notes on the breeding season diet of the wedge-tailed eagle *Aquila audax* in Idalia National Park, south-central Queensland. *Sunbird* **27**, 105-108.

Silva, L. M. and Croft, D. B. 2007. Nest-site selection, diet and parental care of the wedge-tailed eagle *Aquila audax* in western New South Wales. *Corella* **31**(2), 23-31.