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Yardie Creek Fauna Monitoring

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Biota Environmental Sciences

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Yardie Creek Fauna Monitoring

Contents

Executive Summary

Following representations from the NPNCA (now the Conservation Commission of Western Australia) and the Minister for the Environment, CALM commissioned a program to identify and monitor effects of boat tours and tourists on the wildlife at Yardie Creek. In particular, the program needed to provide data on the effects of an increase in boat tour frequency on the behaviour of nesting birds and Black-footed Rock Wallabies *Petrogale lateralis lateralis* in Yardie Creek during spring of 2000 and 2001.

In order to meet these objectives, two field surveys were conducted during which boat tour frequency was manipulated, the first between 15/9/2000 – 23/9/2000 (pilot study) and a second between 22/9/2001 – 5/10/2001 (main study).

Although broadly similar in approach, the pilot study was used to refine the methodology for the 2001 study and as such was not as robust. All results are documented in the body of this report, but only the results of the second study are summarised below.

Rock Wallaby Monitoring

Eleven sites were identified that regularly supported rock wallabies, comprising seven in the section of Yardie Creek navigable by the tour boats (Ficus, Entrance, Beach, Island, Splinter, View and Peninsula) and four over a distance of 750m in the unnavigable section where there is no water (Boulder, Grove, South Grove and Spire). It is estimated that between 21 and 32 animals occurred in the gorge accessible to the boats and that a further 15 animals occurred across the remaining four sites.

Seven observers were seated strategically around the rim of the gorge observing all the rock wallaby sites with the exception of Beach and Spire. Each of the observers was required to score a variety of attributes. These attributes included:

- Time (of recording);
- Sun/Shade (whether the site was in the sun or shade);
- Disturbance (nature of disturbance, if any);
- Boat Type (tour operator);
- Boat Location (physical location of boat in relation to landforms);
- Wallaby Location (physical location of wallaby in relation to static features);
- Rock Wallaby ID;
- Position (whether the animal was in the shade or sun);
- Posture (selected from a number of typical postures);
- Behaviour (selected from a number of typical features); and
- Notes.

Recording of all attributes commenced on the hour, typically between 9am and 4pm. Individual rock wallabies visible to the observer were scored for the above attributes every five minutes. Initially five consecutive recordings were made (between the hour and twenty past), then this was extended to nine recordings, with continuous recording between 1200 and 1400.

Experimental Design

Three levels of boat traffic were created in the gorge: nil (no tours / day) (n=3), low (1-2 tours / day) (n=4) and high (5-6 tours / day) (n=5). Boat trips were all between 1130 and 1500.

Three measures of rock wallaby behaviour were extracted for initial analysis including:

- the number of individual rock wallabies seen during a specific recording period (usually an hour);
- the average number of rock wallabies seen per observation during the recording period; and
- the average number of movements made by each rock wallaby during the recording period.

The number of individuals seen and the average number of rock wallabies were compared among boat levels and across recording time by repeated measures analysis of variance with one between-subject factor (boat level: nil, low or high) and one within-subject factor (time: 1200, 1300, 1400, 1500). It was predicted that if increasing the number of boats on the gorge had an effect, there would be progressively fewer rock wallabies recorded over time on high boat days, leading to a significant interaction between boat level and time.

These two measures were also compared before and during the first and last boat trip of the day among all boat level treatments. These analyses had one between-subject factor as before, but two within-subject factors: time (before or during the boat trip) and boat trip (first or last). Movements per rock wallaby were compared before and during the first boat trip among all boat level treatments. All analyses were performed using SuperAnova (Abacus Concepts 1989), a statistical package for Macintosh.

In addition to the manipulation of boat traffic, we performed two other experiments to test the effects of disturbance on rock wallaby behaviour. The first was performed at Grove and South Grove, sites that are not normally subject to disturbance. On September 29, one of us walked through both these sites at two separate times, yelling and banging on bits of debris. Numbers seen in total and per observation on the five days prior to this disturbance were compared with numbers seen in the following five days by one-way analysis of variance.

The second experiment was carried out on October 5 in the main section of the gorge utilising the CALM dinghy. We deliberately drove this as close as possible to the rock wallabies, yelling, clapping, whistling and revving the motor, while the observers noted down the response of the rock wallabies. This was carried out on all three trips that day.

Results

Rock wallabies did not appear to be affected by differing levels of boat use in the gorge:

- There was no change in numbers of individuals seen during the hours when boats were on the gorge (1200 to 1500hrs) across treatments.
- The number of individuals seen per observation in the impact time (1200 - 1500) did not differ across treatments.
- There was no change in rock wallaby numbers or average number of rock wallabies seen per observation before or during the first or last boat trip, or over levels of boat traffic.
- There was no difference in the number of moves made by rock wallabies before and during the first and last boat of the day among boat use treatments.

A myriad of other analyses could be performed, comparing behaviours before and during boat trips, and some of these analyses might yield a significant effect of boat use. We believe that wallabies are aware of the boats and sometimes respond to them by looking alert, changing their posture or moving away, but that they also show these responses to other disturbances such as birds calling or flying past, and particularly to the presence of other rock wallabies, as well as to walkers and planes. Thus the responses we saw to the boats are just part of the everyday behaviour of the rock wallabies and cannot be easily

differentiated statistically. Importantly these behavioural changes do not result in a numerical response. Rock wallabies were just as numerous and visible on high boat use days as on low or nil boat use days.

It was impossible to detect a change in response of the wallabies even when the boats came up very close and revved their engines while the occupants screamed, stamped and whistled loudly. A number moved away, but not immediately, and just as many remained stationary. Clearly rock wallabies do not see boats or their passengers as a threat.

Despite a trend to lower numbers after the disturbance at Grove, there was no significant difference between either the number of rock wallabies seen or the number seen per observation before and after the disturbance. At the time of the disturbance, the rock wallabies hopped quickly away from the sites, but gradually returned during the same day and in the days following. Only one individual rock wallaby was not sighted again. This is the only evidence we have of a numerical response to disturbance.

Avifauna Monitoring

Timing for the survey was suggested as early spring to coincide with breeding of key species previously identified as having nested or possibly nesting at Yardie Creek. These species are primarily the Eastern Reef Heron and Little Corella. However, four other species including Nankeen Kestrels, Black-faced Cuckoo-shrikes, Little Woodswallows and Welcome Swallows were also recorded nesting within the gorge.

A single observer was positioned opposite the main breeding wall on the northern side of the gorge such that they could view both rock wallabies and nesting/roosting birds along the main nesting wall. Observers monitored the behaviour of birds in response to the approaching vessels and walkers.

On no occasion was there any observed response to any of the tour boats from Eastern Reef Herons that were on the nest. However, birds on the waters edge including the Eastern Reef Heron, White-faced Heron, Darter and Little Pied Cormorant typically flew to new positions either higher up the cliff-face or in the gorge when a boat approached too closely.

In contrast, walkers and swimmers did appear to agitate nesting birds and chicks on several occasions. On 1/10/2001 a Grey phase Eastern Reef Heron left the nest at location 1 when an individual climbed up the cliff face and into the *Ficus* tree in which the nest was located. Similarly the chick at location 5 left the nest as the same climber approached the nest site. On another occasion a walker on the southern rim was observed to frighten a bird off its nest close to the rim. The nest supported one egg and one recently hatched chick.

Impacts and Recommendations

- Tour boats and other vessels approaching too closely to the main nesting wall.

  Recommend that boats stay as far away from the main nesting wall as is safely practicable during the Heron nesting period. This may be particularly relevant to the nest selection period.

  Recommend that boats cross downstream of the mangrove island so as to avoid passing vessels in the vicinity of the main nesting wall and potentially disturbing nesting herons.

- Walkers on the southern rim above the main nesting wall.

  Recommend that the southern rim be out of bounds to walkers above the point where the existing sign indicates the start of the Wildlife Area.

  Provide signage at the commencement of the walk (car park) indicating out of bounds areas.

- Swimmers leaving the water and climbing up the main nesting wall.

  Recommend that the main nesting wall be "out of bounds" to tourists at all times of the year. Recommend that clearly worded signs to this effect be placed at the commencement of the walk near the mouth of the creek and on the beach opposite the main nesting wall.

- Uncontrolled access on the northern rim of the gorge (particularly the eastern end) causing degradation to vegetation.

  Recommend that controlled access be identified along the entire length of the proposed walk and restricted to clearly identified tracks and paths.

Given that peak tourism on Yardie Creek coincides with the winter (mid July) school holidays and the possibility that additional visitors may be impacting on nesting Herons at a time when they are more susceptible to disturbance (nest selection period), it is recommended that further studies be conducted over this period.

Recommend that tourist behaviour during the busiest period (mid July school holidays) be monitored to establish what type of impacts may be occurring.

It would be useful to know the potential carrying capacity of rock wallabies of Yardie Creek. This may be achieved through additional studies carried out as part of either an Honours or Masters course.

Investigate the possibility of further Honours or Masters studies on the ecology of rock wallabies in the gorge.

Given the general lack of published information on this type of study, it is important that the findings of this study be made available in a scientific journal.

Recommend that the results of this study be published in a scientific journal.

In addition, it is recommended that analysis of the long-term data collected by the tour operators be reviewed to determine whether any trends can be identified.

It is the intention of the authors to further analyse the data collected during the two field trips to gain further insights into the behaviour of wallabies in Yardie Creek.

1.0 Introduction

1.1 Background to the Project

The Department of Conservation and Land Management (CALM) has a legislative requirement under the *CALM Act* 1984 to promote the use and understanding of National Parks in WA whilst maintaining the conservation of natural resources: ie. 'to fulfil as much of the demand for recreation by members of the public as may be consistent with the proper maintenance and restoration of the natural environment, the protection of indigenous flora and fauna and the preservation of any feature of archaeological, historic or scientific interest'.

The conservation estate in Western Australia is vested in the Conservation Commission of Western Australia (CCWA). CALM manages land on behalf of the CCWA.

In 2000, the CCWA's predecessor (the National Parks and Nature Conservation Authority (NPNCA)[1]) required that a program to identify and monitor any effects of boat tours and tourists on the wildlife at Yardie Creek be designed and implemented. In particular, the program needed to provide data on the effects of boats on the behaviour of nesting birds (Little Corella, Eastern Reef Heron and Australian Kestrel) and the Black-footed Rock Wallaby *Petrogale lateralis lateralis* in Yardie Creek during spring of 2000 and 2001.

This monitoring study has been commissioned by CALM following representations from the previous vested body (NPNCA) and the Minister for the Environment.

1.1.1 Licensed Tour Operators

Boat tours have been carried out in Yardie Creek since the mid 1980s.

There are currently three licensed operations permitted on Yardie Creek: one tour boat operation (Yardie Creek Tours) and two safari boat licences (Ningaloo Safari Tours and West Coast Safaris). Yardie Creek Tours runs a regular tour boat of up to six trips per day (although more often between one and three). The two safari tour operators are allowed to operate one trip per day in conjunction with safari tour on a launch and retrieval basis.

1.2 Phase I – The Pilot Study

The monitoring carried out between 15/9/2000 – 23/9/2000 identified the best locations from which to view fauna (particularly the rock wallabies) and the type and nature of the data that should be collected.

The 2000 study focussed on the following:
- Avifauna species richness;
- Abundance of species;
- Avifauna habitats;
- Typical responses of avifauna to boats and climbers;
- Number of rock wallaby groups;
- Location of rock wallaby groups;
- Number of rock wallabies per group;

[1] In November 2000, due to changes to the *CALM Act* 1984, the NPNCA was abolished and replaced by a new body, the CCWA.

- Types of behaviours exhibited throughout the day;
- Typical behaviour of rock wallabies in the absence of boat tours; and
- Typical responses of rock wallabies to boats.

The survey found that the numbers of rock wallabies visible to observers was relatively constant within any given period of any given day, but varied among days and among the identified groups (=sites) of wallabies present in the gorge. Eleven sites were identified as supporting between one and six rock wallabies. Between 13 and 17 animals occurred in the gorge accessible to the boats and a further 12 animals occurred over 750 m further up the gorge.

The analysis of the effect of boat use was confounded by the unpredictable schedules of the boat operators (both within and among days) and the presence of other craft such as canoes, kayaks and dinghies in the gorge at unexpected and uncontrollable times. For the purposes of analysing this data set, only the power boats were considered; other boats were ignored.

There was no indication of a change in rock wallaby numbers to level of boat use. Numbers were generally higher before the boats arrived but too variable to differentiate from numbers during and after the boats. Nor did the arrival of the boats induce rock wallabies to move from their positions any more frequently than they did before the boats arrived. However, rock wallabies were not completely oblivious to the boats, acknowledging their arrival with small changes in behaviour, usually involving head raising, looking around and/or changing stance. This was shown statistically by an analysis of the proportion of recordings in which wallabies were observed as being alert.

Thus while rock wallabies were certainly aware of the boats, they did not hide from them or increase their movements in response to them. Anecdotal observations suggested that rock wallabies were more likely to move and hide when disturbed by walkers in close proximity to them, than when boats of any kind were in the gorge.

A total of 29 species of birds was recorded during phase I. This total comprised 18 families and included 18 non-passerines and 11 passerines. Breeding records were obtained for the Eastern Reef Heron (six nests), Nankeen Kestrel (two nests), Little Corella (over 50 nests), Welcome Swallow (over 25 nests), Little Woodswallow (a pair noted carrying nesting material) and the Black-faced Cuckoo-shrike (seen feeding a fledgling).

Little data were collated on the impact of boats on birds, as the observers' time was fully occupied recording rock wallaby behaviour. However, the observations that were made suggested little reaction from any of the nesting species to the presence of boats. In contrast, walkers were seen to cause Little Corellas to leave roosting and nesting sites. Nesting Eastern Reef Herons and Welcome Swallows were not subjected to disturbance from walkers during the 2000 survey.

This information was used to refine the experimental design of the Spring 2001 survey.

The Questionnaire

A questionnaire was developed and circulated to tour boat operators to survey tourists and determine their perceptions and level of satisfaction concerning wildlife sightings.

Findings from the questionnaire have been summarised and presented in the progress report (Biota & Ecological Analysis 2001). Responses to several questions appeared to vary dependent on the respective tour operator.

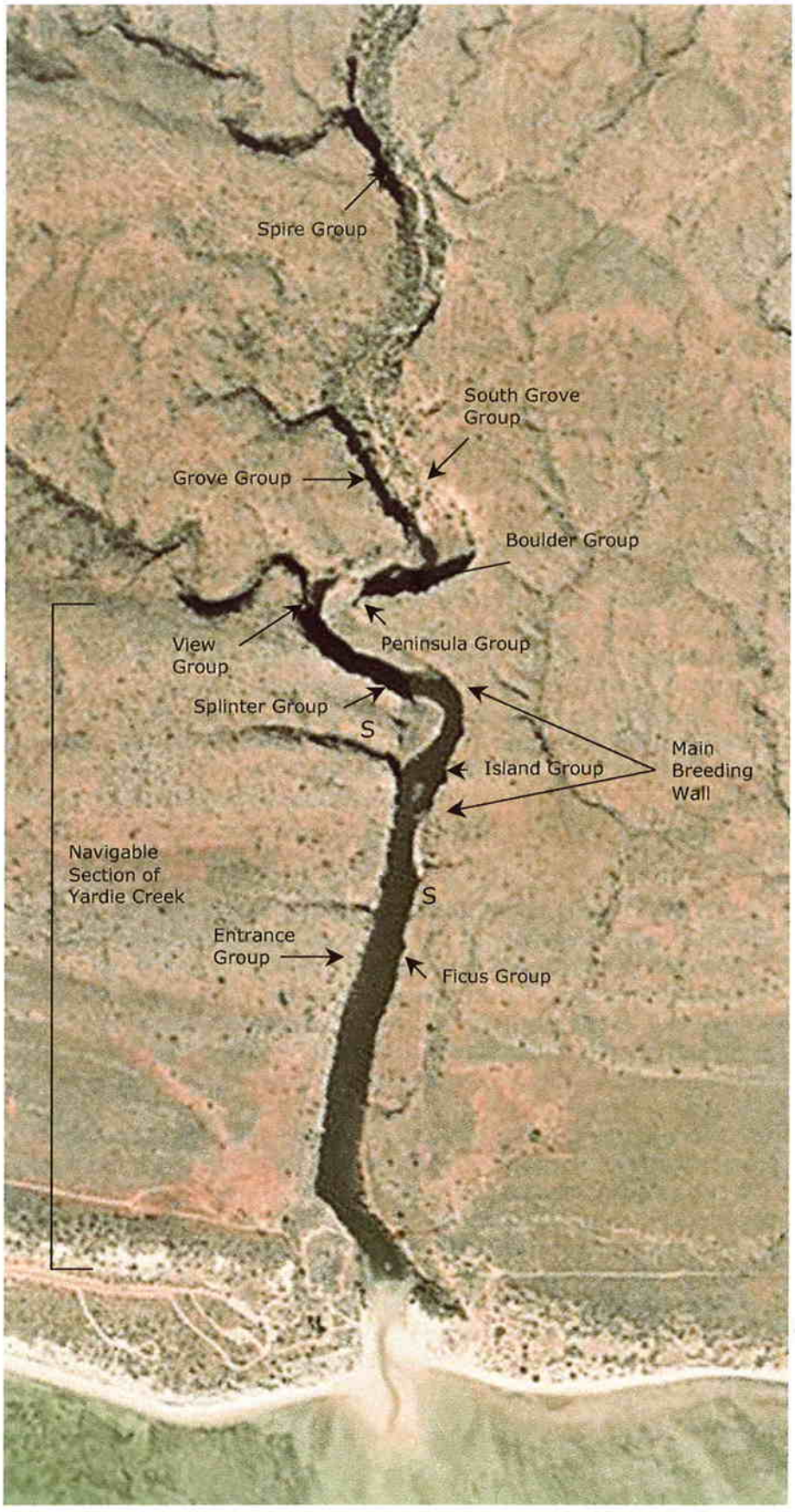

Figure 1.1: Aerial photograph of Yardie Creek. "S" indicates the location of signs indicating a "Wildlife Area".

1.3 Phase II – Main study

Results of Phase I were used to modify the design and analysis for Phase II (section 2.2.3), which was carried out between 22/9/2001 and 5/10/2001. The results of the latter phase are the primary focus of this document.

1.4 Fauna of Interest

1.4.1 Black-footed Rock Wallaby

The Black-footed Rock Wallaby *Petrogale lateralis lateralis* is one of two subspecies of *P. lateralis* occurring in WA (How *et al.*, 2001); the other, the Recherche Black-footed Rock Wallaby *P. l. hacketti,* is restricted to Islands of the Recherche Archipelago off the southern coast of WA (Western Australian Museum FaunaBase). Two chromosomal races are also recognised within this taxon, the MacDonnell Ranges race and the West Kimberley Race (Pearson and Kinnear 1997).

P. l. lateralis occurs as a few scattered remnant populations including on Barrow Island, Cape Range (including Yardie Creek), Calvert Range and Salisbury Island (Recherche Archipelago) (Western Australian Museum FaunaBase; Pearson & Kinnear, 1997). Its status on the Murchison River near Kalbarri and within the Wheatbelt seems uncertain. Mitochondrial DNA work on samples from wallabies at a possible population at Barlee Range (Pearson & Kinnear 1997) concluded that that they are not *P. l. lateralis* (Dr P. Kendrick pers. comm.). Pearson & Kinnear (1997) note that the species has declined in distribution and abundance over much of its former range and considered it to be "Endangered" using the IUCN criteria (see IUCN, 2000). It is currently listed as Vulnerable under the Specially Protected Fauna Notice 2001.

1.4.2 Eastern Reef Heron

The Eastern Reef Heron *Ardea sacra* is considered by Johnstone & Storr (1998) as common in the north (south to Dirk Hartog Island), moderately common in the mid-west (south to the Houtman Abrolhos), uncommon on west coast islands between 30° and 32°S and scarce elsewhere. On the mainland it typically nests in sheltered situations such as beneath mangroves (Johnstone pers comm.) or, as at Yardie Creek, behind *Ficus* spp on cliff faces. Although not listed as a Priority or Schedule taxon, this species is listed under the *Environment Protection and Biodiversity Conservation Act* 1999 as a migratory species.

The following observations are taken from a variety of sources summarised in Appendix 1. In August - September 1972 this species was listed as common in Yardie Gorge, with many birds nesting in the cliff sides. Nests were in *Ficus* trees growing out of cracks in the cliff face. Seven nests were inspected: four contained three eggs, one with three young and one with two young. In October 1973 eight pairs were breeding in Yardie Gorge; nests with eggs and young at various stages were observed. In July 1974 this species was listed as common in Yardie Gorge and one nest with three eggs and several nests with young were noted. Both white and grey phase birds were in the colony and nests ranged from just above water level to 3 m up the cliff wall.

2.0 Materials and Methods

The monitoring carried out between 22/9/2001 – 5/10/2001 focussed on:

- Number of rock wallaby groups;
- Location of rock wallaby groups;
- Number of rock wallabies per group;
- Types of behaviours exhibited throughout the day;
- Typical behaviour of rock wallabies in the absence of boat tours;
- Typical responses of rock wallabies to boats and climbers;
- Avifauna species richness;
- Abundance of species;
- Avifauna habitats; and
- Typical responses of avifauna to boats and climber.

2.1 Limitations of the Study and Population Level Effects

This study can not determine whether there has been a population level effect; that is, whether disturbances to individual nesting birds translate to a reduction in nesting success and an eventual decline in population size. Monitoring over several generations would be required to establish whether impacts on individual birds translate to a population level effect (eg. a reduction in the number of breeding pairs).

2.2 Avifauna Monitoring

Timing for the survey was suggested as early spring to coincide with breeding of key species previously identified as having nested or possibly nesting at Yardie Creek (sources: Johnstone 1990, Johnstone & Storr 1998), specifically:

- Eastern Reef Heron – eggs laid from July to November; and
- Little Corella – eggs laid from July to September.

2.2.1 Effects on Individual Birds

The morning census carried out during Phase I identified those locations that support the greatest number of birds, in particular nesting species, and which were therefore most valuable in obtaining information about effects on individual birds. During Phase II, a single observer was positioned opposite the main breeding wall (Figure 1.1) on the northern side of the gorge such that they could view both rock wallabies and nesting/roosting birds along the main nesting wall (Figure 2.9).

Observers monitored the behaviour of birds in response to the approaching vessels and walkers.

Morning avifauna censuses were also carried out during the first phase and the results are presented in Biota and Ecological Analysis (2001).

2.3 Rock Wallaby Monitoring

At the commencement of the survey, those rock wallaby groups identified during the 2000 survey (Biota and Ecological Analysis, 2001) were re-examined for rock wallaby activity. In all, 11 sites were identified and named according to some prominent feature at the location. Several of these localities are shown in plates 2.1 – 2.12.

Numbers of rock wallabies were accurately determined for most sites. However, wallabies were noted moving between some sites (Table 2.1) on a number of occasions making an accurate total difficult to determine. It is estimated that between 21 and 28 animals occurred in the gorge accessible to the boats and that a further 15 animals occurred over 750 m further up the gorge (Table 2.1). A brief summary of the main features of each site is given below.

Table 2.1: Numbers of Black-footed Rock Wallabies *Petrogale l. lateralis* at each of the identified sites in Yardie Creek gorge during spring of 2000 and 2001.

Site	**Number of wallabies recorded in 2000 that would be visible to tour operators (ie. navigable section of creek)**	**Number of wallabies recorded in 2001 that would be visible to tour operators (ie. navigable section of creek)**
Ficus	One female.	Female, male joey and two males. A second female on one occasion.
Entrance	Not assessed.	Female and joey. Single male occasionally.
Island	Three individuals.	Two females with two pouch young and two males.
Beach	One male.	None.
Splinter	Between five and six individuals.	At least five but possibly seven, including two females with large pouch young and three adult males.
View	Two to three individuals.	A female and at-heel joey often with an adult male. Occasionally a second female with a pouch young and possibly two other males.
Peninsula†	One to three individuals, with at least two seen moving from Boulder.	Typically one individual, thought to be a female. One record of three animals, possibly two males and one female, possibly from Boulder.
Total	13 - 17	21 - 32
Site	**Number of wallabies recorded in 2000 east of the navigable section of Yardie Creek**	**Number of wallabies recorded in 2001 east of the navigable section of Yardie Creek**
Boulder†	Five individuals.	Up to five individuals were seen; at least one adult female and at-heel joey and several males.
Grove	Five individuals.	Possibly nine individuals at Grove, including several females with pouch young, at least three at-heel or newly weaned joeys and two or three males.
South Grove	Two individuals.	One individual, possibly a female.
Spire	Evidence only.	Evidence only.
Total	12	15
Grand Total	**25 - 29**	**36 – approx 47**

† Wallabies were regularly observed moving between Peninsula and Boulder making accurate census difficult.

The Boulder, Grove, South Grove and Spire sites are not accessible to tour boats and would not be included in any tallies historically recorded by tour operators or currently assessed as part of the Visitor Questionnaire.

2.3.1 Site Descriptions

Ficus

Ficus is situated on the south side at the entrance to the gorge (Figure 1.1, Plate 2.3) and is the first available habitat for rock wallabies along the south face. There was always a resident male, female and an at-heel male joey present (Figure 2.1), typically seen in or just outside a wide-mouthed cave. A second male was also seen there on most days, usually behind vegetation or in the rocks to the east of the cave. There were numerous interactions between the males, with the first male clearly dominant and intolerant of any intrusion by the second into the area near the cave. A second female was seen at this site on two days and was observed being chased away by the resident female on one occasion. The animals at this site were extremely visible and did not retreat into the cave for extended periods. The site received direct sun in the morning and by 1430hrs was in full shade.

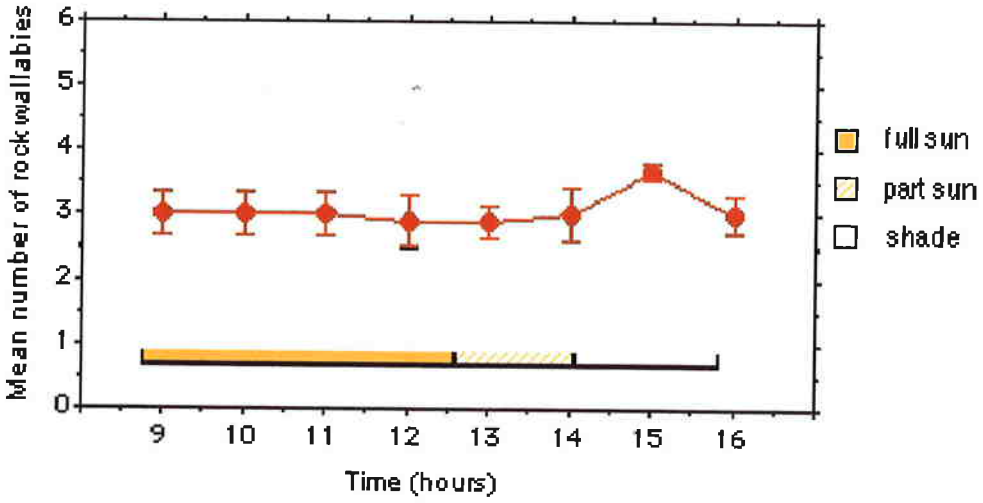

Figure 2.1: Sightings of individual rock wallabies each hour at Ficus site, averaged over nine days observations and shown ± 1 standard error. Sun and shade to the site are indicated on the horizontal bar.

Entrance

This site is directly opposite Ficus on the north face of the gorge (Figure 1.1, Plates 2.1, 2.2). It was shaded during the morning and did not receive full sun until at least 1400hrs (Figure 2.2). A female and her at-heel joey occupied a deep cave, high on the wall, with a long, narrow opening and as a result were not particularly visible. An adult male was present for most of the observation period on one day but was not tolerated near the cave area by either the female or the joey and so was apparently an interloper. The male was not seen again at this site.

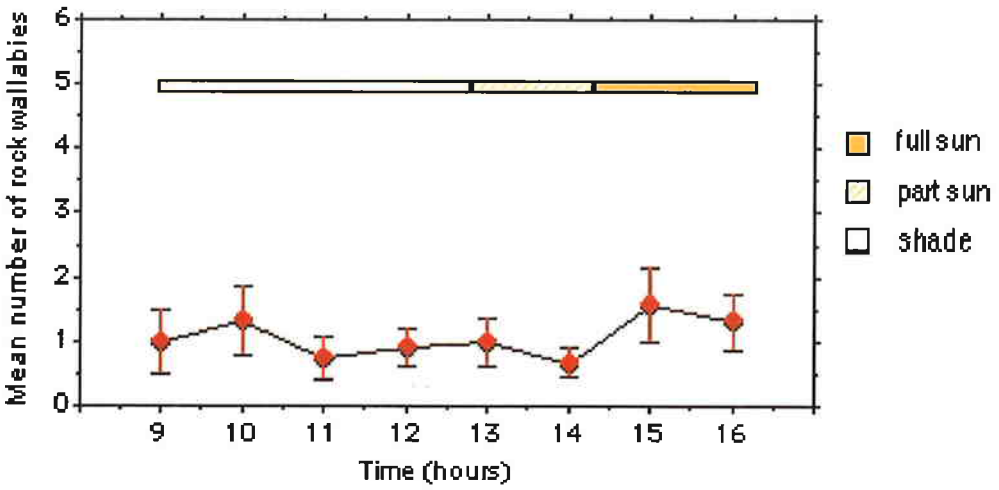

Figure 2.2: Sightings of individual rock wallabies each hour at Entrance site, averaged over eleven days observations and shown ± 1 standard error. Sun and shade to the site are indicated on the horizontal bar.

Island

Island refers to the main rock wall on the south side of the gorge (Figure 1.1, Plate 2.4), after the sandy beach and beginning at the level of the small mangrove island. This site was in full sun until midday and fully shaded by 1400 hrs (Figure 2.3). The wallabies were seen in a series of oblique fissures and crevices on the lower section of the wall. The group consisted of two females each with large pouch young and at least two adult males.

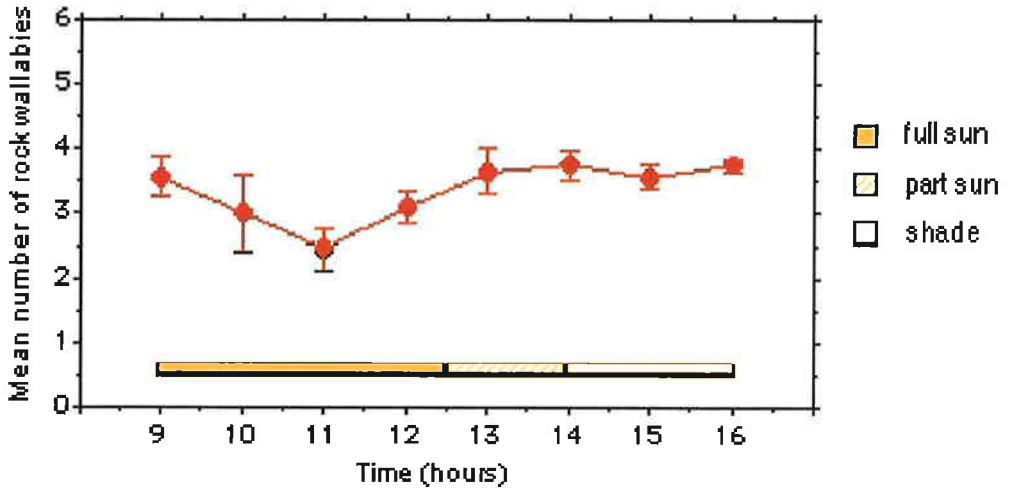

Figure 2.3: Sightings of individual rock wallabies each hour at Island site, averaged over eleven days observations and shown ± 1 standard error. Sun and shade to the site are indicated on the horizontal bar.

Splinter

The Splinter site is on the north face of the gorge beyond the bend in the creek and past the shallow rock bar (Figure 1.1, Plate 2.5). The rock face was only in the sun for a short period in the morning, with some parts being shaded as early as 1000hrs and in complete shade by midday (Figure 2.4). There is an extensive area used by the rock wallabies, from several caves near the top of the cliffs to small ledges and crevices down near the water. The wallabies moved between these areas frequently. Due to the extent and complexity of the site it was difficult to determine exactly how many wallabies were there. A maximum of five wallabies was seen during any one observation period, but there were

probably at least seven, including two females with large pouch young and three adult males.

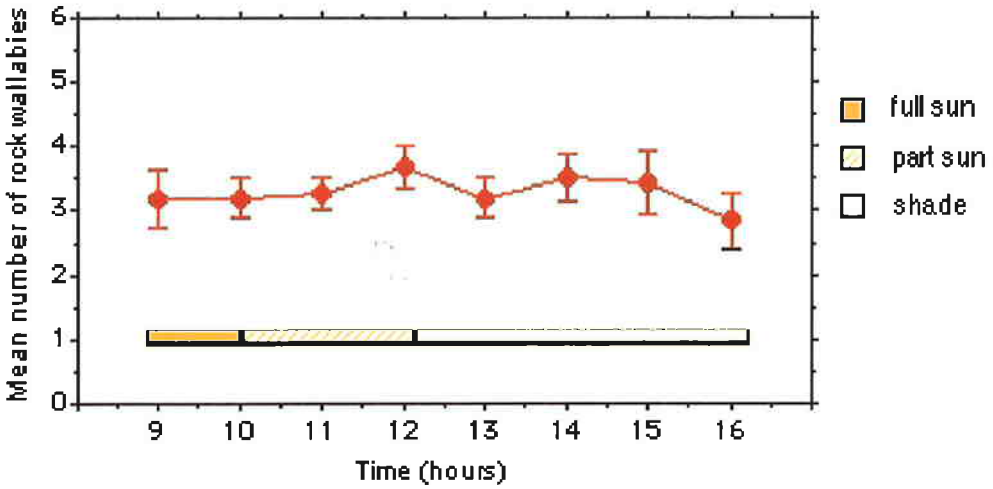

Figure 2.4: Sightings of individual rock wallabies each hour at Splinter site, averaged over twelve days observations and shown ± 1 standard error. Sun and shade to the site are indicated on the horizontal bar.

View

View is also on the north face, nearly at the end of the creek (Figure 1.1, Plates 2.7, 2.10) and separated from Splinter by a sheer section of rock. The site consists of a protruding rock and surrounding boulders that are partly shaded at most times, with most sun in the afternoon (Figure 2.5). A female and at-heel joey were always present, usually along with an adult male. A second female with a pouch young and possibly two other males were recorded there occasionally. These animals may have come from Splinter, although access must have been along the top of the cliff overnight, or from the adjacent gully where animals were regularly sighted, although not recorded.

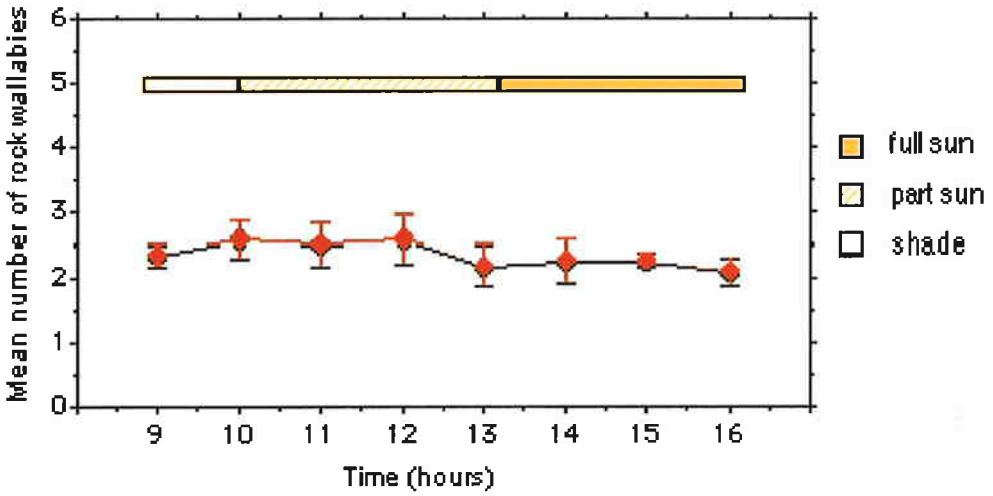

Figure 2.5: Sightings of individual rock wallabies each hour at View site, averaged over twelve days observations and shown ± 1 standard error. Sun and shade to the site are indicated on the horizontal bar.

Peninsula

Peninsula refers to the protruding rock wall on the south side at the end of the creek as the creek bed makes a right-angled turn southwards (Figure 1.1, Plate 2.6). Animals were only seen here on nine of the twelve days and on four of those days were only seen in the last hour of recording (1600hrs) (Figure 2.6). There was typically one individual, thought to be a female, with one record of three animals, possibly two males and one female. Wallabies were frequently seen moving between Peninsula and the adjacent site, Boulder. Peninsula was in full sun most of the day and was only shaded during the last hour of observation (1600hrs).

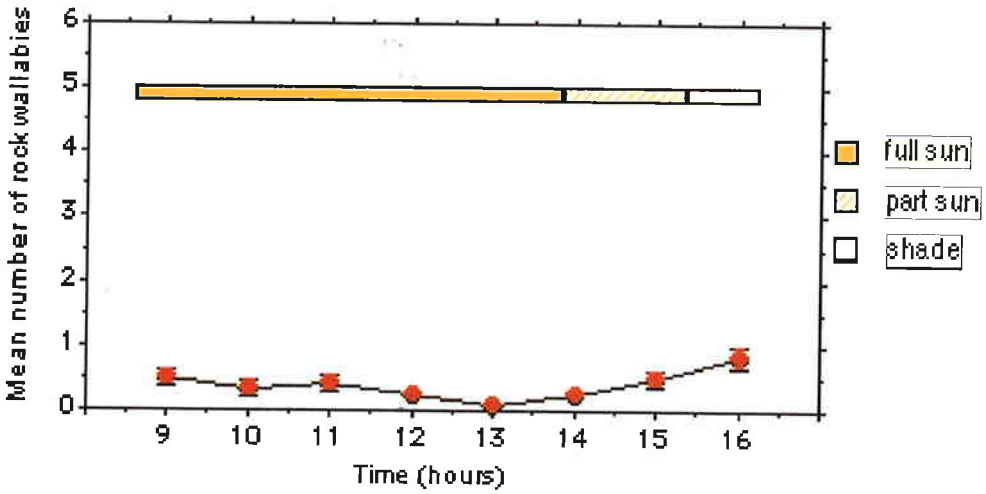

Figure 2.6: Sightings of individual rock wallabies each hour at Peninsula site, averaged over twelve days observations and shown ± 1 standard error. Sun and shade to the site are indicated on the horizontal bar.

Boulder

Boulder is a pile of rocks adjacent to the isolated pool to the south of the permanent creek (Figure 1.1). Wallabies here would be unlikely to have seen the boats but certain to have heard them. As at Peninsula, wallabies were not always seen at Boulder (10 out of 12 days), but their pattern of activity was spread more evenly throughout the day (Figure 2.7). Up to five individuals were seen; at least one adult female and at-heel joey, and several males. Boulder was in full sun in the morning, with part shade by 1300hrs and full shade by 1500hrs.

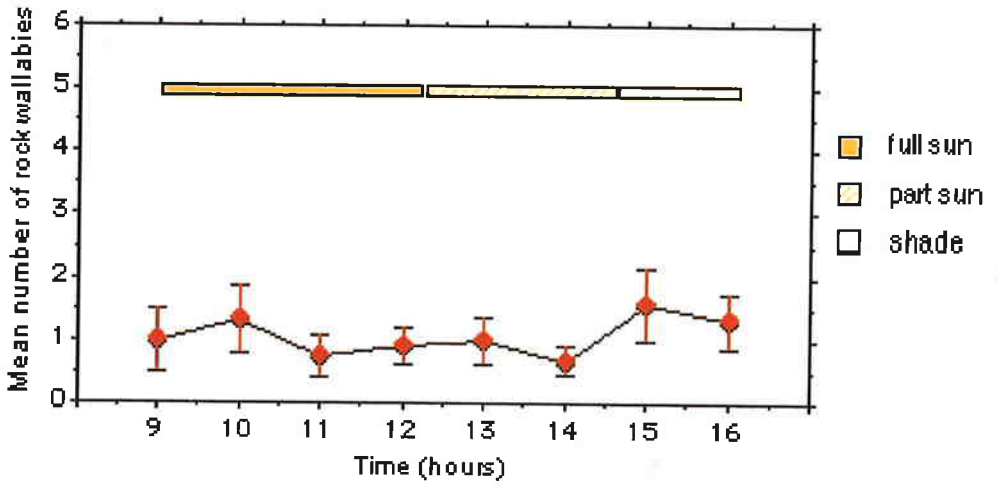

Figure 2.7: Sightings of individual rock wallabies each hour at Boulder site, averaged over twelve days observations and shown ± 1 standard error. Sun and shade to the site are indicated on the horizontal bar.

Grove and South Grove

These sites were 50 metres apart on opposite sides of the dry creek bed after it again turns eastwards (Figure 1.1, Plates 2.8, 2.9, 2.11). There was one (female?) individual resident at South Grove and about nine individuals at Grove, including several females with pouch young, at least three at-heel or newly weaned joeys and two or three males. Unlike all the other sites, Grove and South Grove had a thick cover of vegetation that, together with the boulders, made a complex habitat. Grove had patches of shade early, with full sun from 1000 until 1500 when patches of shade appeared again. South Grove was shaded for most of the day with a period of full sun between 1200 and 1300hrs (Figure 2.8).

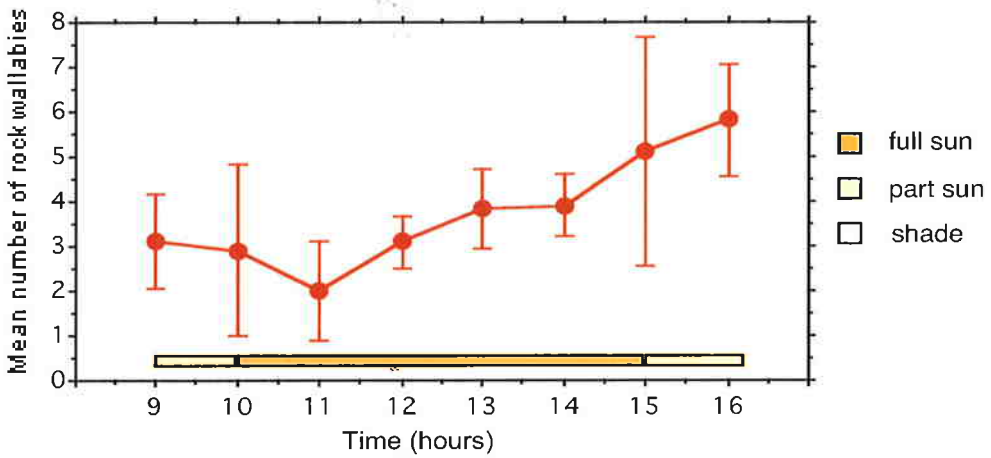

Figure 2.8: Sightings of individual rock wallabies each hour at Grove and South Grove sites, averaged over eleven days observations and shown ± 1 standard error. Sun and shade to the site are indicated on the horizontal bar.

2.3.2 Data Recorded

Observers were provided with data entry sheets (Appendix 2). On each sheet, the name of the site being observed, the date and the name of the observer was recorded. The following attributes were recorded for each rock wallaby:

Time (of recording)

Recording of all attributes commenced on the hour, typically between 9am and 4pm. Individual rock wallabies visible to the observer were scored for their posture, location and behaviour every five minutes. Initially five consecutive recordings were made (between the hour and twenty past), and this was then extended to nine recordings, with continuous recording between 1200 and 1400.

Sun/Shade

This refers to whether or not the site, as distinct from the wallaby, was in sun or shade.

Disturbance

This field was used to identify whether there was any disturbance during the monitoring period. If the disturbance was a boat then the following two fields were also completed. Other disturbances noted included walkers, swimmers, canoeists, planes, birds and observers.

Boat Type

This field was used to record the boat operator in the water during the monitoring period (see Table 2.2).

Table 2.2: Description of boats currently operating on Yardie Creek[2].

Operator	Boat Type	Capacity	Length	Engine Type
CALM	Quicksilver rubber inflatable	6 persons	3.8m	Evinrude 15HP 2 Stroke
Yardie Creek Tours	Multi Hull Australia	30 persons	2.6m x 7m	Yamaha 9.9HP 4 stroke
Ningaloo Safari Tours	Army hull	12 persons		Evinrude 15HP 4 stroke

Boat Location
The location of the boat was recorded using identified landmarks such as the mangrove island, the first bend and each of the wallaby sites etc.

Wallaby Location
Location referred to where the animal was observed in relation to "landmarks", for example at the front of a particular crevice or at the back of a crevice etc. This was used to determine whether an animal had moved between observations.

Rock Wallaby ID
The observers identified individual rock wallabies and followed their behaviour over consecutive recordings. At some sites it was possible to identify the same individuals from day to day. These individuals soon had names and their habits became predictable. At other sites it was difficult to confidently re-identify individuals that disappeared from view, often not reappearing until the following day.

Position
This scored whether the wallaby was in the shade, in the sun or partially in the sun.

Posture
During the initial monitoring phase of this pilot study, the rock wallabies were observed for typical postures. Four different positions were recognised including:
- Tail sitting (Plate 2.12);
- Lying down (Plate 2.13);
- Standing (Plate 2.14); and
- Crouched (Plate 2.15).

On many occasions wallabies were partially obscured by rocks such that the posture could not be determined. These animals were recorded as obscured.

Behaviour
What the animal was doing at the time of each observation was recorded under this heading and included:
- None
- Grooming
- Looking alert
- Foraging
- Interacting
- Not recorded

Typically the wallabies showed no identifiable behaviour and were thus scored as 'None'.

Notes
Each observer had a notebook to record behaviours and interactions other than those listed above. These were numbered in the notebooks and cross referenced by corresponding numbers in the "notes" field.

[2] West Coast Safaris did not run any tours during either field study.

2.3.3 Experimental Design and Analysis

With the co-operation of CALM and the boat tour operators, we were able to arrange three levels of boat traffic in the gorge: nil, low and high. Nil meant no motor boats on the gorge that day, low had just one or two boat trips and high days had five boat trips. Boat trips were all between 1130 and 1500. There were 3 nil, 4 low and 5 high days.

From the massive data set, a few measures of rock wallaby behaviour were extracted for initial analysis. These included:

- the number of individual rock wallabies seen during a specific recording period (usually an hour). This count did not consider how often the rock wallaby was seen during the period, merely how many different individuals were sighted;
- the average number of rock wallabies seen per observation during the recording period; and
- the average number of movements made by each rock wallaby during the recording period.

The number of individuals seen and the average number of rock wallabies were compared among boat levels and across recording time by repeated measures analysis of variance, with one between-subject factor (boat level: nil, low or high) and one within-subject factor (time: 1200, 1300, 1400, 1500). It was predicted that if increasing the number of boats on the gorge had an effect, there would be progressively fewer rock wallabies recorded over time on high boat days, leading to a significant interaction between boat level and time.

These two measures were also compared before and during the first and last boat trip of the day among all boat level treatments. These analyses had one between-subject factor as before, but two within-subject factors: time (before or during the boat trip) and boat trip (first or last). Movements per rock wallaby were compared before and during the first boat trip among all boat level treatments. All analyses were performed using SuperAnova (Abacus Concepts 1989), a statistical package for Macintosh.

In addition to the manipulation of boat traffic, we performed two other experiments to test the effects of disturbance on rock wallaby behaviour. The first was performed at Grove and South Grove, sites that are not normally subject to disturbance. On September 29, one of us walked through both these sites at two separate times, yelling and banging on bits of debris. Numbers of wallabies seen in total and per observation on the five days prior to this disturbance were compared with numbers seen in the following five days by one-way analysis of variance.

The second experiment was carried out on October 5 in the main section of the gorge utilising the CALM dinghy. We deliberately drove this as close as possible to the rock wallabies, yelling, clapping, whistling and revving the motor, while the observers noted down the response of the rock wallabies. This was carried out on all three trips that day.

2.4 Questionnaire / Survey

A questionnaire was developed by CALM and handed out to tour participants to determine their level of satisfaction with the tours. Questions were of three types: respondents were given a choice between alternative answers; respondents were asked to provide data, for example, about themselves or the number of sightings made; and respondents were asked to comment on certain things. Results were entered into an Excel spreadsheet (Microsoft 1998) for analysis.

The number of respondents choosing alternative answers were graphed using Cricket Graph Version 1.3 (Cricket Software 1986-88). The quantitative data were presented as means and standard errors and any comments were summarised. By virtue of the dates and times of the tours, it was apparent that all the respondents had travelled with Yardie Creek Tours. Thus it was not possible to compare responses between tour groups or to take the responses as totally representative of the opinions of all users of the gorge.

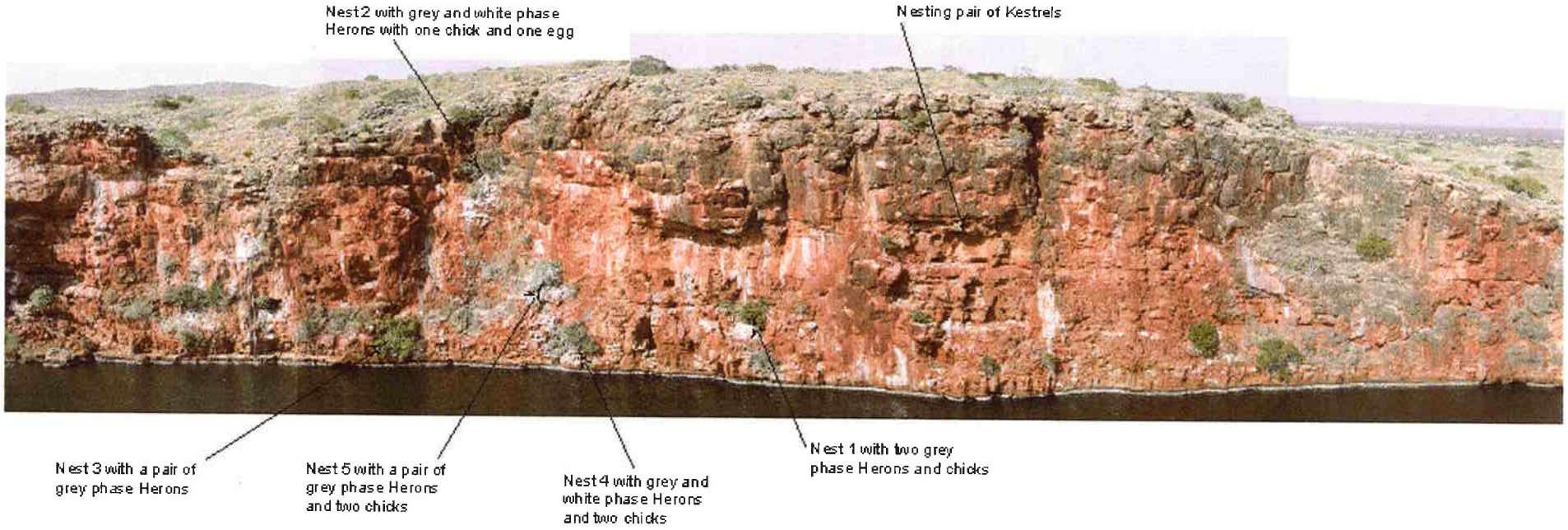

Figure 2.9: Composite photo of the main breeding wall on the southern side of Yardie Creek and locations of Eastern Reef Heron nests. Note that there are also numerous Little Corella nests that are not shown.

Plate 2.1: Entrance site

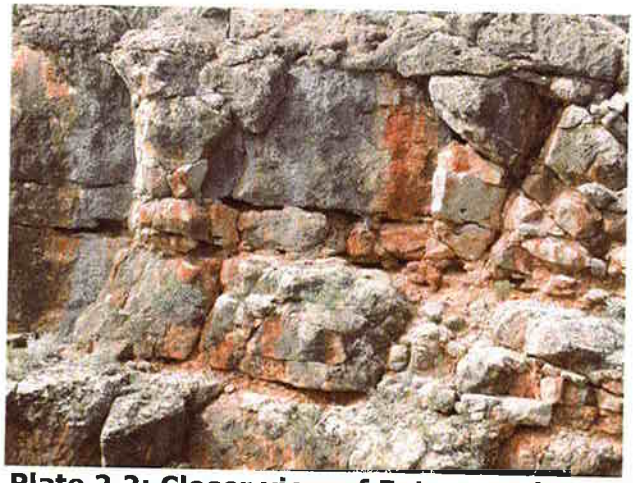

Plate 2.2: Closer view of Entrance site

Plate 2.3: Ficus site

Plate 2.4: Island site

Plate 2.5: Splinter site

Plate 2.6: Peninsula site

Plate 2.7: View site from the West

Plate 2.8: South Grove site

Plate 2.9: Grove site

Plate 2.10: View site from the East

Plate 2.11: Grove site from the east

Plate 2.12: Tail sitting at View

Plate 2.13: Lying-down at View

Plate 2.14: Standing

Plate 2.15: Crouched

2.4.1 Boat Tours

To gain an appreciation of general activities of the two existing tours, the operator of the CALM boat travelled on both tour boats. Average "tours" were then conducted using the CALM boat to increase the number of boat trips per day. The CALM boat "tours" commenced at 11:30, 12:30 and 14:00 and lasted for approximately 60 minutes.

Each of the tour boats are shown in Plates 2.16 – 2.18.

Plate 2.16: Yardie Creek Tours.

Plate 2.17: Ningaloo Safari Tours.

Plate 2.18: CALM "tours".

3.0 Results

3.1 Avifauna Censusing

3.1.1 Habitats at Yardie Creek

- **Mouth of Yardie Creek and Coast**

The mouth of Yardie Creek contains a small area of mangroves, *Avicennia* and several *Rhizophora*, mainly low stunted trees and a few large dome-shaped shrubs. This is the southernmost limit for *Rhizophora* in Western Australia. To the north and south of the creek mouth the coastal strip has a diversity of habitats including broad intertidal flats, both rock and sand foreshore, beaches and small lagoons with mangroves, coastal dunes and samphire flats.

- **Yardie Creek Gorge and Cape Range**

Yardie Creek essentially cuts through the Cape Range, a heavily dissected limestone plateau rising to 315 m. The steep rock slopes are sparingly covered with spinifex (*Triodia* spp.), shrubs and low eucalypts. The upper section of the gorge is more heavily wooded.

3.1.2 The Assemblage

A total of 147 bird species has been recorded for the Yardie Creek area or is expected to occur there from their occurrence nearby. Of these, a number of species have important isolated populations in the Cape Range, mainly the Spinifex Pigeon, Rufous-crowned Emu-wren, Striated Grasswren, Grey-headed Honeyeater, Grey Shrike-thrush, Little Woodswallow and Spotted Bowerbird. Noteworthy of these are the Grey Shrike-thrush *Colluricincla harmonica kolichisi* and the Spotted Bowerbird *Ptilonorhynchus guttatus carteri,* both endemic subspecies in the region (Ford, 1987; Frith & Frith, 1997).

The broad intertidal flats and beaches are important habitats for many seabirds and waders, including many migrants from the northern hemisphere. The small stand of mangroves at Yardie Creek is the southern limit of the Pilbara mangrove system. Many mangrove birds have a broken distribution in Western Australia with isolated populations in the Kimberley, Pilbara and Carnarvon regions. Species that have a Pilbara population at its southern limit in the Yardie Creek area are the Mangrove Heron, White-breasted Whistler, Mangrove Grey Fantail, Dusky Gerygone and Yellow White-eye (Johnstone, 1990).

The Yardie Creek gorge contains one of the few breeding colonies of the Eastern Reef Heron in Western Australia. A high conservation value should be placed on this colony and disturbance to the colony prevented during the breeding season. Other species recorded breeding in the cliffs of Yardie Creek include the Osprey, White-bellied Sea-eagle and Little Corella. This is one of the few areas in Western Australia where Corellas are cliff nesters.

Forty-two species of avifauna were recorded from the two trips (2000 and 2001) combined, comprising 27 non-passerines and 15 passerines (Table 3.1). None of the species recorded were in addition to those listed by Ron Johnstone as having previously been recorded from the area (Appendix 1).

Table 3.1: Bird species recorded from Yardie Creek.

Common Name	Species Name
Emu	*Dromaius novaehollandiae*
Darter	*Anhinga melanogaster novaehollandiae*
Little Black Cormorant	*Phalacrocorax sulcirostris*
Little Pied Cormorant	*Phalacrocorax melanoleucos melanoleucos*
White-faced Heron	*Ardea novaehollandiae*
Eastern Reef Heron (Eastern Reef Egret)	*Ardea sacra sacra*
Striated Heron (Mangrove Heron)	*Butorides striatus stagnatilis*
Rufous Night Heron	*Nycticorax caledonicus hilli*
Osprey	*Pandion haliaetus cristatus*
Brahminy Kite	*Haliastur indus girrenera*
Collared Sparrowhawk	*Accipiter cirrocephalus cirrocephalus*
Wedge-tailed Eagle	*Aquila audax*
Spotted Harrier	*Circus assimilis*
Australian Kestrel	*Falco cenchroides cenchroides*
Peregrine Falcon	*Falco peregrinus macropus*
Buff-banded Rail	*Gallirallus philippensis mellori*
Common Sandpiper	*Tringa hypoleucos*
Pied Oystercatcher	*Haematopus longirostris*
Red-capped Plover	*Charadrius ruficapillus*
Silver Gull	*Larus novaehollandiae novaehollandiae*
Caspian Tern	*Sterna caspia*
Crested Tern	*Sterna bergii*
Crested Pigeon	*Ocyphaps lophotes*
Spinifex Pigeon	*Geophaps plumifera*
Little Corella (Pilbara)	*Cacatua sanguinea westralensis*
Horsfield's Bronze Cuckoo	*Chrysococcyx basalis*
Sacred Kingfisher	*Todiramphus sanctus sanctus*
Brown Honeyeater	*Lichmera indistincta indistincta*
Singing Honeyeater	*Lichenostomus virescens*
Grey-headed Honeyeater	*Lichenostomus keartlandi*
Magpie-lark	*Grallina cyanoleuca*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae novaehollandiae*
White-breasted Woodswallow	*Artamus leucorynchus leucopygialis*
Little Woodswallow	*Artamus minor*
Pied Butcherbird	*Cracticus nigrogularis*
Little Crow	*Corvus bennetti*
Western Bowerbird	*Ptilonorhynchus maculatus guttatus*
Welcome Swallow	*Hirundo neoxena*
Tree Martin	*Hirundo nigricans nigricans*
Grey-breasted White-eye (Silvereye)	*Zosterops lateralis gouldi*
Mistletoebird	*Dicaeum hirundinaceum hirundinaceum*
Zebra Finch	*Taeniopygia guttata castanotis*

Of the total recorded, six were noted as nesting within the gorge area (Table 3.2).

Table 3.2: Bird species recorded nesting at Yardie Creek.

Species	# of identified nests 2000	# of identified nests 2001
Eastern Reef Heron	6	8
Little Corella	Numerous	Numerous
Nankeen Kestrel	4	2
Black-faced Cuckoo-shrike	Adults seen with fledgling at mouth of Yardie Creek	None
Little Woodswallow	None	None (though birds seen carrying nesting material)
Welcome Swallow	Numerous	None

Nesting pairs of Eastern Reef Herons provided the focus for the monitoring work during 2001. Seven nesting pairs were located, with nests typically hidden amongst the branches of the *Ficus* plants growing out of the rock face, or in narrow ledges or crevices behind these trees. All but two nests were located along the main nesting wall (Figure 2.9). The nests are as follows:

- Nest 1 on main nesting wall: Grey and white phase adults with chicks.
- Nest 2 on main nesting wall: Grey and white phase on nest.
- Nest 3 on main nesting wall: Two grey phase birds on nest.
- Nest 4 on main nesting wall: Grey and white phase pair on nest with chicks.
- Nest 5 on main nesting wall: Two grey phase birds on nest with single large chick.
- Entrance: Two grey phase birds on nest with two chicks. Nest located on ledge shielded by hanging ficus.
- A white-phase pair apparently commenced a nest on the northern side of the gorge below the Island observation point.

In comparison, six nests were identified during the 2000 survey (Biota and Ecological Analysis, 2001).

The Little Corella was both the most numerically abundant and most commonly recorded nesting species. Nest sites were located exclusively within the natural holes and crevices of the cliff face, both on the northern and southern walls, although predominantly along the main breeding wall (Figure 2.9).

Three nesting pairs of Kestrels were noted, two of which occurred along the main nesting wall, whilst the third occurred above the Boulder Site. During the 2001 survey, the pair nesting along the main breeding wall were repeatedly observed mating.

The Welcome Swallows were observed feeding fledglings in a narrow cleft below the View observation point. However, no evidence of nesting was noted during the 2001 survey.

Little Woodswallows were observed carrying nesting material to several locations along the cliff-face during the 2001 survey. However, no nests were located.

A fledgling Black-faced Cuckoo-shrike was noted from the *Avicennia marina* at the mouth of Yardie Creek during the 2000 survey. No evidence of nesting was noted during the 2001 survey.

3.2 Response of Birds to Tour Boats and Tourists

On no occasion was there any observed response from Eastern Reef Herons that were on the nest to any of the tour boats. However, birds on the waters edge including the Eastern Reef Heron, White-faced Heron, Darter and Little Pied Cormorant typically flew to new positions either higher up the cliff-face or in the gorge when a boat approached too closely.

In contrast, walkers and swimmers did appear to agitate nesting birds and chicks on several occasions. On the 1/10/2001 a grey phase Eastern Reef Heron left the nest at location 1 when a tourist who had been swimming in the creek climbed up the cliff face and into the *Ficus* tree in which the nest was located. Similarly the chick at location 5 left the nest as the same climber approached the nest site. On another occasion a walker on the southern rim was observed to frighten a bird off its nest close to the rim (nest 2, Figure 2.9). The nest supported one egg and one recently hatched chick.

There are reports that boats travelling too close to the main nesting wall have disrupted birds when they are selecting nest sites. With the exception of one pair, all remaining pairs of Eastern Reef Herons identified during the 2001 survey were on nests. However, the age of nests varied; for example, one nest supported a chick that had recently hatched, whilst at another the chick regularly ventured away from the nest by climbing along the cliff face.

The majority of activity of Eastern Reef Herons seemed to be associated with adults travelling to and from the ocean, probably with food for the young. This is supported by observations of the recently returning adults feeding their young and the other adult flying towards the ocean.

There was no response from nesting Corellas or the Kestrels to boat tours.

3.3 Response of Rock Wallabies to Altered Boat Use in the Gorge

Rock wallabies did not appear to be affected by differing levels of boat use in the gorge. There was no change in numbers of individuals seen during the hours when boats were on the gorge (1200 to 1500hrs). This analysis was carried out twice; once for numbers seen at Ficus and Entrance (Table 3.3) and once for numbers at Island, Splinter and View (Table 3.4). This was to accommodate the different number of days each group of sites was observed and to reflect the different pattern of boat presence at those two groups of sites.

Table 3.3: Effect of level of boat use on rock wallaby numbers seen between 1200 and 1500 hours at Entrance and Ficus. Numbers seen were analysed by repeated measures analysis of variance with one between subject factor (boat use) and one within subject factor (time). Means are presented (± 1 standard error) in Figure 3.1.

Source	df	Mean square	F-value	p-value
Boat Use (nil, low or high)	2	0.0694	0.0289	0.972
Subject within groups	6	2.4028		
Impact time (1200, 1300, 1400, 1500)	3	1.8226	1.8837	0.169
Impact time x Boat use	6	0.3009	0.3110	0.923
Impact time x Subject within groups	18	0.9676		

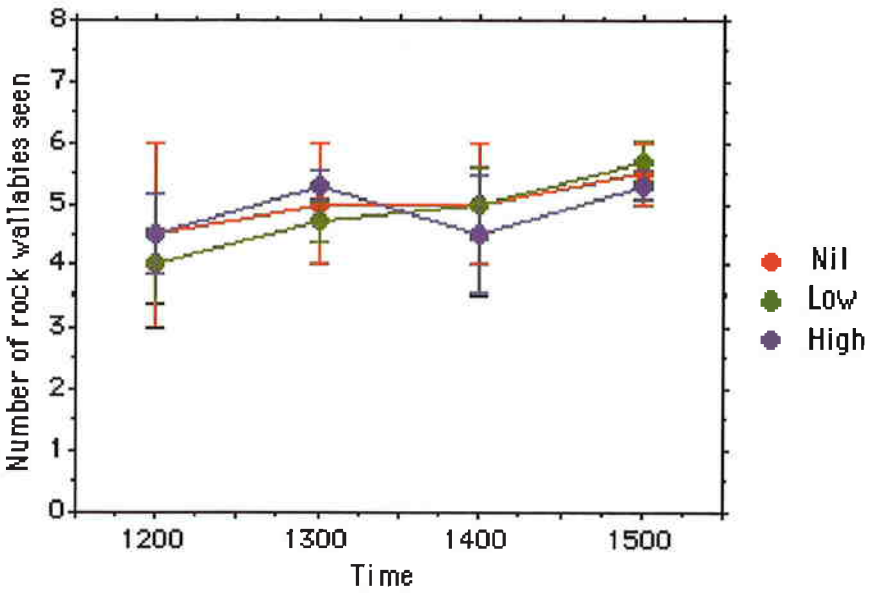

Figure 3.1: The number of rock wallabies seen between 1200 and 1500 hours at Entrance and Ficus on days of nil (n=2), low (n=3) and high (n=4) boat tours.

Table 3.4: **Effect of level of boat use on rock wallaby numbers seen between 1200 and 1500 hours at Island, Splinter and View.** Numbers seen were analysed by repeated measures analysis of variance with one between subject factor (boat use) and one within subject factor (time). Means are presented (± 1 standard error) in Figure 3.2.

Source	df	Mean square	F-value	p-value
Boat Use (nil, low or high)	2	1.6136	0.2608	0.777
Subject within groups	8	6.1875		
Impact time (1200, 1300, 1400, 1500)	3	1.1833	0.4146	0.744
Impact time x Boat use	6	0.4621	0.1619	0.985
Impact time x Subject within groups	24	2.8542		

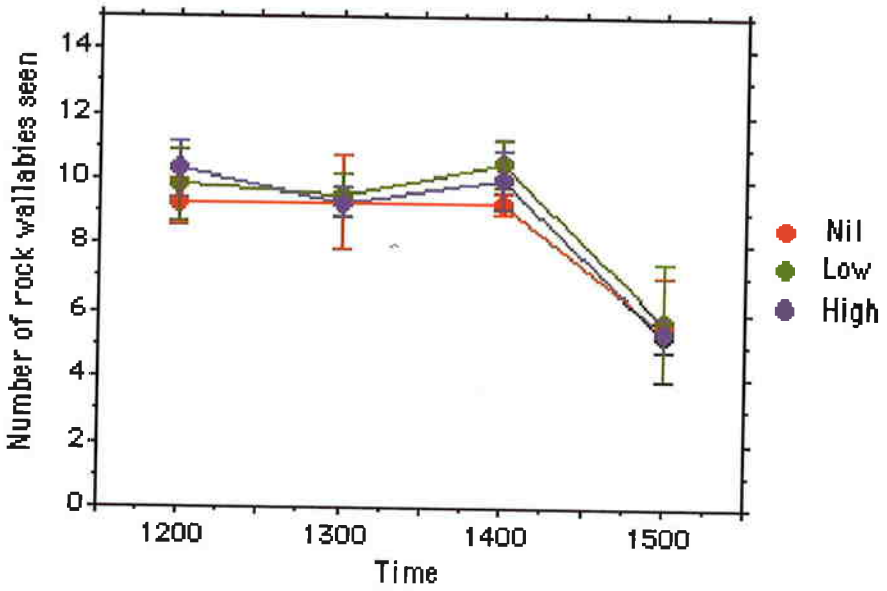

Figure 3.2: **The number of rock wallabies seen between 1200 and 1500 hours at Island, Splinter and View on days of nil (n=3), low (n=4) and high (n=4) boat tours.**

Similarly the number of individuals seen per observation in the impact time (1200 - 1500) did not differ across treatments (Tables 3.5 and 3.6). In both cases there was very little variation between the treatments as shown by the extremely low F values in both analyses. These analyses, together with the previous two, show no evidence to suggest that increased boat use was affecting sightings of rock wallabies in any way.

Table 3.5: **Effect of level of boat use on the average number of rock wallabies seen per observation between 1200 and 1500 hours at Ficus and Entrance.** Numbers seen were analysed by repeated measures analysis of variance with one between subject factor (boat use) and one within subject factor (time). Means are presented (± 1 standard error) in Figure 3.3.

Source	df	Mean square	F-value	p-value
Boat Use (nil, low or high)	2	0.1201	0.1191	0.890
Subject within groups	6	1.0082		
Impact time (1200, 1300, 1400, 1500)	3	0.1406	0.5282	0.669
Impact time x Boat use	6	0.1333	0.5009	0.780
Impact time x Subject within groups	18	0.2661		

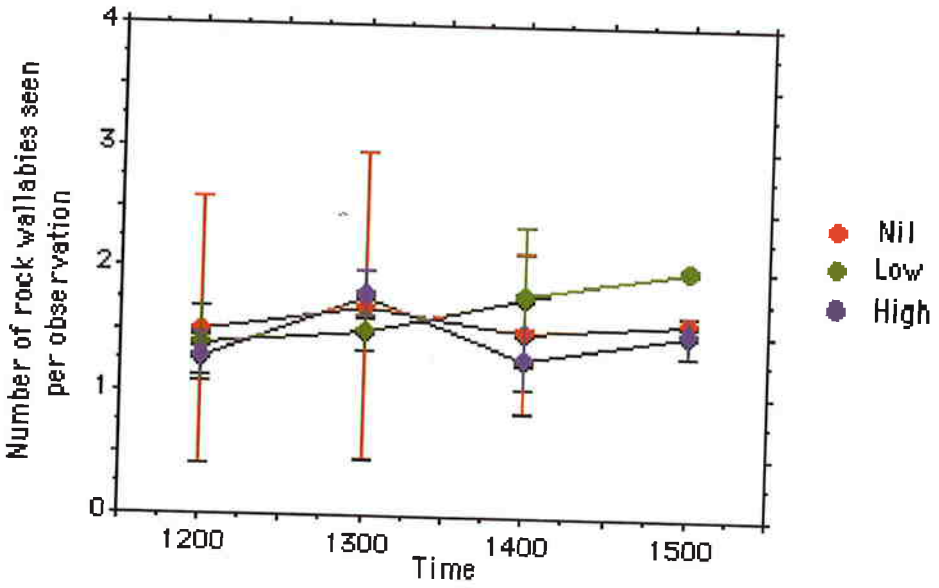

Figure 3.3: **Number of rock wallabies seen per observation between 1200 and 1500 hours at Entrance and Ficus on days of nil (n=2), low (n=3) and high (n=4) boat tours**

Table 3.6: **Effect of level of boat use on the average number of rock wallabies seen per observation between 1200 and 1500 hours at Island, Splinter and View.** Numbers seen were analysed by repeated measures analysis of variance with one between subject factor (boat use) and one within subject factor (time). Means are presented (± 1 standard error) in Figure 3.4.

Source	df	Mean square	F-value	p-value
Boat Use (nil, low or high)	2	0.2023	0.1808	0.840
Subject within groups	8	1.1191		
Impact time (1200, 1300, 1400, 1500)	3	0.1366	1.4634	0.250
Impact time x Boat use	6	0.0730	0.7817	0.593
Impact time x Subject within groups	24	0.0934		

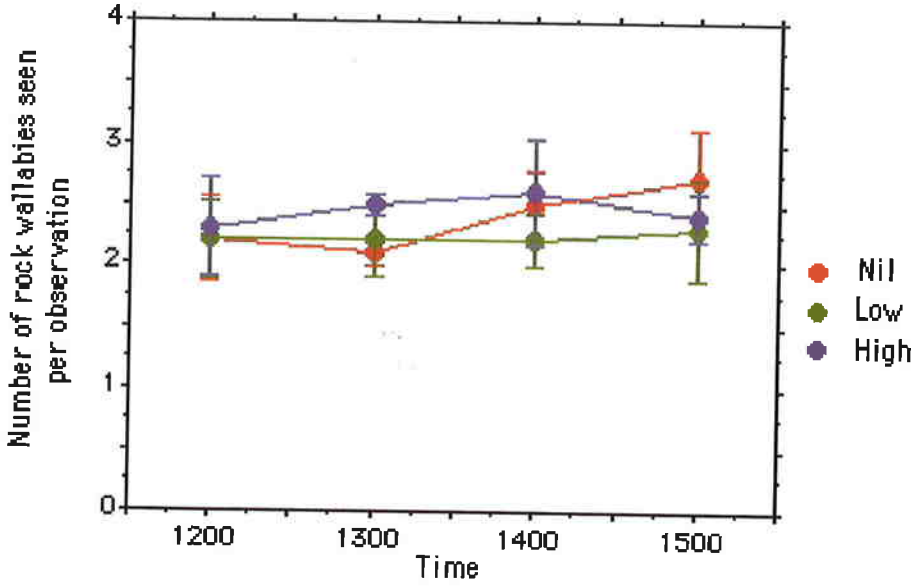

Figure 3.4: Number of rock wallabies seen per observation between 1200 and 1500 hours at Island, Splinter and View on days of nil (n=3), low (n=4) and high (n=4) boat tours.

There was also no change in rock wallaby numbers (Table 3.7) or average number of rock wallabies seen per observation (Table 3.8) before or during the first or last boat trip or over levels of boat traffic. These analyses are only presented for data from Island, Splinter and View, but data from Entrance and Ficus showed the same effect.

Table 3.7: Effect of level of boat use on the number of rock wallabies seen at Island, Splinter and View before and during the first and last boat trips. Numbers seen were analysed by repeated measures analysis of variance with one between subject factor (boat use) and two within subject factors (time and boat trip). Means are presented (± 1 standard error) in Figure 3.5.

Source	df	Mean square	F-value	p-value
Boat Use (nil, low or high)	2	3.4366	0.3853	0.692
Subject within groups	8	8.9193		
Boat trip (first or last)	1	6.3021	2.5078	0.152
Boat trip x Boat use	2	2.0161	0.8023	0.481
Boat trip x Subject within groups	8	2.5130		
Time (before or during)	1	3.5021	1.7955	0.217
Time x Boat use	2	1.4479	0.7423	0.506
Time x Subject within groups	8	1.9505		
Boat trip x Time	1	2.2688	1.7816	0.219
Boat trip x Time x Boat use	2	1.1108	0.8723	0.454
Boat trip x Time x Subject within groups	8	1.2734		

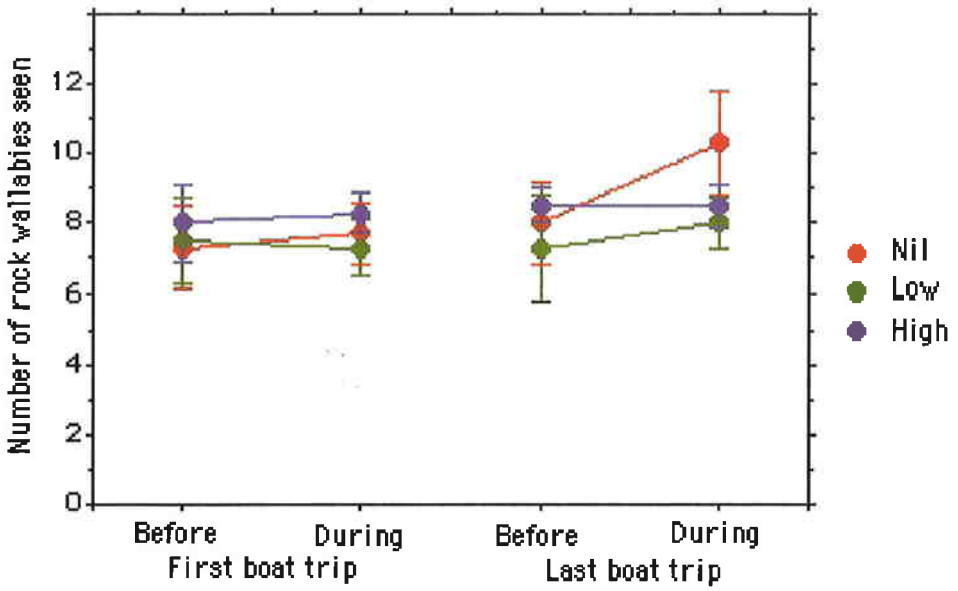

Figure 3.5: Number of rock wallabies seen at Island, Splinter and View before and during the first and last boat tour on days of nil (n=3), low (n=4) and high (n=4) boat tours.

Table 3.8: Effect of level of boat use on the average number of rock wallabies seen per observation at Island, Splinter and View before and during the first and last boat trips. Numbers seen were analysed by repeated measures analysis of variance with one between subject factor (boat use) and two within subject factors (time and boat trip). Means are presented (± 1 standard error) in Figure 3.6.

Source	df	Mean square	F-value	p-value
Boat Use (nil, low or high)	2	0.5518	0.5019	0.623
Subject within groups	8	1.0994		
Boat trip (first or last)	1	0.1621	0.3341	0.579
Boat trip x Boat use	2	0.1993	0.4109	0.676
Boat trip x Subject within groups	8	0.4852		
Time (before or during)	1	0.0321	0.2446	0.6342
Time x Boat use	2	0.0558	0.4253	0.668
Time x Subject within groups	8	0.1311		
Boat trip x Time	1	0.0446	1.1095	0.323
Boat trip x Time x Boat use	2	0.0261	0.6476	0.549
Boat trip x Time x Subject within groups	8	0.0402		

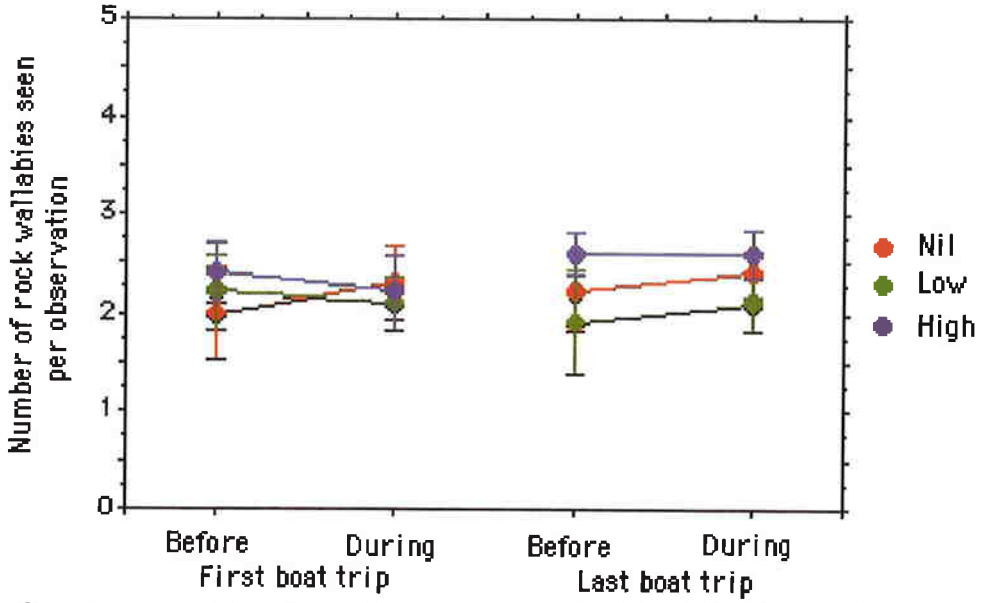

Figure 3.6: Number of rock wallabies seen per observation at Island, Splinter and View before and during the first and last boat tour on days of nil (n=3), low (n=4) and high (n=4) boat tours

Finally, there was no difference in the number of moves made by rock wallabies before and during the first and last boat of the day among boat use treatments (Table 3.9). The last day was not included in this analysis as wallabies were subjected to different treatment during that day (see below).

Table 3.9: Effect of level of boat use on the number of moves made by rock wallabies at all sites before and during the first and last boat trips. Numbers seen were analysed by repeated measures analysis of variance with one between subject factor (boat use) and two within subject factors (time and boat trip). Means are presented (± 1 standard error) in Figure 3.7.

Source	df	Mean square	F-value	p-value
Boat Use (nil, low or high)	2	14.1896	0.3651	0.707
Subject within groups	7	38.8601		
Boat trip (first or last)	1	4.9261	0.4722	0.514
Boat trip x Boat use	2	2.7896	0.2674	0.773
Boat trip x Subject within groups	7	10.4315		
Time (before or during)	1	19.3201	1.0141	0.3474
Time x Boat use	2	29.8729	1.5681	0.274
Time x Subject within groups	7	19.0506		
Boat trip x Time	1	42.0473	3.1641	0.119
Boat trip x Time x Boat use	2	22.9396	1.7262	0.246
Boat trip x Time x Subject within groups	7	13.2887		

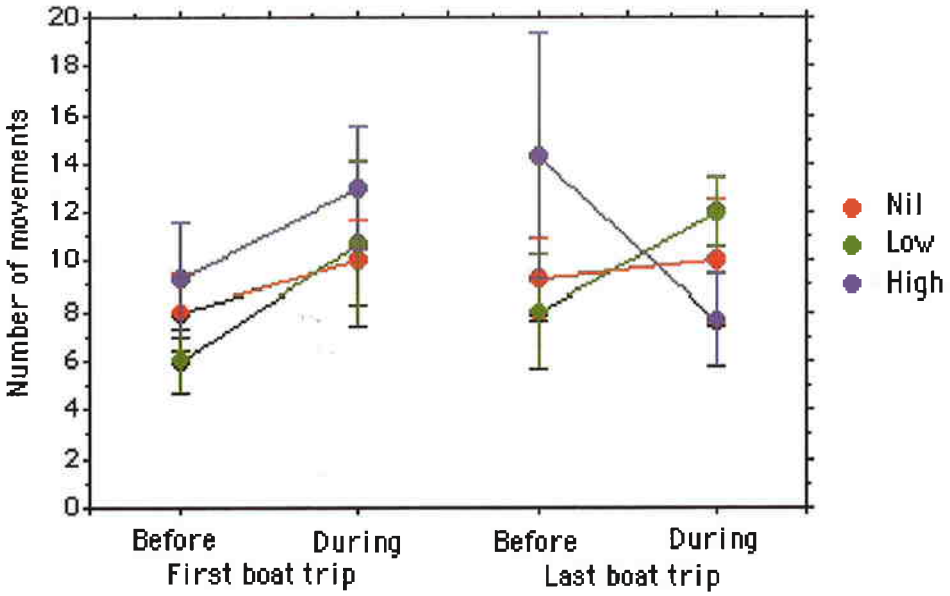

Figure 3.7: Number of movements made by rock wallaby at all sites before and during the first and last boat trip on days of nil (n=3), low (n=4) and high (n=3) boat tours.

3.4 Response of Rock Wallabies at Grove and South Grove to Disturbance

Despite a trend to lower numbers after the disturbance, there was no significant difference between either the number of rock wallabies seen or the number seen per observation before and after the disturbance (Tables 3.10 and 3.11; Figures 3.8 and 3.9). At the time of the disturbance, the rock wallabies hopped quickly away from the sites, but gradually returned during the same day and in the days following. Only one individual rock wallaby was not sighted again. This is the only evidence we have of a numerical response to disturbance.

Table 3.10: Comparison of rock wallaby numbers averaged by hour on the five days preceding the disturbance and the five days following the disturbance by one-way analysis of variance. Means are presented (± 1 standard error) in Figure 3.8.

Source	df	Mean square	F-value	p-value
Disturbance (before, after)	1	0.6891	0.4168	0.537
Residual	8	1.6531		

Mean number before: 4.1±0.58. Mean number after: 3.6±0.57

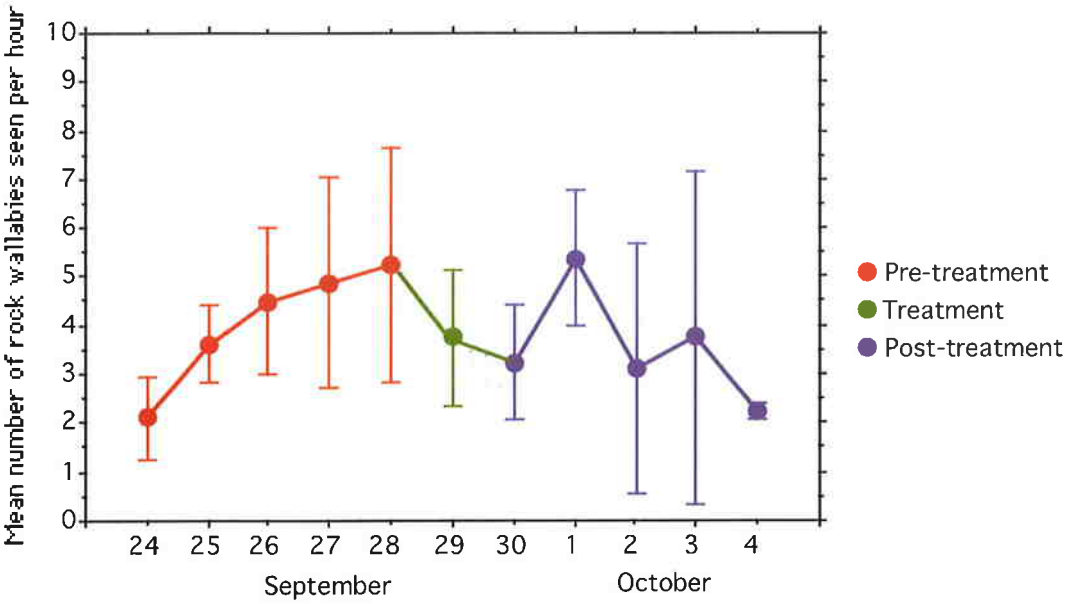

Figure 3.8: Mean (± 1 standard error) number of individual rock wallabies seen per hour on days before, during and after the disturbance at Grove and South Grove. The mean number of rock wallabies seen per hour each day was used in the analysis above (Table 3.10)

Table 3.11: Comparison of the average number of rock wallabies seen per observation averaged by hour on the five days preceding the disturbance and the five days following the disturbance by one-way analysis of variance. Means are presented (± 1 standard error) in Figure 3.9.

Source	df	Mean square	F-value	p-value
Disturbance (before, after)	1	0.3697	0.3237	0.585
Residual	8	1.1422		

Mean number before: 2.5±0.52 Mean number after: 2.2±0.43

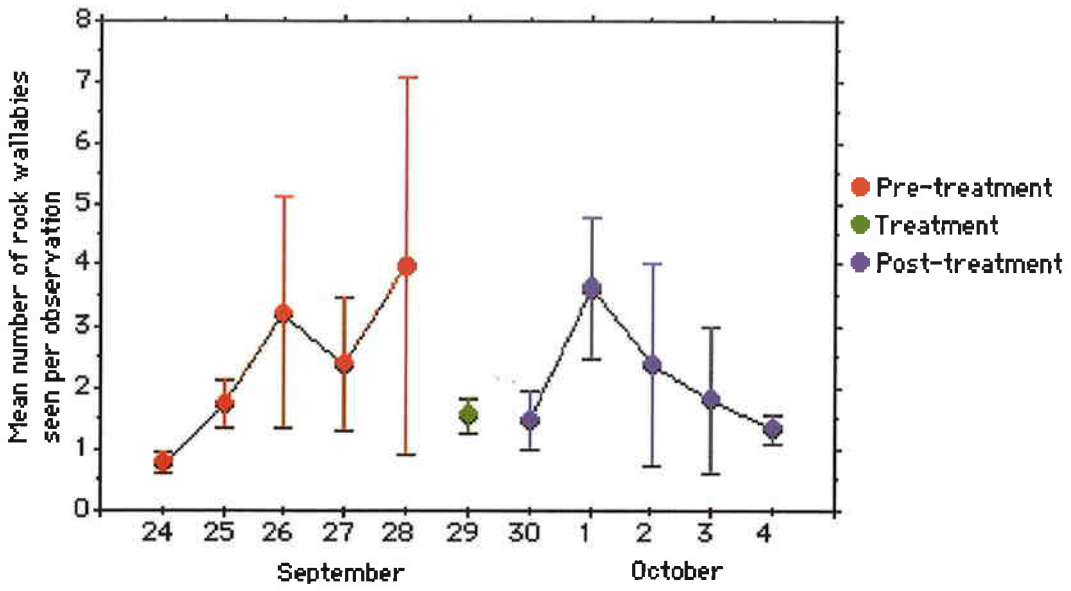

Figure 3.9: Mean (± 1 standard error) number of rock wallabies seen per observation on days before, during and after the disturbance at Grove and South Grove. The mean number of rock wallabies seen per hour each day was used in the analysis above (Table 3.10).

3.5 Response of Rock Wallabies to Excessive Disturbance from Boats

There was no consistent change in the behaviour of rock wallabies even when the boat came up very close with the engine revving while the occupants yelled, stamped and whistled loudly. When first approached in this way, two rock wallabies moved but 11 did not. This was no different from the amount of movement seen at a similar time on the previous day without the disturbance of the boat, when two rock wallabies moved and nine did not. Of the 11 that did not move, only two "looked alert", the remaining nine were completely unperturbed.

The impact was slightly greater on the second attempt to disturb the rock wallabies. Five out of 13 wallabies moved, but again only two of the remaining eight looked alert. Again this was not different from the amount of movement at the same time on the previous day. Clearly rock wallabies do not see boats or their passengers as a threat.

4.0 Discussion

4.1 Effects of Tourism/Boating on Birds

Little work has been done on the impacts of tourism/boats on breeding colonies of birds. Most available information is anecdotal and descriptive with little statistical analysis. Furthermore, most studies focus on individuals rather than populations. However, according to a 1984 review of the status of worldwide seabird populations, 85 seabird species were considered endangered or affected by human activities, and population decreases in 25% of these species were attributed to recreational visits and tourism related activities (Giese, 1999). Breeding success was found to be reduced by disturbance in 36 of 40 papers studying breeding biology. The reduction was attributed to increased predation and nest abandonment (Hockin *et al.*, 1992). Similarly, Jehl (1993) attributed persistent boating activities associated with whale watching activities around Isla San Martin (California) to the significant decline in numbers of breeding Brown Pelicans *Pelicanus occidentalis californicus,* and tourists visiting the Antarctica via helicopter have caused a 50% decline in an Adelie Penguin rookery (www.edf.org).

Studies that have been done suggest that various bird species respond differently to different types of disturbances. Blue Herons (*Ardea herodias*) were more disturbed by shore-based activities than water-based activities (Vos *et al.* 1985). This was also the case for Coots *Fulica atra*, but the reverse was true for Great Crested Grebes *Podiceps cristatus* (Pluger and Ingfold 1988). Common Terns were found to fly away from windsurfers earlier than from either rowing or motor boats (Dietrich and Keopff, 1986). Rogers and Smith (1995) found that some species of colonial waterbirds (eg. cormorants) could be approached closer by boat than on foot before flushing from their nests. Dunnet (1977) noticed that a close approach of crayfish boats to nesting seabirds did not cause any change in adult nest attendance.

Observations during both the Spring 2000 and 2001 surveys suggest that walkers will cause Little Corellas to leave nest holes but that boats have little noticeable effect. It was unclear whether the nests were abandoned entirely as a response to walkers or whether a single parent was still left inside. In addition, on several occasions Corellas were seen to fly away from the southern rim in response to walkers passing by. This behaviour was not noted when the boats alone moved below the nest sites. Interestingly there were fewer nesting Little Corella on the northern side of the creek compared to the southern side. It is unclear whether this is a result of fewer available nest holes or other physical factors or increased disturbance from walkers.

Similarly observations on the Eastern Reef Heron nests, all of which were well above the water line and located behind *Ficus* plants on the cliffs, noted discrepancies between responses to different types of disturbances. The boats were able to cruise past nesting Herons without causing birds to leave their nests. These nests were well concealed and not observed by most persons on board the tour boats. In contrast, walkers and swimmers did appear to agitate nesting birds and chicks on several occasions, most notably when tourists swimming below the main nesting wall left the water and began climbing up the cliff.

One authors' (R.E. Johnstone) experience in the lower Ord River gorges (between Kona Lakeside and the main Ord Dam) suggests that responsible boat owners can approach rookeries without causing stress. The area has 3-5 tour boats and numerous pleasure boats that visit bird breeding areas, flying fox roosts and rock wallaby sites on a regular basis. Johnstone observed that if boats are kept at a 'reasonable' distance with motors

idling or turned off, a close approach can be made to nesting birds and resting mammals. On the Ord, Johnstone has boated to within 20 m of Cormorant and Heron rookeries without birds flushing.

Responses to disturbance vary depending on the severity of the disturbances. Slight disturbances may result in head raising or small body movements. Giese and Riddle (1999) monitored the effect of overflights of a Sikorsky S-76 twin engine helicopter at 1000 m on creching Emperor Penguins (*Aptenodytes forsteri*). These authors found that "all chicks became more vigilant when the helicopter approached and 69% either walked or ran, generally moving less than 10 m toward other chicks (ie. not scattering). Most chicks (83%) displayed flipper-flapping, probably indicating nervous apprehension. This behaviour was seldom displayed in the absence of disturbance." Moderate disturbances result in animals moving small distances or wing flapping by birds, whilst prolonged or significant disturbances will initiate bolting or escape responses.

The response of animals to a disturbance can also vary depending upon the external parameters and life history characteristics of the animal; eg. season, current activity of the animal, sex, age, previous exposure and whether the animal may already be stressed (Manci *et al.*, 1988). For example, Burger and Gallie (1987) reported that the proportion of Gulls flying away when disturbed was less in a heavily disturbed area compared to areas where disturbances were less frequent. This suggests that these birds have become habituated to disturbances, and to some extent it is likely that nesting birds in Yardie Creek have become similarly habituated.

The time of the disturbance can be important both from a seasonal and daily perspective. Disturbances during the breeding season are likely to be worse, especially for colonial nesting species, as are disturbances during the early stages of the breeding cycle when complete nest abandonment is more likely (Anderson, 1988; Anderson and Keith, 1980; Preece and Simons, 1986). Given this, it is possible that the nesting sites occupied during the recent survey are those that provide the most shelter to Herons, and that other potential sites have been abandoned due to disturbances from boats, swimmers and walkers. The consequences of this are twofold. Firstly, if these nesting sites provide adequate shelter from tourism based activities during the earlier and perhaps more vulnerable stage of the nesting cycle, then it is unlikely that any response would be noted from similar disturbances during the latter stages of the cycle (ie. when the monitoring was carried out). Secondly, the gorge could potentially support additional nesting pairs.

Determining whether pairs are abandoning potential nest sites that are more exposed would be extremely challenging given the extended nesting period of Eastern Reef Herons, difficulty with identifying nest selection behaviour and tracking individual birds. During the 2001 survey the most advanced nest site supported one chick that had almost fledged whilst another supported one egg and one recently hatched chick. Egg laying in this species occurs between July and November (Johnstone and Storr 1998) with an incubation period of 25 - 28 days. Nestlings usually wander away from the nest after about three weeks and hide and fledge in about 5-6 weeks (Johnstone pers com.). Peak tourism on Yardie Creek coincides with the school holidays, particularly the winter (mid July) and spring (late September - early October) holidays (Table 4.1). As such, the peak tourism period coincides with the commencement of the breeding cycle in the Eastern Reef Heron.

It is worth noting that in August - September 1972, G. Lodge regarded the Eastern Reef Heron as common in Yardie Creek Gorge, with many birds nesting in the cliff sides. Nests were in *Ficus* sp. growing out of the cracks in the cliff face. Seven nests were inspected: four contained three eggs, one with three young and one with two young. In October 1973, G. Lodge and P. Stone recorded eight breeding pairs of Eastern Reef Heron, a very similar tally to that recorded in both 2000 and 2001.

Given the anticipated difficulty in establishing whether pairs are being disturbed during nest selection, it may be prudent to develop measures to reduce potential impacts (see Section 4.3).

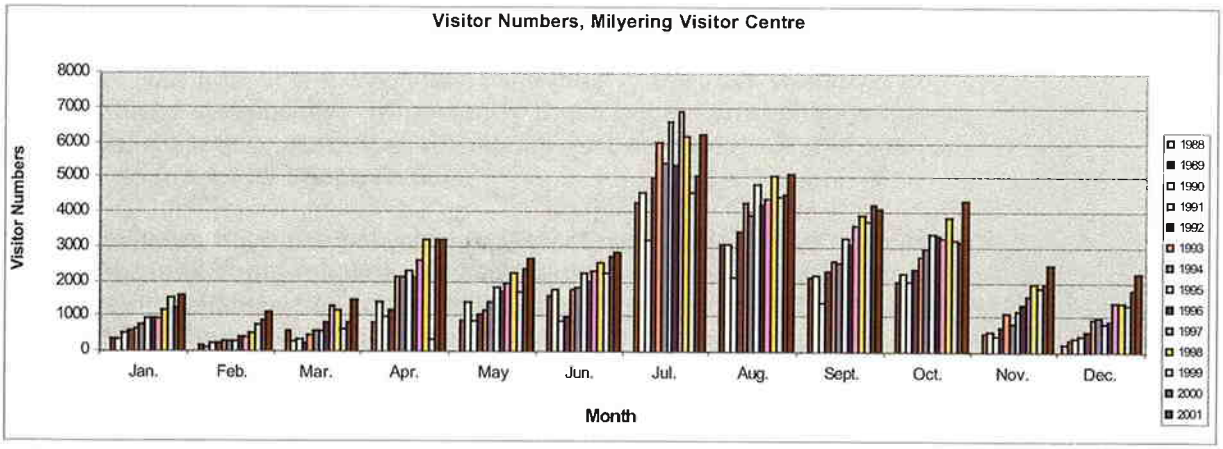

Table 4.1: Average monthly visitor numbers to the Milyering Information Centre since 1988 (Source: Milyering Information Centre).

4.2 Effects of Tourism/Boating on Rock Wallabies

The numbers of rock wallabies visible to observers were relatively constant within any given period of any given day, but varied among days and among the identified groups of wallabies present in the gorge. Between 21 and 32 animals occurred in the section of gorge accessible to the boats and a further 15 animals occurred over a distance of 750 m further up the gorge, giving a total of between 36 and 47 animals. The uncertainty in actual numbers is a consequence of the movement between sites by rock wallabies and the fact that not all wallabies were visible at any one site during any observation period.

Rock wallabies did not appear to be affected by differing levels of boat use in the gorge. This is evident from the analysis performed on the extensive data set yielding the following conclusions:

- There was no change in numbers of individuals seen during the hours when boats were on the gorge (1200 to 1500hrs) across treatments (nil, low and high boat use days).
- The number of individuals seen per observation in the impact time (1200 - 1500) did not differ across treatments (nil, low and high boat use days).
- There was no change in rock wallaby numbers or average number of rock wallabies seen per observation before or during the first or last boat trip, or over levels of boat traffic (nil, low and high).
- There was no difference in the number of moves made by rock wallabies before and during the first and last boat of the day among boat use treatments (nil, low and high boat use days).
- It was impossible to detect a change in response of the wallabies even when the boats came up very close and revved their engines while the occupants yelled, stamped and whistled loudly.

A myriad of other analyses could be performed, comparing behaviours before and during boat trips, and some of these analyses might yield a significant effect of boat use. We believe that wallabies are aware of the boats and sometimes respond to them by looking alert, changing their posture or moving away, but that they also show these responses to other disturbances such as birds calling or flying past, and particularly to the presence of other rock wallabies, as well as to walkers and planes. Thus the responses we saw to the boats are just part of the everyday behaviour of the rock wallabies and cannot be easily differentiated statistically. Importantly these behavioural changes do not result in a numerical response. Rock wallabies were just as numerous and visible on high boat use days as on low or nil boat use days.

Clearly walkers have the potential to impact rock wallabies to a greater extent than boats. This is because boats follow a predictable path and by and large do not encroach closely on the rock wallabies. In contrast, walkers are not predictable and can potentially access caves and resting sites. This type of behaviour has been reported to us by the tour operators, but was not observed during either survey. However, on one occasion a party of walkers was observed descending from the northern rim and crossing to the southern rim at the Peninsula site. On this occasion a rock wallaby was observed to leave its resting site, move behind several larger boulders and wait for the party to leave the area before returning to its original site. The individual walkers appeared not to notice the rock wallaby.

When one of the authors disturbed the animals at the Grove site by walking through the colony, yelling and banging on bits of debris, it did result in a significant flight response with all rock wallabies leaving the area. However, they gradually returned during the same day and in the days following. Only one individual rock wallaby was not sighted again. This is the only evidence we have of a numerical response to disturbance. Nevertheless there was no significant difference between either the number of rock wallabies seen or the number seen per observation before and after the disturbance.

Encounters between our observers and rock wallabies rarely elicited a fright response from the wallabies as long as the observer moved past quietly and slowly. Occasionally the wallaby would move a few metres further away, but typically they stayed still. On several occasions wallabies approached observers seated on the southern rim during the late afternoon.

During the field survey, walkers were observed throwing large rocks into the water. This was particularly common at the highest point of the gorge: above the Splinter site on the northern rim.

4.3 Impacts and Recommendations

- Tour boats and other vessels approaching too closely to the main nesting wall.

  Recommend that boats stay as far away from the main nesting wall as is safely practicable during the Heron nesting period. This may be particularly relevant to the nest selection period.

  Recommend that boats cross downstream of the mangrove island so as to avoid passing vessels in the vicinity of the main nesting wall and potentially disturbing nesting herons.

- Walkers on the southern rim above the main nesting wall.

  Recommend that the southern rim be out of bounds to walkers above the point where the existing sign indicates the start of the Wildlife Area.

  Provide signage at the commencement of the walk (car park) indicating out of bounds areas.

- Swimmers leaving the water and climbing up the main nesting wall.

  Recommend that the main nesting wall be "out of bounds" to tourists at all times of the year. Recommend that clearly worded signs to this effect be placed at the commencement of the walk near the mouth of the creek and on the beach opposite the main nesting wall.

- Uncontrolled access on the northern rim of the gorge (particularly the eastern end) causing degradation to vegetation.

  Recommend that controlled access be identified along the entire length of the proposed walk and restricted to clearly identified tracks and paths.

Given that peak tourism on Yardie Creek coincides with the winter (mid July) school holidays and the possibility that additional visitors may be impacting on nesting Herons at a time when they are more susceptible to disturbance (nest selection period), it is recommended that further studies be conducted over this period.

Recommend that tourist behaviour during the busiest period (mid July school holidays) be monitored to establish what type of impacts may be occurring.

It would be useful to know the potential carrying capacity of rock wallabies of Yardie Creek. This may be achieved through additional studies carried out as part of either an Honours or Masters course.

Investigate the possibility of further Honours or Masters studies on the ecology of rock wallabies in the gorge.

Given the general lack of published information on this type of study, it is important that the findings of this study be made available in a scientific journal.

Recommend that the results of this study be published in a scientific journal.

In addition, it is recommended that analysis of the long-term data collected by the tour operators be reviewed to determine whether any trends can be identified.

5.0 Responses to the Yardie Creek Visitors Survey

Question 1. What was the main reason for taking your tour today?
Please tick one or more boxes.

To sightsee ☐ **To meet people** ☐

To take photos ☐ **To see rock wallabies** ☐

To learn about the landscapes ☐ **To see the bird life** ☐

To see other animals (please specify) _____

For other reasons (please specify) _____

Response

Most people came on the tours to sightsee and learn about the landscape, together with seeing rock wallabies and bird life and taking photos (Figure 5.1). This agrees closely with the findings of the 2000 survey. Nobody came to meet people, but some respondents were hoping to see fish, euros, kangaroos and wildlife generally. Other reasons for taking the tour included an interest in geology and aboriginal heritage, something to do on a holiday, and wanting to see the gorge in a non-intrusive way.

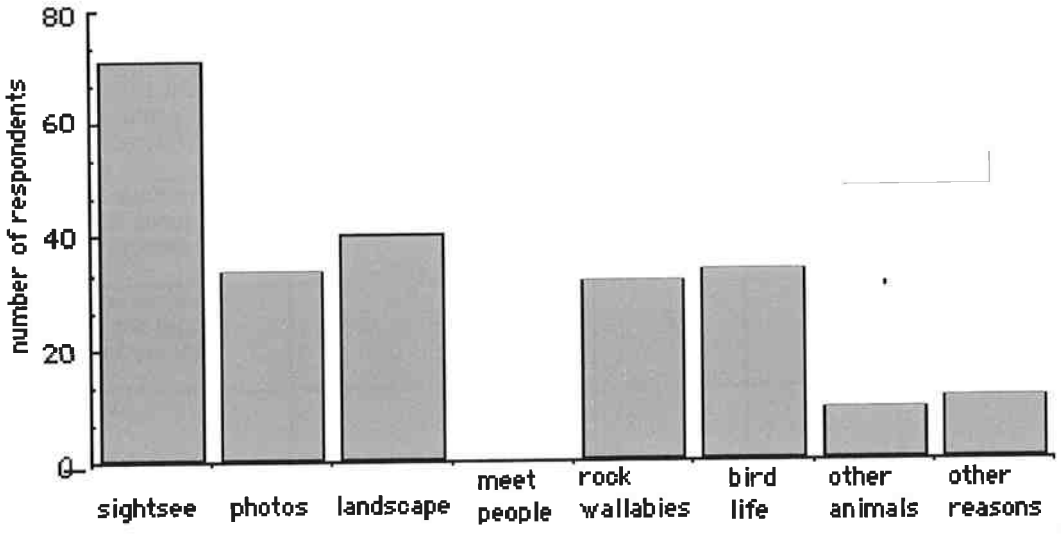

Figure 5.1: Reasons for taking the tour. Each respondent was able to give more than one reason.

Question 2. The number of rock wallabies I saw in this tour was:

Please write the number in the box.

Response

The respondents claimed to have seen between 2 and 15 rock wallabies during their tour, an average of 8.0 ± 0.31. This was higher than the numbers seen in the 2000 survey (6.4 ± 0.25) and tied in well with the higher numbers of wallabies seen by Biota observers in 2001 compared to 2000.

Biota observers consistently saw more rock wallabies than the tour participants. Between 30 September and 5 October, Biota observers saw an average of 11.2 ± 0.97 rock wallabies during the times that the first boat tour of the day was adjacent to the observation sites. Respondents on that tour on those days reported seeing 8.7 ± 1.14 rock wallabies. This differed from the 2000 survey when numbers seen by tour participants and Biota observers were very similar, and can be attributed to the extra observers utilised and the increased familiarity with the wallabies and their whereabouts.

Question 3. How do you feel about your tour today?

Please circle one number only in each row.

Please mark 'not applicable' (N/A) if the statement does not apply to your tour. We would appreciate the other comments you may have.

Statement	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree	N/A Don't Know
I was satisfied with the number of rock wallabies seen	1	2	3	4	5	
I was satisfied with the number of birds seen	1	2	3	4	5	
I was satisfied with the diversity (number of different species) of birds seen	1	2	3	4	5	
I received sufficient information about the birds and animals during the tour	1	2	3	4	5	
There were too many people on the tour to fully appreciate the wildlife	1	2	3	4	5	
Comments						

Response

The respondents were generally satisfied with the number of rock wallabies and birds that they saw on their tour, but were less sure about the diversity of birds (Figure 5.2). 76.5% either agreed or strongly agreed that they were satisfied with the number of rock wallabies they saw, 71.8% with the numbers of birds, while only 64.7% were satisfied with the diversity of birds. These figures are very similar to those recorded in last year's survey (86.7%, 75.4% and 64.2% respectively). The lower level of satisfaction with the rock wallaby numbers this year comes despite an increase in the average number of rock wallabies seen.

Most respondents (96.5%) were satisfied with their tour guide and very few respondents (5%) thought there were too many people on their boat tour.

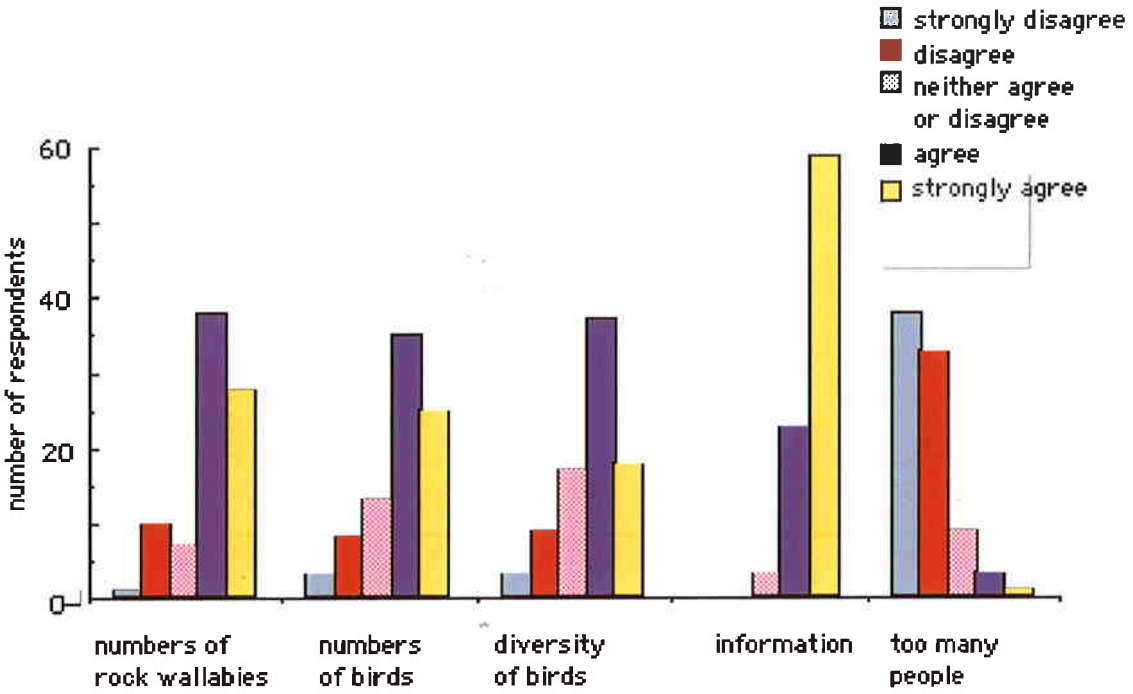

Figure 5.2: Responses to Question 3 regarding the level of satisfaction with aspects of the tour (n = 85 in each case).

Question 4. With regards to viewing wildlife the boat speed was:

Please tick one box.

The boat speed was too slow ☐ **The boat speed was appropriate** ☐

The boat speed was too fast ☐

Response

All respondents (n = 85) thought the boat speed was appropriate.

Question 5. Which of the following statements best describe your sightings of birds?

Please tick one box for each row.

	I noticed many birds	I noticed some birds	I noticed no birds at all
On the water	☐	☐	☐
Along the gorge	☐	☐	☐
Nesting	☐	☐	☐
Flying overhead	☐	☐	☐

Comments_____

Response

Respondents were more likely to have noticed "some" rather than "many" birds in the four locations (Figure 5.3). 'On the water' was the location where respondents were most likely to have seen no birds. These responses are almost identical to those given in the 2000 survey.

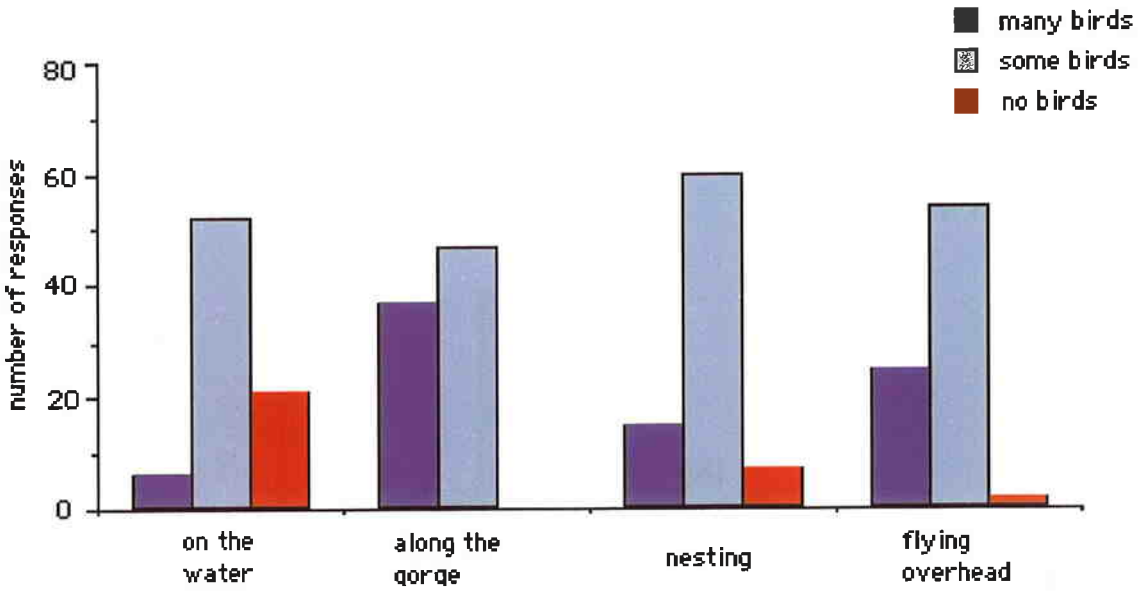

Figure 5.3: Responses to question 5 regarding the sightings of birds.

Question 6. During the tour, the birds I sighted behaved as follows:
Please tick one box for each row where appropriate.

	All birds moved away	Some birds moved away	No birds moved away	N/A Don't know
When walker(s) approached	☐	☐	☐	☐
When the boat moved slowly	☐	☐	☐	☐
When the boat Moved faster	☐	☐	☐	☐
When other boat(s) approached	☐	☐	☐	☐

Comments_____

_____

Response

Many respondents did not know what happened to the birds when walkers or other boats approached. Of the few that did know, most recorded that some birds moved away. The majority recorded that no birds moved away when the boat moved slowly, but that some did when the boat moved faster. Again these results are similar to last year, and suggested that few respondents saw any major disruption to bird life in the gorge during their tour.

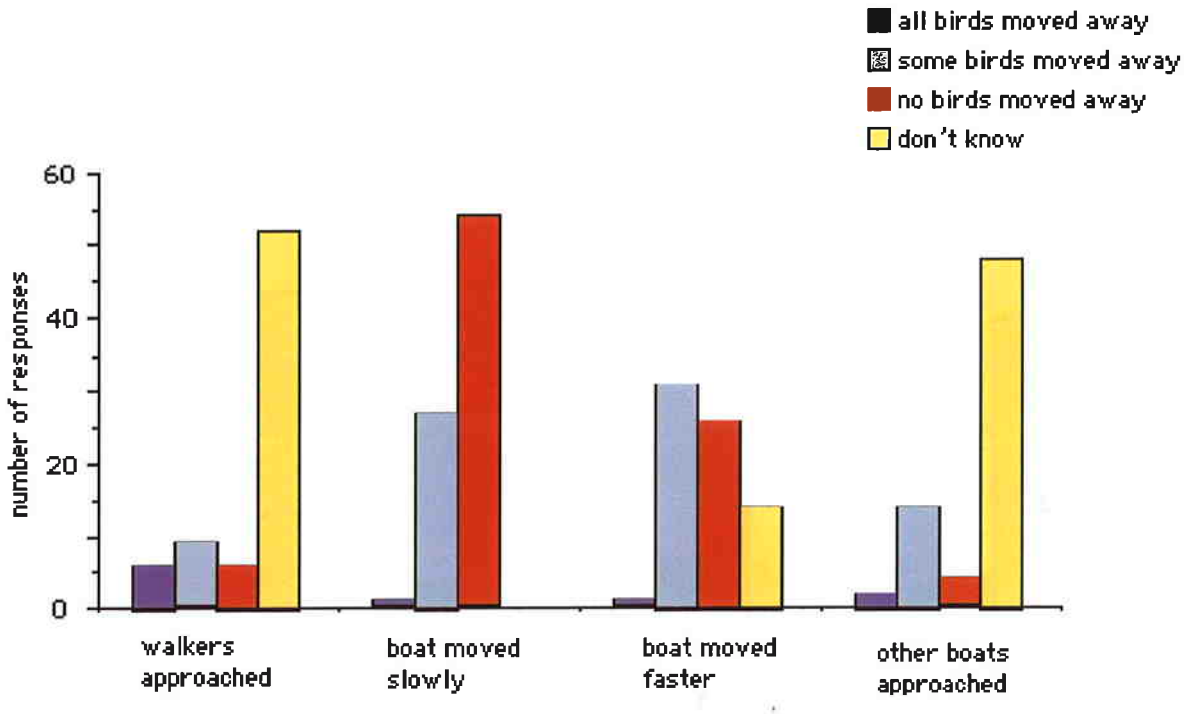

Figure 5.4: Responses to question 6 regarding the behaviour of birds.

Question 7. During the tour, the rock wallabies I sighted behaved as follows:

Please tick one box for each row where appropriate.

	All wallabies moved away	Some wallabies moved away	No wallabies moved away	N/A Don't know
When walker(s) approached	☐	☐	☐	☐
When the boat moved slowly	☐	☐	☐	☐
When the boat Moved faster	☐	☐	☐	☐
When other boat(s) approached	☐	☐	☐	☐

Comments _____

_____

Response

Responses to this question were similar to those for the previous question. Many respondents did not know what happened when walkers or other boats approached, but were adamant that no or only some wallabies moved when the boat went slowly or moved faster. This is in agreement with Biota's findings that wallabies do not respond to the presence of boats.

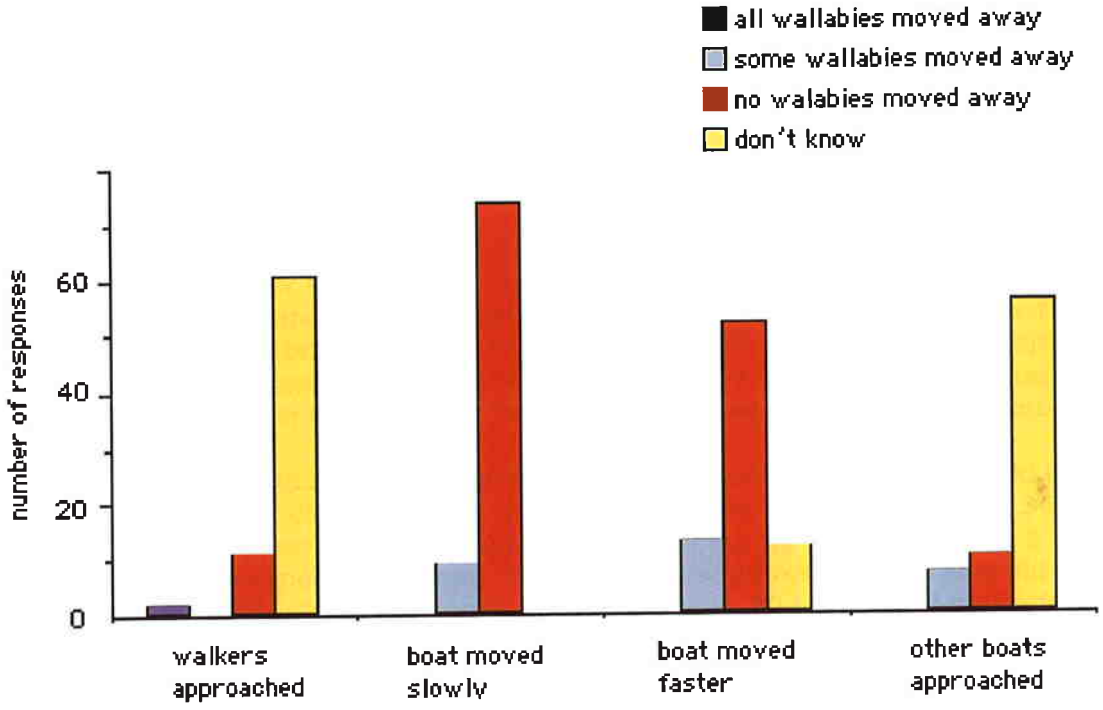

Figure 5.5: Responses to question 7 regarding the behaviour of rock wallabies.

Question 8. How many people were in your boat tour?

☐ *(number)*

Response

According to the respondents, there was an average of 22.8 ± 5.69 people on each tour. There was no correlation between the number of people recorded on the tour and the respondents dissatisfaction with the number of people on the tour as expressed in question 3e ($r = 0.06$, $df = 84$, $p > 0.05$).

Question 9a. How many other boats did you see during your tour?

Please write the number in the boxes provided. If you saw none please write zero.

Power boats ☐ **Others (eg. Canoes/kayaks)** ☐

Response

Fifty five (69%) of the 80 respondents to this question did not see another power boat on the gorge during their tour. Eighteen (22.5%) saw one power boat and seven (8.5%) saw two. Similarly, 56 respondents out of 76 (74%) saw no canoes or kayaks, nine (12%) saw one and the remainder saw between two and five.

Question 9b. The presence of another boat interferes with my enjoyment of the wildlife viewing tour.

Please circle one number only.

Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree	N/A Don't Know
1	2	3	4	5	

Response

Considering that all or nearly all the respondents were on Yardie Creek Tours, the very strong statement of another boat interfering with their enjoyment of the tour (79.3% either agreeing or strongly agreeing with the statement; Figure 5.6) is in keeping with the results from respondents on Yardie Creek Tours in 2000, when 58% of the respondents agreed that the presence of another boat would interfere with their enjoyment of the tour.

Of the 65 respondents who indicated that the presence of another boat would interfere with their enjoyment of the tour (ie. those circling agree or strongly agree), 34 (52.3%) also indicated that they had not seen any other boat during their tour, while a further 12 (18.5%) only saw canoes or kayaks. However, of the 26 respondents who did see one or more other power boats on the gorge during their tour, 20 (77%) said it interfered with their enjoyment of the trip.

The absence of respondents from Ningaloo Safari Tours means that these data are probably not representative of the range of sentiment about this issue. In 2000, 60% of the respondents from Ningaloo Safari Tours indicated that the presence of another boat

did not interfere with their enjoyment of the tour, in direct contrast to the 58% of respondents from Yardie Creek Tours who indicated that it did.

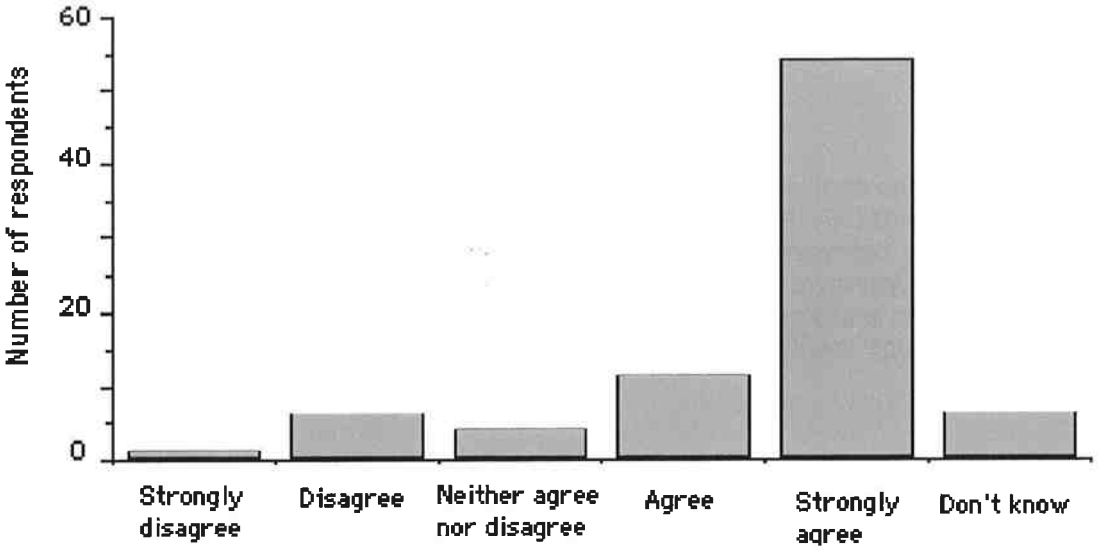

Figure 5.6: Responses to question 9b regarding whether or not the presence of another boat interfered with the enjoyment of the tour (n = 82). (NB. Agree/Strongly Agree = did interfere with enjoyment.)

Question 10. Would you recommend this tour to others?

Yes ☐ **Because** _____

_____

No ☐ **Because** _____

_____

Response

Every respondent would recommend their tour to other people. The comments were again very complimentary of the tour leader's knowledge of the area and the wildlife it supported. Other comments included the chance of seeing the wildlife in their natural surroundings and of looking at the scenery in a peaceful, non-intrusive manner.

Question 11. Where do you normally live?

Locally ☐ **WA Country** ☐ **WA Perth Metro Area** ☐

Interstate _____ **(State)** **Overseas** _____**(Country)**

Response

Nearly half of the respondents (49.4%) were from the Perth metropolitan area and there were proportionately fewer respondents from interstate (14.1%) than in the previous survey (36%). The small proportion of respondents from overseas (10.3%) was similar to the proportion seen from Yardie Creek Tours in the previous survey. In contrast, 30% of respondents from Ningaloo Safari Tours were from overseas tours in the 2000 survey. As all the respondents this year were apparently from Yardie Creek Tours, no comparison between tours or years was possible.

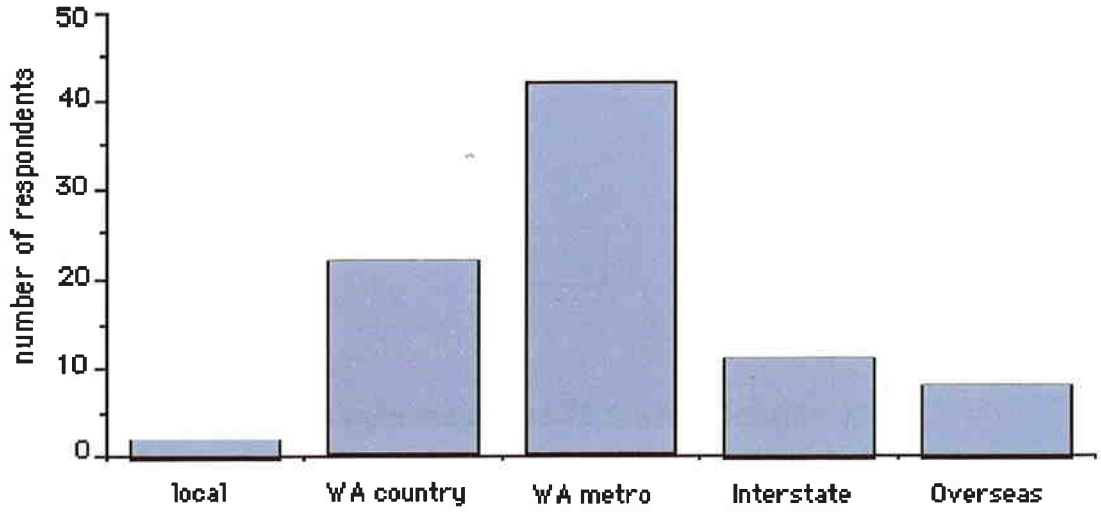

Figure 5.7: Place of origin of respondents (n = 85).

Question 12. Age group

Under 15 ☐ **25 - 39** ☐ **60 & Over** ☐

15 - 24 ☐ **40 - 59** ☐

Response

Just over 40% of the respondents were in the 40-59 age group (Figure 5.8), a similar result to the previous year (39%). Younger adults were poorly represented, but there were more children listed on the forms this year. The 60+ age group made up a smaller proportion (11%) than they had in the previous year (26%).

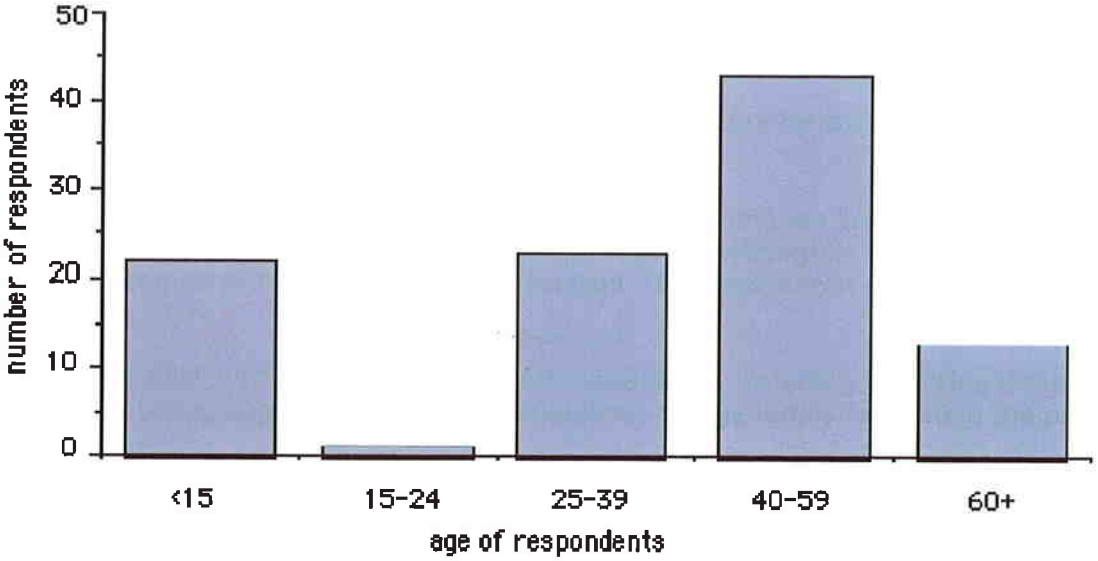

Figure 5.8: Age groups of the respondents (n = 102).

Question 13. Are you?

Male ☐ **Female** ☐

Response

29.5% of the respondents were males and 70.5% females (n = 78).

6.0 Acknowledgements

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Annotated Bird List

Appendix 1

Information provided in the annotated list comes from a variety of sources including:

- Thomas Carter who resided at Point Cloates from 1889 - 1902. During this period he made several trips along the coast to Yardie Creek and North-West Cape. In 1911, 1913 and 1916 he re-visited Point Cloates, travelling north to Yardie Creek in 1913 and to Yardie Creek and North-West Cape in 1916.
- I. C. Carnaby's visit from early January to late October 1943.
- A. Douglas and G. F. Mees visit in August 1959.
- G. Lodge's visits in May 1964, July 1972, August - September 1972, August - September 1974, July 1982, August 1983 and July - August 1984.
- G. Lodge's and P. Stone's visit in October 1973.
- N. Kolichis visit in July 1976, 1977 and 1978.
- T. C. Allen's visit in July - August 1977.
- J. R. Ford's visit in October 1978.
- R. E. Johnstone's visits in July 1978 and July 1980.

Annotated Species List

Status of a species is listed as very common, common, moderately common, uncommon, scarce or rare either throughout its distribution or in given habitats. Season of occurrence of regular non-breeding visitors is indicated by months of earliest and latest records. For vagrants and rare visitors, records are often individually cited. Species in square brackets are recorded from just outside the region eg. Mangrove Bay and Point Cloates. Nomenclature follows Johnstone (2001).

FAMILY CASUARIIDAE

Dromaius novaehollandiae Emu. Moderately common. Mainly on coastal strip and base of range. Breeding recorded near Yardie Creek in samphire.

FAMILY PHASIANIDAE

[*Coturnix novaezelandiae* Stubble Quail. Possibly an uncommon visitor to coastal area. Breeding reported at Point Cloates in August and September.]

[*Coturnix ypsilophora* Brown Quail. Listed by Carter as occasionally breeding near the coast. It is doubtful whether this species does occur here.]

FAMILY ANATIDAE

[*Cygnus atratus* Black Swan. Possibly an uncommon visitor to mouth of Yardie Creek. Breeding recorded just outside the area in July.]

Anas gracilis Grey Teal. Moderately common visitor, often breeding. Pools on Yardie Creek and flooded samphire flats. Listed by Carter for the North-West Cape region as "the commonest duck breeding in hollow gum spouts". Breeding from February to October.

Anus castanea Chestnut Teal. Scarce or rare. Small flocks recorded just outside the area at Mangrove Bay in July 1980. Probably more common in past, as Carter recorded a great flock on large open sheet of water surrounded by mangroves between Yardie Creek and Vlaming Head in June 1902. He saw a pair at the same place in August 1916 and was told that they frequently occurred at these mangroves and occasionally bred there.

Anus superciliosa Pacific Black Duck. Uncommon visitor, occasionally breeding. Mainly Yardie Creek gorge.

Malacorhynchus membranaceus Pink-eared Duck. Uncommon visitor. Mainly near coastal pools.

Athya australis Hardhead. Uncommon visitor. Yardie Creek gorge and flooded samphire on coast.

FAMILY PODICIPEDIDAE

[*Poliocephalus poliocephalus* Hoary-headed Grebe. Scarce or rare visitor to coastal areas. Recorded just outside the area.]

FAMILY PHALACROCORACIDAE

Phalacrocorax varius Pied Cormorant. Uncommon or scarce visitor to coast.

FAMILY ARDEIDAE

Ardea pacifica White-necked Heron. Uncommon. Inland pools and occasionally on beach.

Ardea novaehollandiae White-faced Heron. Uncommon to moderately common. Flooded coastal flats, edges of mangroves and inland pools. Breeding recorded in mangroves in July and August - September.

Recorded on four occasions during the current survey. Recorded as singles, twos and threes typically from the waters edge.

Ardea alba Great Heron. Scarce. Coastal lagoons.

Ardea garzetta Little Heron. Scarce. Edges of mangroves.

Ardea sacra Eastern Reef Heron. Common resident. Tidal flats, rocky and sandy beaches and lower Yardie Creek. Breeding recorded from July to October. In August - September 1972 listed as common in Yardie Gorge with many nesting in the cliff sides. Nest were in *Ficus* sp. trees growing out of the cracks in the cliff face. Seven nests were inspected: four contained three eggs, one with three young and one with two young. In October 1973 eight pairs were breeding in Yardie Gorge; nests with eggs and young at various stages. In July 1974 listed as common in Yardie Gorge and one nest with three eggs and several nests with young were noted. Both white and grey phase birds in the colony and nests ranged from just above water level to 3 m up the cliff wall.

Recorded on 23 occasions, typically as singles or twos. Often seen on the banks of the creek, the cliff face, mangroves and on nests behind ficus trees on cliff faces. Both white phase and dark phase birds were observed.

Butorides striatus Striated Heron. Uncommon to moderately common in ones, twos and small groups. Mangroves and rocky, muddy and sandy tidal flats. Breeding in mangroves near Yardie Creek, August - September.

Single bird seen resting on the stilt roots of the *Rhizophora stylosa* adjacent to the boat mooring.

Nycticorax caledonicus Rufous Night Heron. Uncommon or scarce. Recorded by Carter as plentiful about mangrove creeks in North-West Cape region and near Yardie Creek in early nineteen hundreds.

Single bird seen during the current survey perched on the stilt roots of *Rhizophora stylosa* adjacent to the boat mooring.

FAMILY THRESKIORNITHIDAE

Threskiornis molucca Australian White Ibis. Scarce or rare visitor. Carter was informed that they occasionally occurred in small numbers with flocks of Straw-necked Ibis.

Threskiornis spinicollis Straw-necked Ibis. Scarce, irregular visitor. First recorded by Carter in the North-West Cape region in May 1888 when numbers suddenly appeared. After the 1889 - 91 drought broke, immense numbers were seen. On 1 September 1913 Carter found the remains of an immature at Yardie Creek.

FAMILY ACCIPITRIDAE

Pandion haliaetus Osprey. Uncommon to locally moderately common. Mainly coast especially areas with mangroves and along Yardie Creek. Breeding recorded at Yardie Creek (nest on edge of cliff) in June.

Elanus caeruleus Black-shouldered Kite. Uncommon to moderately common. Many seen on coast during drought of 1891 by Carter and noted as fairly common in 1900. Recorded breeding just outside the area in July 1974 (nests with eggs and young) and recorded at Low Point in July 1980.

Hamirostra melanosternon Black-breasted Buzzard. Moderately common over range and coastal habitats.

[*Haliastur sphenurus* Whistling Kite. Uncommon or scarce visitor to the area.]

Haliastur indus Brahminy Kite. Uncommon. More frequent in mangroves further south on peninsula.

Accipiter cirrocephalus Collared Sparrowhawk. Single bird seen chasing kestrels above the cliffs at the upper reaches of the water in Yardie Creek.

Accipiter fasciatus Brown Goshawk. Moderately common autumn - winter visitor from further south. Mainly well wooded habitats along Yardie Creek and mangroves.

Aquila audax Wedge-tailed Eagle. Single bird seen over the cliffs at the end of the water in Yardie Creek.

Haliaeetus leucogaster White-bellied Sea-Eagle. Moderately common along the coast in ones and twos. Breeding recorded at Yardie Creek in June - July. Nests in cliff edges or in low trees on cliff edges.

Circus assimilis Spotted Harrier. Moderately common. Mainly over mangroves, samphire flats and coastal areas. Noted by Carter as most numerous in winter. Breeding recorded (nest with three eggs) in eucalypt, just outside the Yardie Creek area in July 1982.

Immature bird seen on two occasions over the sand dunes adjacent to the carpark.

[*Circus approximans* Swamp Harrier. Possibly a rare visitor. One collected by Carter at Point Cloates.]

FAMILY FALCONIDAE

Falco berigora Brown Falcon. Common resident. Breeding from June to August. Most nests in trees but one reported on top of a large termitarium.

Falco cenchroides Australian Kestrel. Common resident and autumn - winter visitor. Usually single but occasionally in twos or small parties. Favours coastal habitats especially samphire flats and dunes, also edges of range and Yardie Gorge. Breeding recorded in July to September. Nesting sites include tree hollows and ledges of cliffs in range and gorges.

Three pairs recorded nesting within the small overhangs in the cliff face.

Falco longipennis Australian Hobby. Uncommon, possibly only a winter visitor. Noted as quite common in the region by Carter during the abnormally wet year of 1900.

[*Falco peregrinus* Peregrine Falcon. Possibly only a rare visitor. One observed by Carter well to the north at Vlaming Head on 15 June 1902.]

Two records of a single bird over the cliffs at the end of the water in Yardie Creek.

FAMILY RALLIDAE

[*Gallirallus philippensis* Buff-banded Rail. Scarce. Nomadic. Ones and twos recorded just outside the area including a nest with eight eggs in dense clump of samphire near mangroves at Low Point in July 1980.]

Gallinula ventralis Black-tailed Native-hen. Nomadic. Locally common in good years but generally scarce, in ones, twos or small parties. Mainly inundated coastal flats (following winter or summer rains).

Fulica atra Eurasian Coot. Uncommon visitor. Listed by Carter for the North-West Cape region as an occasional visitor when water is plentiful, notably in 1898 and 1900.

FAMILY OTIDIDAE

Otis australis Australian Bustard. Nomadic. Uncommon to moderately common depending on season. Listed by Carter as very abundant in good seasons in pairs and small mobs. Mainly coastal flats. Breeding reported for May, July, August and September.

FAMILY TURNICIDAE

Turnix velox Little Button-quail. Common to moderately common in good seasons. Mainly coastal flats. Breeding in April and September.

FAMILY SCOLOPACIDAE

[*Limosa limosa* Black-tailed Godwit. Scarce visitor from northern hemisphere; recorded just outside the area at Low Point in July 1980. Tidal flats.]

Limosa lapponica Bar-tailed Godwit. Moderately common visitor from northern hemisphere. Sandy, rocky and muddy coasts. Numerous records in July 1980.

[*Numenius minutus* Little Curlew. Uncommon summer visitor from northern hemisphere. Small flocks recorded outside the region at North-West Cape and Point Cloates. Mainly coastal flats.]

[*Numenius phaeopus* Whimbrel. Scarce visitor from northern hemisphere. Recorded just outside the region at Low Point in July 1980. Coastal flats.]

Numenius madagascariensis Eastern Curlew. Moderately common visitor from northern hemisphere; usually in ones or twos, occasionally small parties. Mainly tidal flats. Noted by Carter as a common summer visitor, arriving about the end of September with odd birds remaining all winter. On 14 June 1902 he recorded "Curlews" as abundant at a large open sheet of water surrounded by mangroves between Yardie Creek and Vlaming Head (presumably the Mangrove Bay area).

[*Tringa totanus* Redshank. A shy wader seen by Carter at a large open sheet of water surrounded by mangroves between Yardie Creek and Vlaming Head (presumably near Mangrove Bay) on 22 June 1902 is believed to have been this species. Rare visitor from northern hemisphere.]

Tringa nebularia Greenshank. Scarce visitor (late August to early June) from northern hemisphere. Mainly tidal flats, mangroves, samphire flats, beaches and freshwater pools. One collected at Yardie Creek on 24 January 1898.

Tringa hypoleucos Common Sandpiper. Moderately common visitor from northern hemisphere (late August to early May). Usually in ones or twos. Tidal mud flats, mangroves, beaches and rocky pools including mouth of Yardie Creek.

Single seen around the mangroves near the mouth of Yardie Creek on three occasions.

Tringa brevipes Grey-tailed Tattler. Moderately common summer visitor from northern hemisphere; usually in ones or twos, occasionally flocks (up to 12). Mainly tidal flats, mangrove areas and shallow brackish water on coastal flats. Listed by Carter as fairly numerous on coast in summer from November to May.

Arenaria interpres Ruddy Turnstone. Moderately common visitor from northern hemisphere (especially in summer). Mainly ones, twos or small flocks. Tidal flats, beaches and edges of coastal lakes.

Calidris alba Sanderling. Uncommon to moderately common visitor from northern hemisphere; usually in small flocks. Mainly sandy beaches, but in July 1980 also observed around sandy edges of small coastal lakes near Low Point.

Calidris ruficollis Red-necked Stint. Common visitor from northern hemisphere. Tidal mud flats and beaches.

Calidris acuminata Sharp-tailed Sandpiper. Uncommon visitor from northern hemisphere (August - June). Recorded in mangroves near North-West Cape and on flooded saltmarsh near Point Cloates.

FAMILY BURHINIDAE

Burhinus grallarius Bush Stone-curlew. Uncommon, in ones and twos. Listed by Carter for the North-West Cape region as evenly distributed but nowhere in large numbers. Three in wash leading into range (just outside the Yardie Creek region) in July 1982.

Esacus neglectus Beach Stone-curlew. Uncommon. Several pairs recorded by Carter at Low Point and near Yardie Creek. Nest with one egg on a shingly ridge near Low Point on 24 October 1900.

FAMILY HAEMATOPODIDAE

Haematopus longirostris Pied Oystercatcher. Moderately common resident. Mainly in pairs and small flocks (up to 15). Favours sandy beaches. Breeds on coast from July to September.

Single bird seen on the rock platform at low tide adjacent to the mouth of Yardie Creek.

Haematopus fuliginosus Sooty Oystercatcher. Uncommon to moderately common resident. Tidal flats and beaches. Breeding recorded in September.

FAMILY RECURVIROSTRIDAE

Himantopus himantopus Black-winged Stilt. Nomadic. Scarce to moderately common. Listed by Carter for the North-West Cape region as numerous at pools and swamps after heavy rains.

[*Recurvirostra novaehollandiae* Red-necked Avocet. Nomadic. Scarce visitor. A small flock was seen by Carter at a large sheet of open water surrounded by mangroves

between Vlaming Head and Yardie Creek (presumably Mangrove Bay area) on 22 June 1902.]

FAMILY CHARADRIIDAE

Pluvialis squatarola Grey Plover. Common summer visitor from northern hemisphere, but some birds remain during the winter. Sandy, muddy and rocky coasts and brackish near-coastal lakes.

Pluvialis fulva Pacific Golden Plover. Scarce visitor from northern hemisphere. Usually single occasionally in small parties. Listed by Carter as a summer visitor and rather more numerous than Grey Plover. He observed them feeding at high water mark among seaweed left by tide.

Charadrius ruficapillus Red-capped Plover. Moderately common in ones, twos, small flocks and larger aggregations (up to 80). Tidal flats, beaches, open samphire flats and coastal lakes. Breeding recorded in July and August - September. Most nests are shallow scrapes in the ground just above high-water mark and often at edges of mangroves.

Two birds seen on the beach near the swash zone adjacent to the mouth of Yardie creek

Charadrius mongolus Lesser Sand Plover. Scarce visitor from northern hemisphere. Tidal flats. One collected in North-West Cape region by Carter on 28 January 1900.

Charadrius leschenaultii Large Sand Plover. Moderately common visitor from northern hemisphere. Usually in ones, twos or small parties. Mainly sandy beaches.

Charadrius melanops Black-fronted Dotterel. Scarce. Two observed at Yardie Creek on 7 June 1978.

Charadrius veredus Oriental Plover. Common summer visitor (late August - early April) from northern hemisphere. Listed by Carter as a common summer visitor, arriving very regularly in second week of September and leaving about mid March. Mostly seen in flocks on saltmarshes, open grass and spinifex flats near the coast and beaches. In December 1895 Carter noted that the beach was lined with them for miles.

FAMILY GLAREOLIDAE

Glareola maldivarum Oriental Pratincole. Common, irregular visitor from northern hemisphere (December - May). Numerous flocks seen by Carter usually just before rains or stormy weather.

FAMILY LARIDAE

[*Larus pacificus* Pacific Gull. Several recorded by Carter at the whaling station near Point Cloates on 6 September 1913; he believed that they had been attracted to the hundreds of dead whales that lay along the beach from Point Maud to North-West Cape in 1913.]

Larus novaehollandiae Silver Gull. Uncommon to moderately common in small flocks (up to 50). Tidal flats and sandy beaches.

Recorded on seven occasions typically as singles or small groups of 2-3 on the beach adjacent to the mouth of Yardie Creek, however on one occasion a single flock of 11 was seen at the mouth.

Sterna nilotica Gull-billed Tern. Scarce. Recorded once by Carter for the North-West Cape region.

Sterna caspia Caspian Tern. Moderately common resident. Mainly in ones and twos and occasionally small groups. Coastal areas. Breeding (nests solitary or in colonies) recorded on tops of bare sand-drifts and at mouth of Yardie Creek; March to early November.

Single bird recorded from the rock platform adjacent to the mouth of Yardie Creek.

Sterna bengalensis Lesser Crested Tern. Moderately common, mainly in small flocks. Coastal areas. Listed by Carter for the North-West Cape region as fairly numerous in summer. In July 1980 a flock of sixteen was observed resting on exposed rocks at Mangrove Bay and on a sandy spit at Low Point.

Sterna bergii Crested Tern. Moderately common, in small flocks (up to 20). Coastal areas.

Single seen on the beach adjacent to the mouth of Yardie Creek.

[*Sterna dougallii* Roseate Tern. Common and recorded in large numbers about Frazer Island and on sandy points on the mainland.]

[*Sterna hirundo longipennis* Common Tern. Regular visitor to Pilbara coast (late August - late April) from north-east Asia. Flocks of '*Sterna frontalis*' recorded by Carter during the summer months in the North-West Cape region are almost certainly referable to *S. h. longipennis*.]

[*Sterna nereis* Fairy Tern. About 40 pairs were breeding on a sandy flat near Low Point on 3 October 1979. Coasts and blue-water seas.]

[*Anous stolidus* Common Noddy. Carter recorded great numbers on low sandbanks adjoining Frazer Island in April - May 1902.]

FAMILY COLUMBIDAE

Phaps chalcoptera Common Bronzewing. Scarce or uncommon. Several recorded by Carter.

[*Phaps histrionica* Flock Pigeon. Scarce. Irregular visitor from Kimberley. Recorded by Carter for the North-West Cape region. Common in some seasons usually after good rains.]

Ocyphaps lophotes Crested Pigeon. Uncommon to moderately common, mainly ones and twos and small flocks. Coastal flats, edges of range, also gorges. Breeding in July - August, nests in small trees and shrubs.

Recorded on eight occasions as either singles or twos typically from the near coastal dunes or adjacent areas.

Geophaps plumifera Spinifex Pigeon. Moderately common in Cape Range south to Yardie Creek, in pairs and small groups (up to 7). Breeding recorded in May, July and August - September. Nests on ground on slopes of gorges and hilly country with spinifex and acacia. Birds from the Cape Range are the palest of all red-bellied populations (see Johnstone, 1981) and are isolated from the Pilbara population by the unsuitable sandy country south and east of Exmouth Gulf.

Geopelia cuneata Diamond Dove. Partly nomadic, uncommon to common. Recorded by Carter for the region as very common in summer when water is scarce especially on the ranges at Yardie Creek. Often aggregating in pairs or small parties at permanent water.

[*Geopelia humeralis* Bar-shouldered Dove. Recorded just outside the area at Mangrove Bay, the southernmost record for this species in Western Australia. Confined to coastal mangroves.]

FAMILY PSITTACIDAE

[*Cacatua roseicapilla* Galah. Uncommon. Mainly coastal plain near Mangrove Bay.]

Cacatua sanguinea Little Corella. Common at Yardie Creek in flocks (up to 200). Breeding in crevices of the cliffs in July - August. Also reported in other parts of Cape Range.

The most commonly recorded species during the current survey. This species was seen throughout the day regularly moving between nesting sites in the cliffs above Yardie Creek and feeding sites in the coastal dunes. There were approximately 50 nesting pairs in the cliffs with many more further up Yardie Creek.

Nymphicus hollandicus Cockatiel. Uncommon to moderately common depending on rainfall; usually in pairs or small flocks. Listed by Carter as occasionally visiting the coast after rains, April to July. Common in July - August 1984 flying over ranges. Breeding recorded in hollows in eucalypts in the ranges in July - August.

Platycercus zonarius Ring-necked Parrot. Moderately common in gorges in range. Breeding in tree hollows in July - September.

[*Neophema elegans* Elegant Parrot. Rare, autumn - winter visitor from the south-west. Recorded at Point Cloates.]

Melopsittacus undulatus Budgerigar. Abundance extremely variable, scarce or absent after long dry periods to common in good seasons. Breeding in hollows in eucalypts in gorges and on range in July - August.

FAMILY CUCULIDAE

Cuculus pallidus Pallid Cuckoo. Moderately common winter visitor from south-west. Open acacia and edges of mangroves.

Chrysococcyx basalis Horsfield's Bronze Cuckoo. Moderately common. Breeding visitor and passage migrant. Noted by Carter as a common winter visitor arriving usually in June but occasionally seen after summer rains. Most habitats including samphire flats. Breeding recorded in May, parasitising *Malurus*.

FAMILY STRIGIDAE

Ninox novaeseelandiae Boobook Owl. Scarce or rare, probably mostly winter visitor. Recorded for the North-West Cape region.

FAMILY TYTONIDAE

Tyto alba Barn Owl. Scarce or rare. Perhaps only an autumn - winter visitor. Listed by Carter as a winter visitor to the North-West Cape region.

FAMILY PODARGIDAE

Podargus strigoides Tawny Frogmouth. Scarce in wooded habitats. Breeding reported just outside the area in July.

FAMILY CAPRIMULGIDAE

Eurostopodus argus Spotted Nightjar. Uncommon. Recorded near the coast at Yardie Creek.

FAMILY AEGOTHELIDAE

Aegotheles cristatus Australian Owlet Nightjar. Uncommon in most wooded habitats. Breeding in hollows in eucalypts in gorges and edges of range in July and August.

FAMILY APODIDAE

Apus pacificus Fork-tailed Swift. Irregular visitor (November - April) from north-east Asia. Recorded in the North-West Cape region.

FAMILY HALCYONIDAE

Todiramphus pyrrhopygia Red-backed Kingfisher. Uncommon. Carter listed a pair breeding in a large white-ant hill at Yardie Creek on 4 August 1916.

Todiramphus sanctus Sacred Kingfisher. Uncommon to moderately common. Mangroves and Yardie Gorge. Most are probably winter visitors from south-west.

Single birds recorded from mangroves on three occasions. Localities included adjacent to the boat mooring, the mangrove island in the middle of Yardie Creek and the mangroves at the major bend in the creek.

[*Todiramphus chloris* Collared Kingfisher. Recorded by Carter as not uncommon on the coast especially in summer but these records are more likely Sacred Kingfishers. The Collared Kingfisher ranges south only to Bay of Rest.]

FAMILY MEROPIDAE

Merops ornatus Rainbow Bee-eater. Uncommon to moderately common. Mainly winter visitor and passage migrant. Lightly wooded country especially near water including Yardie Creek.

FAMILY MALURIDAE

Malurus lamberti Variegated Fairy-wren. Moderately common resident. Mainly edges of mangroves and coastal acacia thickets in gullies. Breeding recorded in July and August - September. Most nests in acacia on edge of range.

Malurus leucopterus White-winged Fairy-wren. Moderately common in small flocks (up to 6). Mainly coastal dunes with *Spinifex longifolius,* samphire flats, edges of mangroves and open acacia. Breeding reported in May.

Stipiturus ruficeps Rufous-crowned Emu-wren. Moderately common. Isolated population in the Cape Range south to Yardie Creek. Mainly dense *Triodia* on range especially along drainage lines and watercourses. Breeding in clumps of spinifex in July - August.

Amytornis striatus Striated Grasswren. Uncommon in pairs and family parties. Isolated population in Cape Range about the sources of Yardie Creek. Mainly *Triodia* in rocky or stony country including gorges. Breeding in April - May.

FAMILY PARDALOTIDAE

Pardalotus rubricatus Red-browed Pardalote. Uncommon in ones or twos. Reported for the Yardie Creek area. Mainly canopy of eucalypts.

FAMILY ACANTHIZIDAE

Calamanthus fuliginosus Striated Fieldwren. Moderately common resident. Coastal dunes, samphire flats and coastal heath. Breeding in July - August. Most nests in spinifex just above high-water mark.

[*Gerygone tenebrosa* Dusky Gerygone. Moderately common in mangroves in Mangrove Bay area. Confined to mangroves.]

FAMILY MELIPHAGIDAE

Lichmera indistincta Brown Honeyeater. Uncommon to moderately common in ones and twos. Mainly well wooded habitats in range and in mangroves.

Recorded from calls on four occasions and as two birds once. Typically from the areas of dense vegetation in the gorge and minor gullies.

Certhionyx niger Black Honeyeater. Irregular visitor. Locally and seasonally common eg: throughout the North-West Cape peninsula in June 1902 and August 1970, but generally scarce. Attracted to flowering *Acacia, Grevillea* and *Eucalyptus.*

Certhionyx variegatus Pied Honeyeater. Irregular visitor. Locally and seasonally common eg: North-West Cape peninsula in June 1902 and July - August 1982 and 1984. Open woodlands with flowering trees and shrubs. Breeding recorded in July - August.

Lichenostomus virescens Singing Honeyeater. Moderately common to common, usually in ones and twos. Mangroves, open acacia behind coastal dunes, gorges and range country. Breeding recorded in July - August.

Recorded on 16 occasions typically from the coastal dunes and adjacent areas.

Lichenostomus keartlandi Grey-headed Honeyeater. Locally common in ones and twos. Mainly eucalypts in gorges and on ranges. Isolated population in Cape Range south to Yardie Creek. Breeding in July, August and September. Most nests in eucalypts in ranges.

A single group of three birds recorded from amongst *Ficus* trees in a small gully near the end of the water in Yardie Creek.

[*Melithreptus gularis* Black-chinned Honeyeater. Possibly an uncommon or scarce visitor, two collected by Carter from a party of six near Exmouth in June 1902.]

Phylidonyris albifrons White-fronted Honeyeater. Irregular visitor. Locally common in some years. Recorded at Yardie Creek and common in some years at Point Cloates. Mainly lightly wooded areas with flowering trees and shrubs.

[*Manorina flavigula* Yellow-throated Miner. Uncommon, usually in pairs or small parties. Breeding recorded edge of range in July and August.]

Acanthagenys rufogularis Spiny-cheeked Honeyeater. Moderately common in Cape Range in ones, twos or small flocks. All wooded habitats including mangroves. Breeding reported in July.

[*Epthianura albifrons* White-fronted Chat. Rare, possibly a casual visitor. Carter noted flocks in February - May 1899.]

Epthianura tricolor Crimson Chat. Irregular visitor, numbers varying according to rainfall. Uncommon to common.

FAMILY EOPSALTRIIDAE

Petroica goodenovii Red-capped Robin. Uncommon winter visitor. Mainly coastal acacia thickets.

FAMILY CINCLOSOMATIDAE

Psophodes occidentalis Western Wedgebill. Uncommon in ones and twos. Mainly *Acacia* thickets. Breeding recorded just outside the area in July - August.

FAMILY PACHYCEPHALIDAE

Oreoica gutturalis Crested Bellbird. Moderately common in ones and twos. Mainly open acacia. Breeding in May and July.

[*Pachycephala melanura* Mangrove Golden Whistler. One collected by Carter in dense patch of mangroves between Yardie Creek and Vlaming Head (presumably Mangrove Bay area) on 14 June 1902. There are no other records for the area.]

[*Pachycephala lanioides* White-breasted Whistler. Moderately common in Mangrove Bay area, confined to mangroves.]

Colluricincla harmonica Grey Shrike-thrush. Moderately common in Cape Range. This isolated population treated as a subspecies *C. h. kolichisi* Ford 1987 is endemic to the region.

FAMILY DICRURIDAE

Rhipidura phasiana Mangrove Grey Fantail. Common resident in mangroves. Breeding in spring.

[*Rhipidura fuliginosa* Grey Fantail. Winter visitors of *R. f. preissi* from southern Western Australia have been recorded in the area.]

Rhipidura leucophrys Willie Wagtail. Moderately common winter visitor. Noted by Carter as arriving in middle of April and leaving in October. Mangroves and open woodland.

Grallina cyanoleuca Magpie-lark. Recorded on four occasions as single birds from the mangroves adjacent to the boat mooring during the course of the survey.

FAMILY CAMPEPHAGIDAE

Coracina novaehollandiae Black-faced Cuckoo Shrike. Moderately common resident. Mainly mangroves and woodlands. Breeding in July - August, most nests in river gums.

A pair seen feeding a fledging in the mangroves adjacent to the boat mooring.

Two adults and a fledgling recorded from the mangroves at the mouth of Yardie Creek.

[*Lalage tricolor* White-winged Triller. Moderately common breeding visitor and passage migrant. Recorded by Carter as a common winter visitor in the North-West Cape region. Also recorded breeding at Point Cloates in July.]

FAMILY ARTAMIDAE

Artamus leucorhynchus White-breasted Woodswallow. Moderately common along the coast especially about mangroves. Breeding reported in August - September.

Artamus personatus Masked Woodswallow. Nomadic visitor. Locally and seasonally uncommon to very common. Usually in small flocks, occasionally in large flocks. Mainly lightly wooded country. Breeding in large numbers in July - August 1984.

Artamus cinereus Black-faced Woodswallow. Uncommon to moderately common. Mainly lightly wooded country.

Artamus minor Little Woodswallow. Uncommon to moderately common in range country. Isolated population in the Cape Range south to Yardie Creek. Mainly about cliffs in gorges. Breeding in cliffs in August - September.

Recorded in small groups of between two and four including a pair that was collecting nesting material and constructing a nest in the cliff face.

FAMILY CRACTICIDAE

Cracticus nigrogularis Pied Butcherbird. Moderately common. Most habitats including mangroves. Recorded breeding in July - September.

Identified from call and seen in twos and threes above a small pool just past the upper reaches of the water in Yardie Creek.

FAMILY CORVIDAE

Corvus orru Torresian Crow. Uncommon, usually in ones and twos. Mainly coast and gorges. Specimen collected from Yardie Creek and reported breeding in August - September.

Corvus bennetti Little Crow. Nomadic, uncommon to common. Lightly wooded country, vicinity of water, garbage and road kills. Breeding in July.

FAMILY PTILONORHYNCHIDAE

Ptilonorhynchus maculatus Spotted Bowerbird. Uncommon in one, twos and small parties. Isolated population in Cape Range south to Yardie Creek. Mainly gorges and *Ficus* thickets in vicinity of water. Breeding in July - August.

Single birds recorded on four occasions. Recorded from the mangroves, dense Eucalypts and over the coastal dunes.

FAMILY ALAUDIDAE

[*Mirafra javanica* Singing Bushlark. Uncommon and patchily distributed further south eg: near Point Cloates.]

FAMILY MOTACILLIDAE

Anthus novaeseelandiae Richard's Pipit. Moderately common. Mainly open samphire flats and coastal dunes.

FAMILY PASSERIDAE

Taeniopygia guttata Zebra Finch. Common in flocks (up to 50). Lightly wooded habitats including mangroves. Breeding in July and August - September.

Single flock of four recorded from the base of Yardie Creek.

FAMILY DICAEIDAE

Dicaeum hirundinaceum Mistletoebird. Moderately common throughout the Cape Range also recorded in mangroves.

FAMILY HIRUNDINIDAE

[*Cheramoeca leucosterna* White-backed Swallow. Recorded breeding in hard sandy cliffs of the beach near Point Cloates.]

Hirundo neoxena Welcome Swallow. Moderately common resident. Mainly coastal.

Numerous pairs noted with young on the lower sections of the cliffs near the upper reaches of the water in Yardie Creek.

Hirundo nigricans Tree Martin. Common winter visitor. Mainly coastal dunes and samphire flats also vicinity of water in gorges.

Two birds seen flying over the cliffs during the current survey.

FAMILY SYLVIIDAE

[*Megalurus gramineus* Little Grassbird. Status uncertain, possibly a rare non-breeding visitor. Recorded in flooded samphire near Mangrove Bay in July 1980.]

Eremiornis carteri Spinifex-bird. Moderately common in Cape Range south to Yardie Creek. Dense spinifex on range. Breeding in July - August. Nests in clumps of spinifex.

Cincloramphus cruralis Brown Songlark. Uncommon to common. Coasts and inland. Breeding in July - August, nests on ground in low vegetation.

FAMILY ZOSTEROPIDAE

Zosterops lutea Yellow White-eye. Common, confined to mangroves. In ones, twos and small flocks (up to 20). Breeding in July.