6. Coconut crabs

A study on coconut crabs commenced in October 2006 with the aim of determining the following:

1. Changes in apparent abundance of coconut crabs in relation to season
2. Relative densities of coconut crabs in different vegetation types, in relation to distance from the coast, and between the four main islands of Aldabra Atoll
3. Absolute population estimate for Aldabra Atoll
4. Population structure of the coconut crab on Aldabra
5. Relative growth rates in relation to vegetation type
6. Movement patterns within Picard Island

Close on weekly counts of coconut crabs were made on the Picard back path and coastal path, usually both transects being covered between 20h00 and 23h00. During some monthly visits to camps around the atoll searches were also made around the hut and in some cases along existing transects for coconut crabs (Table 8). Each crab encountered (520 in total) was weighed and carapace length measured. Moult status, in other words relative duration since last moult, was also estimated by the sharpness of the dactyls on the front legs which wear down with time (Table 9). During the onset of the study several other morphometric measurements were taken to see which correlated the best with weight. The sex of each crab was determined and for the latter part of the study individuals were marked with a permanent marker pen on the inside of the claw. This area is generally not exposed or dragged along the ground and from recaptured individuals it is evident that these marks last at least eight weeks. This is a long enough period to determine movement patterns (by recording the point of initial and recapture along these transects) and weight gain from recaptured individuals.

Table 8. Number of coconut crabs marked and number resighted at various study sites around the atoll.

Area	Marked	Resights	Total
Anse Mai	61		61
Cinq Cases Circular	5		5
Cinq Cases Cocos	7		7
Cinq Cases Hut	44	7	51
Malabar Hut	65		65
Picard Back Path	113	8	121
Picard Coastal Path	157	8	165
Research Station	45		45
Total	497	23	520

Table 9. Description of moult status codes assigned.

Code	Name	Description
1	newly moulted	dactyl is needle-sharp, lots of new hairs present
2	recent moult	dactyl looks sharp but doesn't prick the skin, new hairs present
3	old moult	dactyl blunt, worn hairs present
4	very old moult	dactyl very blunt or absent, no hairs present

Some preliminary results follow from the limited data collected: A significant relationship between moult status and the ratio of carapace length to weight was apparent (Figure 21). This relationship is

intuitive seeing that the carapace in crustaceans does not grow between moults but weight is gained. A good relationship was similarly present between carapace length and body weight (Figure 22).

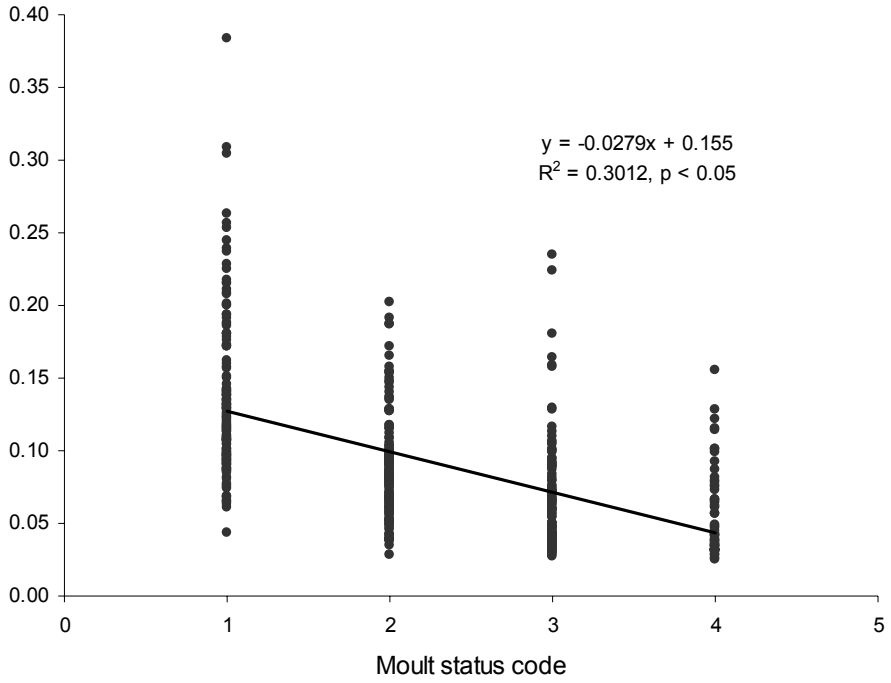

Figure 21. Relationship of moult status and the ratio of carapace length to body weight in coconut crabs at Aldabra.

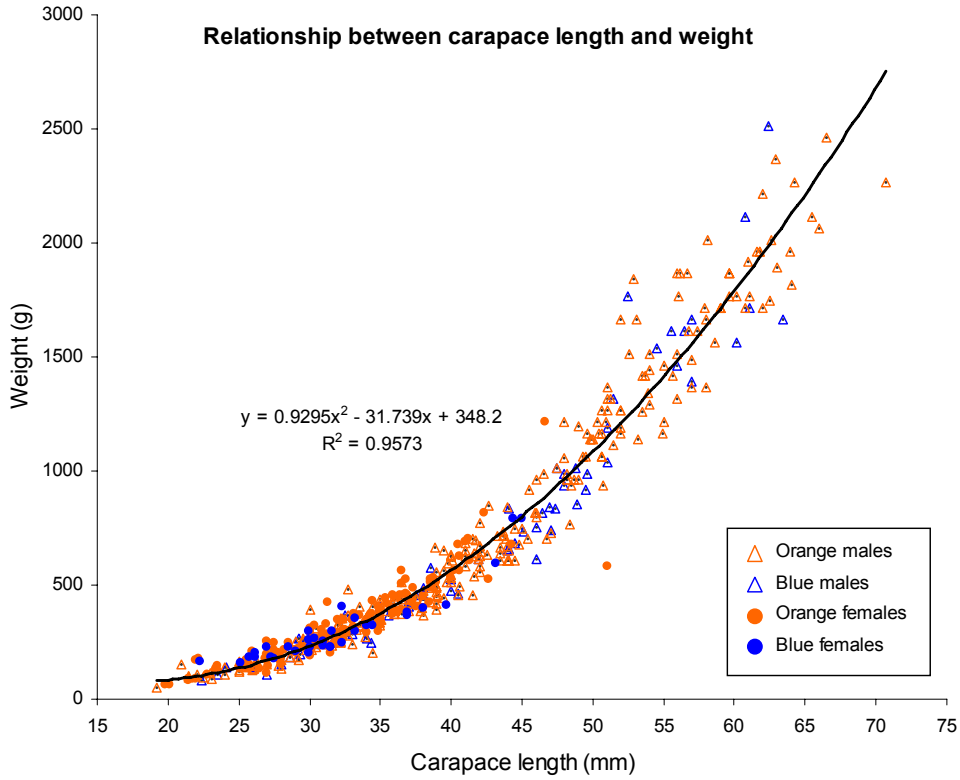

Figure 22. Relationship between carapace length and weight in coconut crabs at Aldabra.

The weight distribution of coconut crabs showed substantial variation according to locality (Figure 23). The area close to the Cinq Cases hut showed the largest number of larger individuals. At all localities the 400g weight class was the most abundant. Very few individuals reach more than 2.5kg in weight.

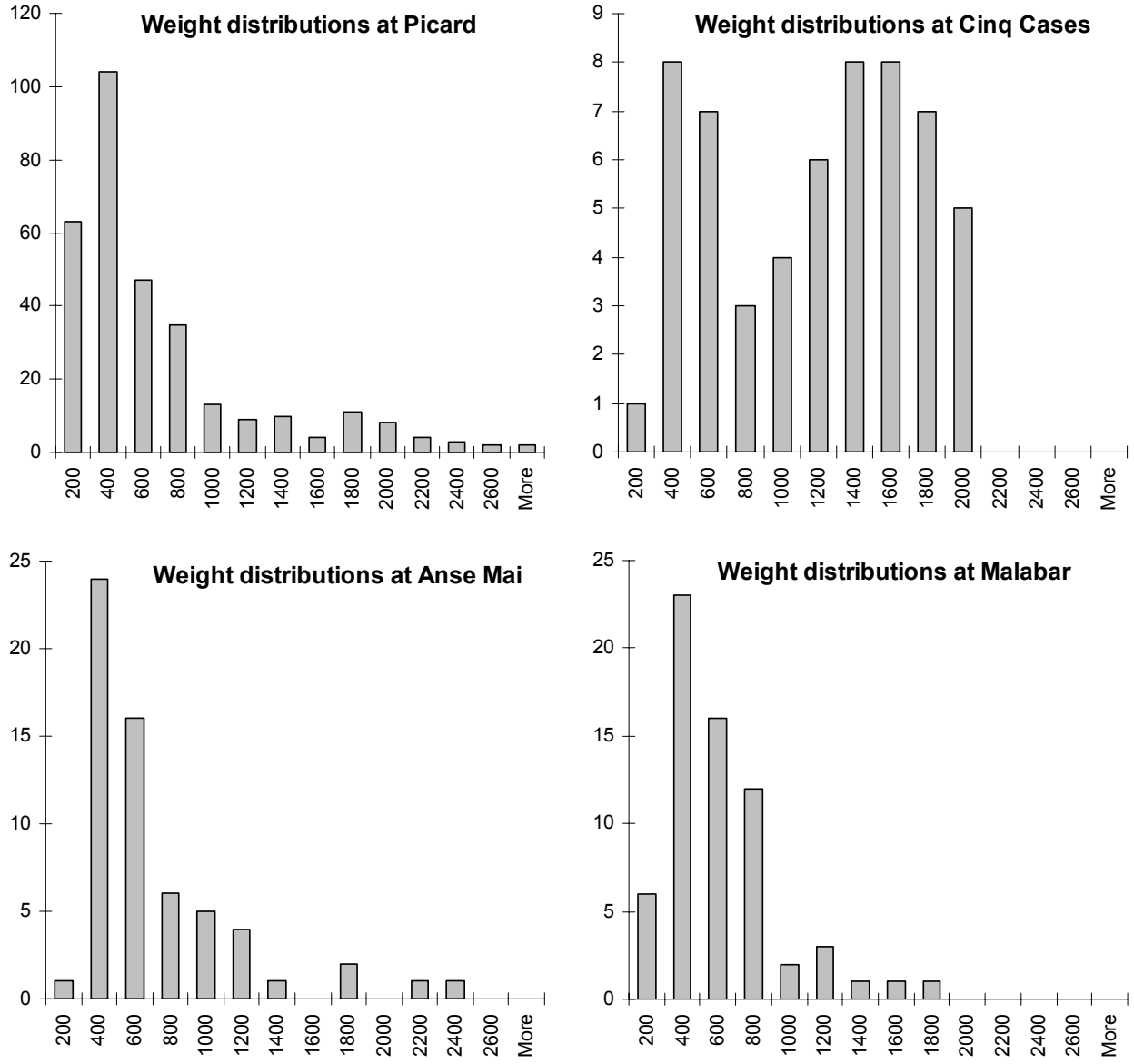

Figure 23. Weight (in grams) distribution of coconut crabs around Aldabra.

Table 6. Total weight of demersal fish caught, total fishing trips and number of trips from which CPUE could be estimated, and annual average number of lines per trip at Aldabra for the period 1998-2007.

Year	*Kilograms*	*Total fishing trips*	*Fishing trips with CPUE*	*Average lines per trip*
1995 (Oct-Dec)	394	6	0	unrecorded
1996	1,715	28	0	unrecorded
1997	2,459	42	0	unrecorded
1998	1,742	27	9	4
1999	1,430	26	20	4
2000	1,817	42	31	4
2001	2,246	55	33	4
2002	1,309	40	27	3
2003	991	28	21	4
2004	1,147	37	33	4
2005	1,748	61	48	3
2006	1,948	41	30	4
2007 (Jan-May)	519	13	7	4
Total	**19,499**	**446**	**259**	**4**

Presently, before visiting boats come to Aldabra they are provided with rules and regulations stating that fishing within 1km of the atoll is illegal. If there is place available on the boat, a ranger will also accompany vessels at all times (the occasional exception being when they are moored/anchored in front of the station). Atoll round patrols are supposed to take place monthly but often resources are not available (boats, boatman, rangers) or the sea conditions are unfavourable. More effort should be spent making sure that these patrols do take place regularly. Some form of automated surveillance (e.g. radar) would be ideal and should become a priority.

6. Robber crabs

Robber crab monitoring commenced in October 2006, but regular counts (including marking and weighing) along the back path and coastal path at Picard only started in March 2007. Data collection will continue until the end of February 2008 to give complete monthly information over an entire year. Data will then be thoroughly examined before recommendations are made regarding the continued monitoring of the population. Below I present some of the preliminary results from the monitoring program based on data collected from 1499 individuals of which 140 marked individuals were recaptured at a later stage.

It has previously been reported that robber crabs are most active during dark nights and less so during times when the moon is near full. We have found no such relationship as is evident from Figure 17. This means that a temporal comparison of apparent abundance would not be biased by variation in the lunar phase during the time that counts are performed. Although there was a positive relationship between recent rainfall and robber crab numbers this was not significant (Figure 18).

Despite the variance associated with the monthly means being high due to few counts per month, a seasonal pattern has emerged (Figure 19). Maximum numbers were seen in March and counts declined to a low during July through September before increasing again. The very low counts in January and February could be a result of the limited coverage during these months.

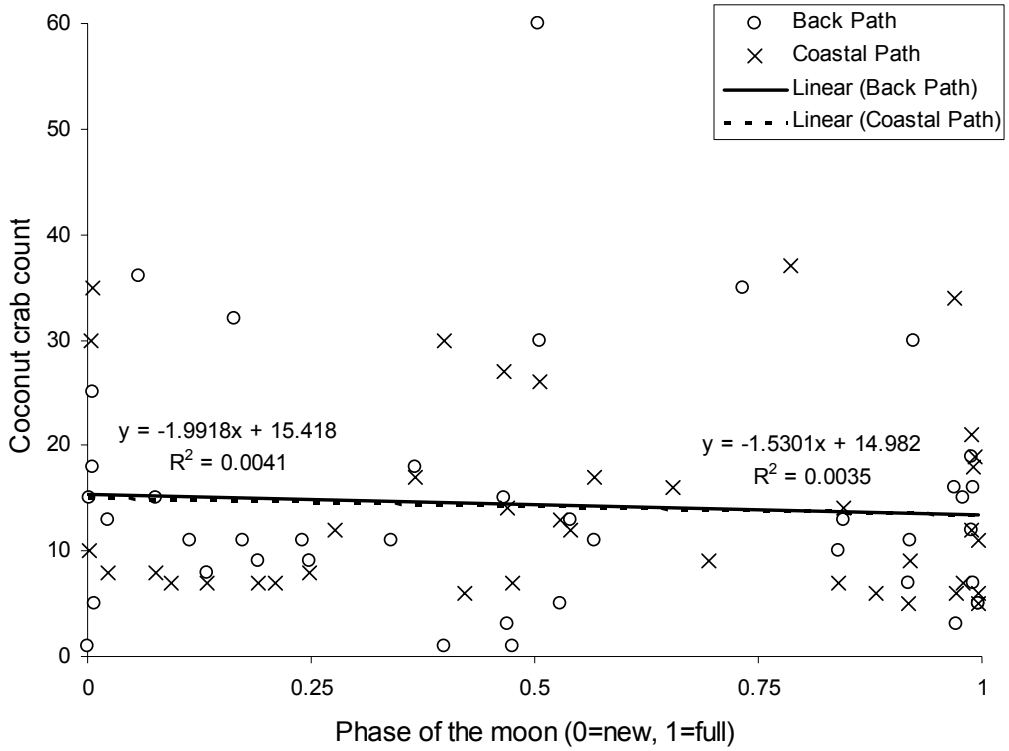

Figure 17. Relationship between robber crab counts and phase of the moon.

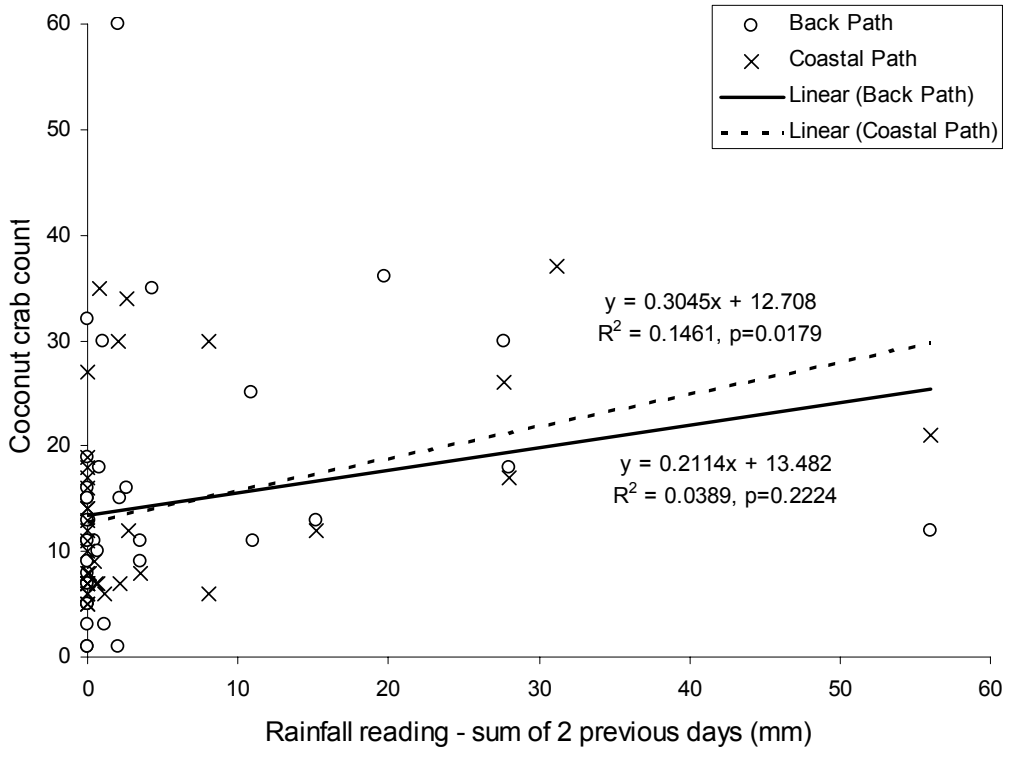

Figure 18. Relationship between robber crab counts and rainfall.

The largest percentage of male robber crabs weighed in the region of 400 grams and females between 200 and 300 grams (Figure 20). Interesting to note is the similar percentage of males in weight categories greater than a kilogram. This would suggest that mortality is very low once this weight is reached. The maximum size that females reached was 1.5 kg and the heaviest male recorded was 3.625 kg.

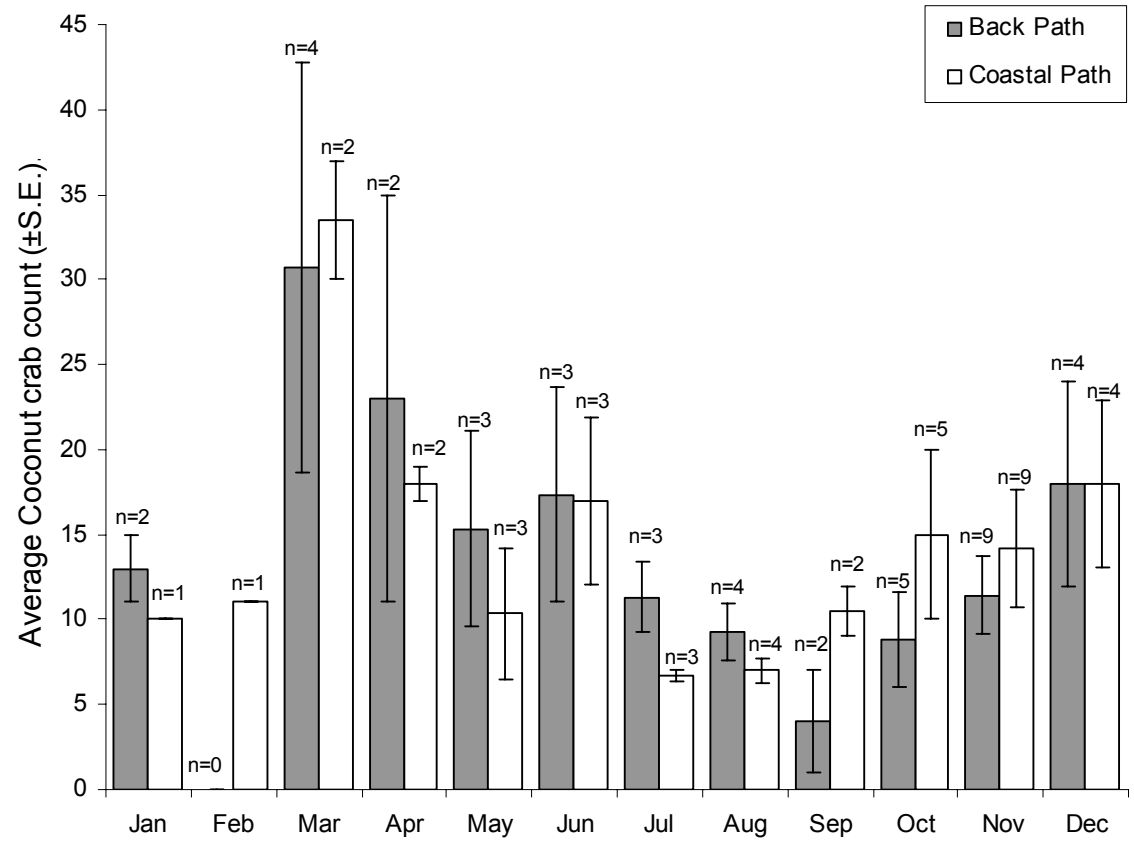

Figure 19. Average monthly counts of robber crabs on two transects at Picard.

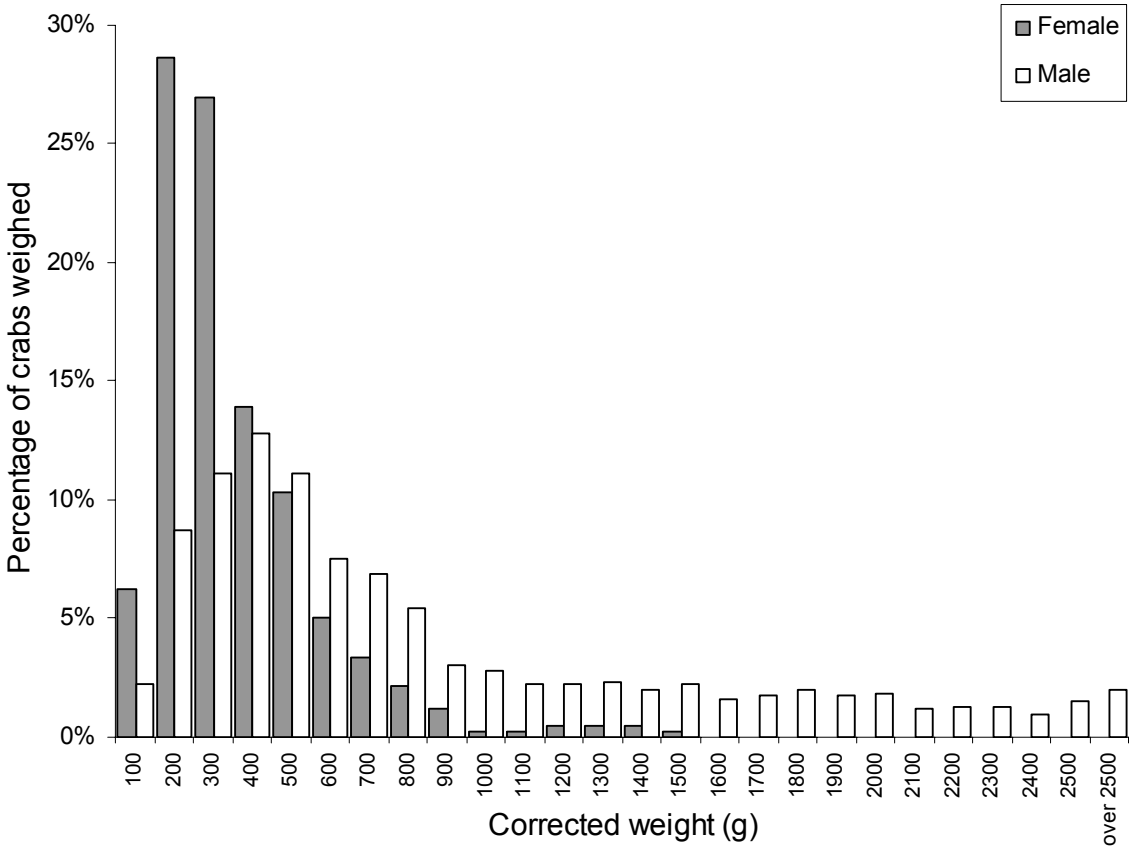

Figure 20. Weight distribution of robber crabs on Aldabra Atoll.

Just under 70% of recaptured robber crabs were found within 50 meters of the site where they were marked or last observed (Figure 21). About 15% were seen over 500 meters from the last site and one was seen 1.3 km from the last site. These crustaceans therefore do have the potential to move large distances in search of food or mates. The longest period between resights was just over 6 months, demonstrating the efficacy of the marking method.

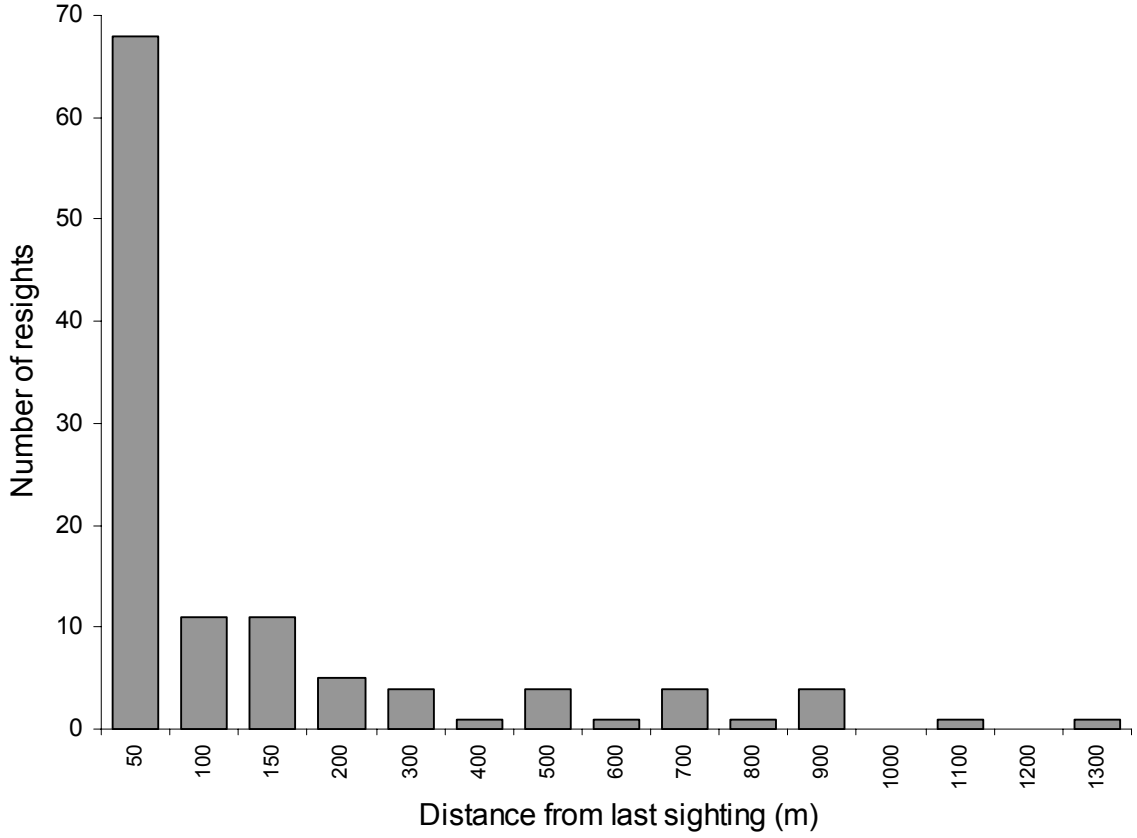

Figure 21. Distance from last sighting of robber crabs on Picard.

A crab marked with permanent marker under the claw

A 'fat-tail', ready to moult

8.0: Robber Crabs

Robber crab monitoring was first instigated in October 2006 with an increase in the effort invested in this monitoring commencing in March 2007 by the then RO Pierre Pistorius. This monitoring has continued on a regular basis since this time. In 2007 it included investigations of the movement of individuals by marking them with distinctive numbers. In 2008 no marking of animals was conducted and monitoring was restricted to abundance, size and sex ratio along both the back path and coastal path on Picard. The aim of the current monitoring is to provide information on seasonal and size related activity patterns as well as population density. Previous analysis of the data (see RO Annual Report 2007) has revealed that despite the large variance associated with monthly means which is often related to the variation in the number of counts per month there is a seasonal pattern in the abundance and size distribution of coconut crabs.

A larger number of coconut crabs were recorded in 2008 along the back path on Picard than along the coastal path (Figure 19 and Figure 20). However, this is effected by the difference in length of the 2 transects with the coastal transect finishing at point 12 along the path and as a result this transect is of a shorter length. There is no obvious difference in the size distribution of individuals along both paths, however, there is a smaller difference between the size of males and females on the coastal path than that evident on the back path.

The data collected in 2008 along the pack path shows a similar pattern to that evident in previous years with maximum numbers recorded around March and April with numbers then declining to lows in abundance from August – September (Figure 19). The mean thoracic length (which serves as a reliable index of weight) shows that the males recorded were consistently larger than females, however, an obvious pattern is also evident in the distribution of size with a greater difference in the mean thoracic length between males and females obvious in March and again in August (Figure 19). In comparison to this in May, June and July there was only a small difference in the size of males and females recorded with the majority of males observed being significantly smaller than males recorded in other months.

Unfortunately no monitoring of the coconut crabs on the coastal path was completed in March which has previously been recorded as the time with the highest number of crabs recorded. This was also the month with the highest abundance of coconut crabs on the back path. While the data collected along the coastal path has this highest abundance of individuals in November (mean number over 25) the total recorded is still much lower than the maximum mean number recorded along the back path in March (just under 50).

Along the coastal path, as with the back path, male coconut crabs were consistently larger than females, as expected. However, the difference between the observed males and females was generally much smaller with males observed being consistently smaller than along the back path. Females along the coastal path showed no significant difference in size although females on the coastal path were slightly larger than on the back path (Figure 19 and Figure 20).

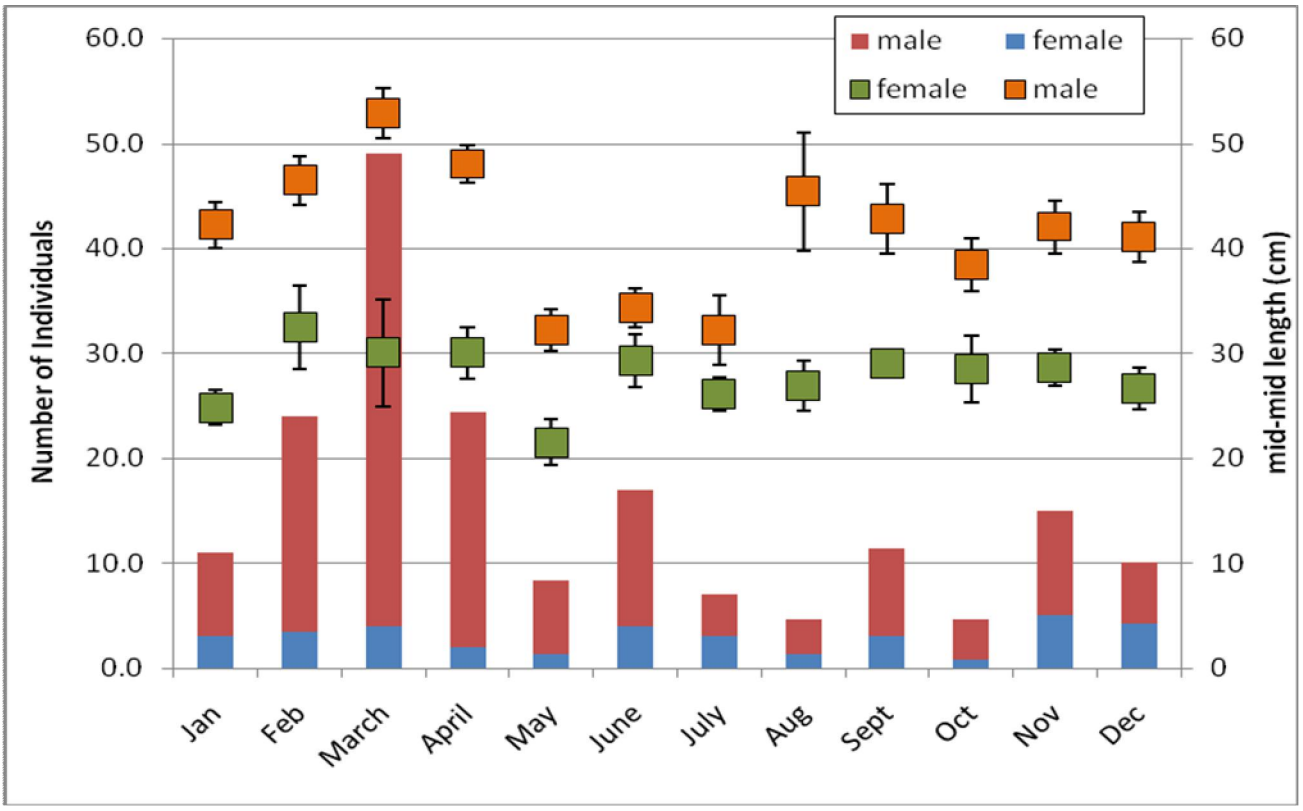

Figure 19: Mean abundance (bars) and size (with standard errors) of coconut crabs recorded along the back path each month in 2008.

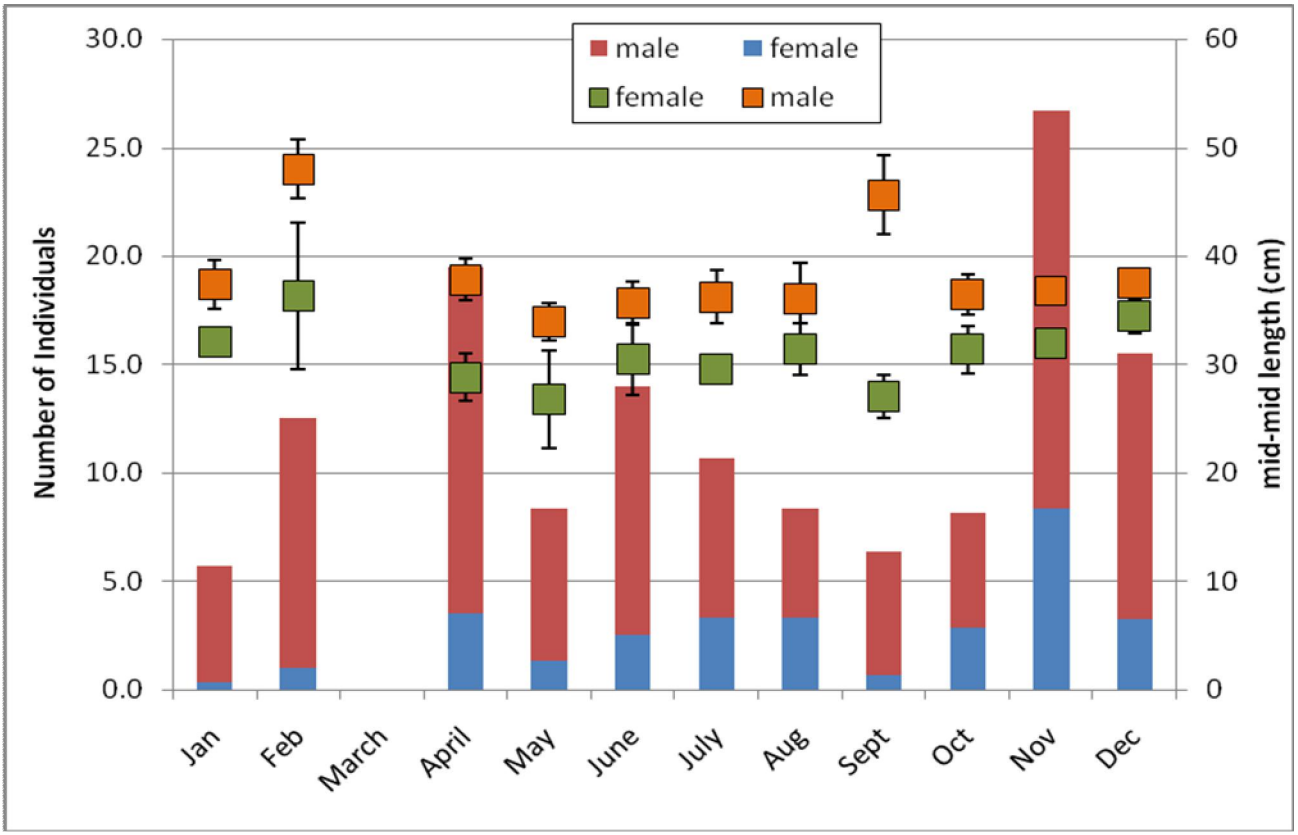

Figure 20: Mean abundance (bars) and size (with standard errors) of coconut crabs recorded along the coastal path each month in 2008.

Species	Common Name	transect 1	transect 2
C. auriga	threadfin	3.1	3.6
C. bennetti	Bennett's	1.3	1.4
C. falcula	saddleback	8.4	1.7
C. guttatissimus	spotted	4.1	3.5
C. kleinii	Kleins	1.9	1.5
C. lineolatus	lined		2.0
C. lunula	racoon	4.9	4.6
C. melannotus	blackbacked	4.3	2.4
C. meyeri	maypole	1.9	2.3
C. trifascialis	chevron	2.0	3.0
C. trifasciatus	purple	3.7	3.8
C. unimaculatus	teardrop		1.0
C. xanthocephalus	yellowhead	2.0	1.5
C. zanzibariensis	Zanzibar		1.0
F. flavissimus	long-nosed	3.5	5.3
H. acuminatus	reef		2.0
H. diphreutes	schooling	6.0	7.0
H. monoceros	masked	2.0	1.7
H. zoster	black pyramid	4.5	1.5

Dives in other areas of the atoll provided an opportunity to identify and note other species of Chaetodontids that were not recorded on either transect or only recorded infrequently. Two such species included *Chaetodon bennetti*, Bennett's butterflyfish (Figure 29 a), which has been recorded along the monitoring transect and *C. madagascariensis*, Madagascar butterflyfish (Figure 29 b), which is noted in the monitoring records as being uncommon in the area and has not previously been recorded on the transect.

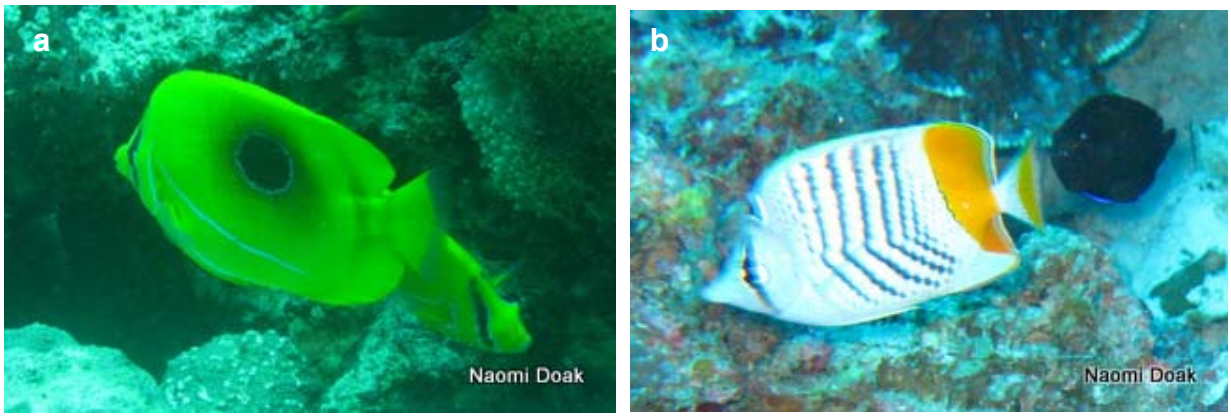

Figure 29: *Chaetodon bennetti* (a) and *C. madagascariensis* (b).

9.0: Robber Crabs

Robber crab monitoring was first instigated in October 2006 with an increase in the effort invested in this monitoring commencing in March 2007 by the then RO Pierre Pistorius to gather detailed information on the movements of individuals and the distribution of the population along the back

path and coastal transects. This monitoring has continued on a regular basis since then. The aim of the current monitoring is to provide information on seasonal and size related activity patterns as well as population density. Previous as well as ongoing monthly analysis of the data throughout 2009 has continued to reveal that despite the large variance associated with monthly means which is often related to the variation in the number of counts per month there is a seasonal pattern in the abundance and size distribution of robber crabs. It has also shown no long term change in the mean number of individuals recorded.

As in previous years a larger number of robber crabs were recorded along the Back Path on Picard than along the Coastal Path (Figure 30 and Figure 31). However, this is likely to be affected by the difference in length of the two transects with the coastal transect finishing at point 12 along the path and as a result this transect being of a shorter length. There is no obvious difference in the size distribution of individuals along both transects. However, there is a smaller difference between the size of males and females on the Coastal Path than that evident on the Back Path. In addition during months in which very few individuals were recorded on either transect (e.g. November) those individuals that were recorded tended to be very large males (Figure 30 and Figure 31).

The data collected in 2009 showed a similar pattern to that evident in previous years with a peak in abundance recorded in the first 6 months of the year, specifically around February, March and April with numbers then declining to lows in abundance from September (Figure 30). The mean thoracic length (which serves as a reliable index of weight) shows that the males recorded along the Back Path were again consistently larger than females with the largest males being recorded in the months with the fewest individuals recorded.

Along the Coastal Path, as with the Back Path, male robber crabs were consistently larger than females, as expected. However, the difference between the observed males and females was generally much smaller with males observed being consistently smaller than those recorded along the back path. Females along the Coastal Path showed no significant difference in size although females on this path were slightly larger than those on the Back Path (Figure 30 and Figure 31) which is consistent with results from the analysis in 2008.

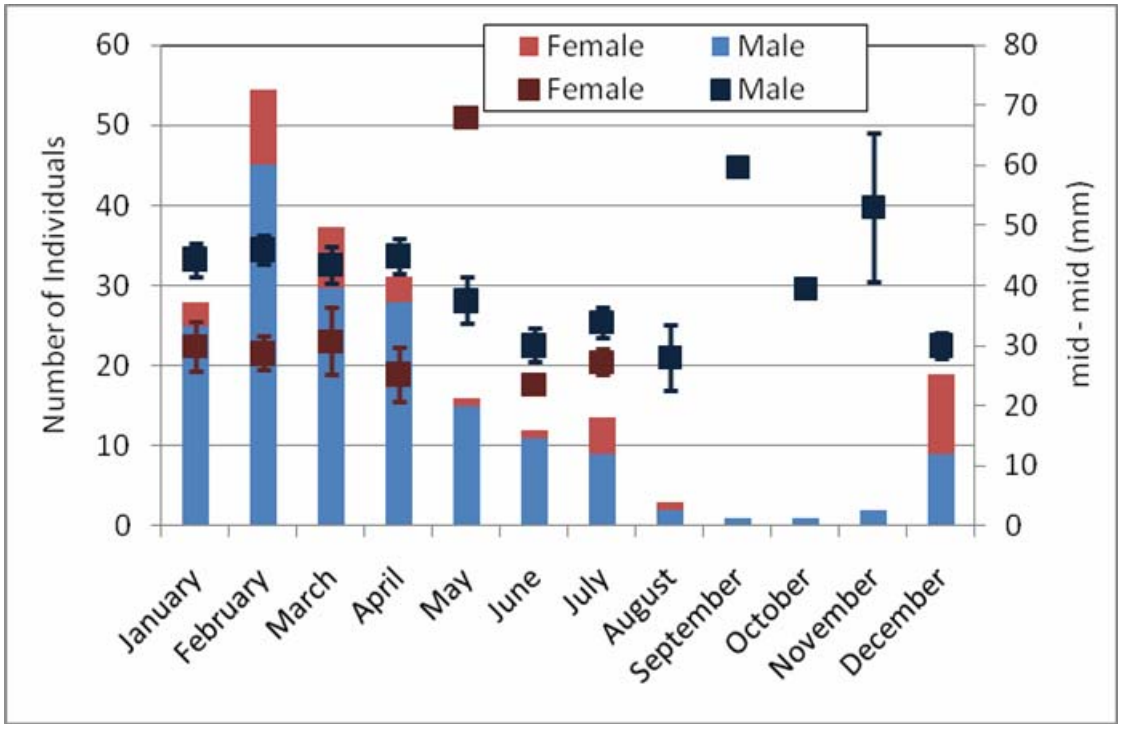

Figure 30: Mean abundance (bars) and size (± SE) of robber crabs recorded along the Back Path each month in 2009.

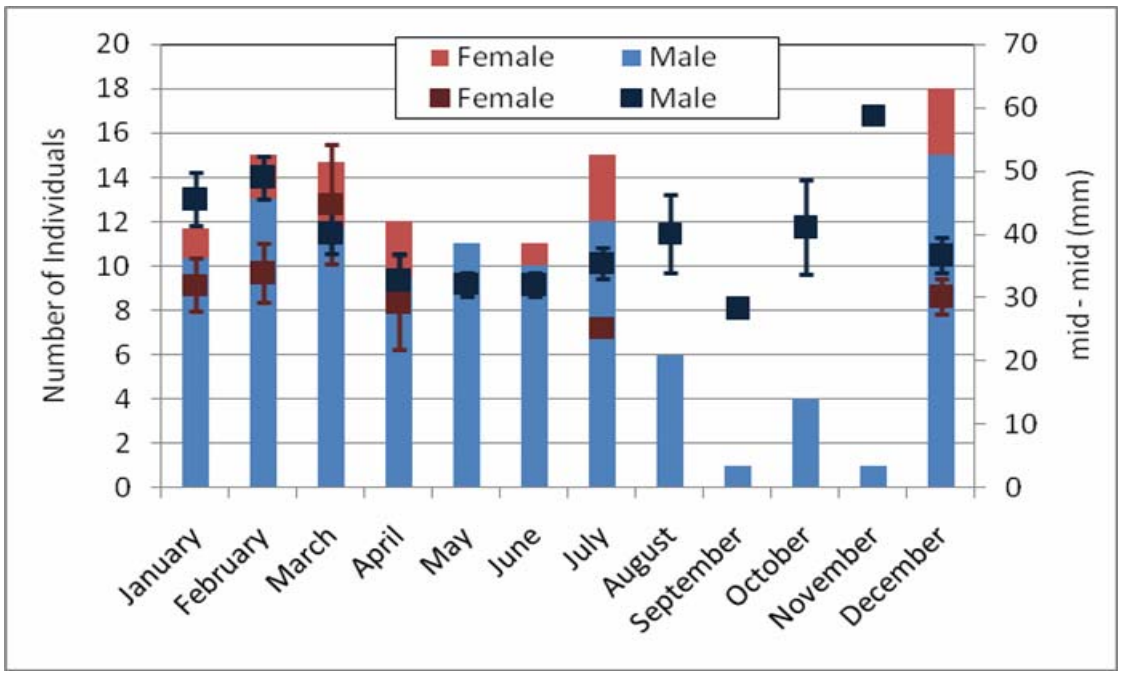

Figure 31: Mean abundance (bars) and size (± SE) of robber crabs recorded along the Coastal Path each month in 2009.

10.0: Marine Mammals

10.1: Dugongs

No targeted dugong surveys were conducted during 2009. A lack of appropriate boats and motors currently restricts any targeted searches in suitable habitat. However, it was a considerably productive year for sightings of this species. The fieldwork being conducted by the CCRU research team and the amount of time spent in the lagoon as a result of the habitat mapping project provided a perfect opportunity for opportunistic sightings.

On Friday 30th January, during one of the trips conducted by the CCRU GIS research group in the lagoon to validate habitat classifications for the mapping project, they saw a single adult dugong. They were able to obtain underwater video footage and above water photographs to confirm the identification (Figure 32 a). The individual was sighted in relatively shallow water on the south-east side of Ile Esprit and the footage obtained is the first underwater footage of this species on Aldabra.

During a transfer between locations in the lagoon on 15th February, two staff members; Skipper, Jude Brice and Volunteer Jennifer Stockdale, spotted two separate individuals. The first individual (Figure 32 b, approximately 2m in length) was seen at 8:55 am in approximately 2 metres of water. This particular individual was followed and filmed on a small digital camera for 2 minutes. The second individual was seen as soon as the first had moved out of sight and was smaller than the first (approximately 1.5m in length). Of particular importance the first of these two individuals has a distinctive white mark on the dorsal surface just behind the head. This was captured in the video and makes the individual distinguishable enabling identification.

4.2 Coconut Crabs

The coconut crab monitoring programme on Aldabra was initiated in 2006. Initially data were collected from several camps and included mark and recapture studies in 2007. However the programme has since been downscaled and currently two transects on Picard (BP and CP transects) are surveyed after dark twice a month. The carapace length, colour morph and sex of each individual within a 10-m wide transect are recorded.

When plotting the average monthly transect counts, there does not seem to be a strong seasonal signal, although greater numbers of crabs are evident in the first and second quarter of the year, which is especially pronounced on the BP transect (Figure 20). Fewest crabs are encountered during the late dry season, which might be due to coconut crabs needing to keep their branchiostegal lungs moist and therefore prefer humid environments and are less likely to leave their burrows during the driest time of the year.

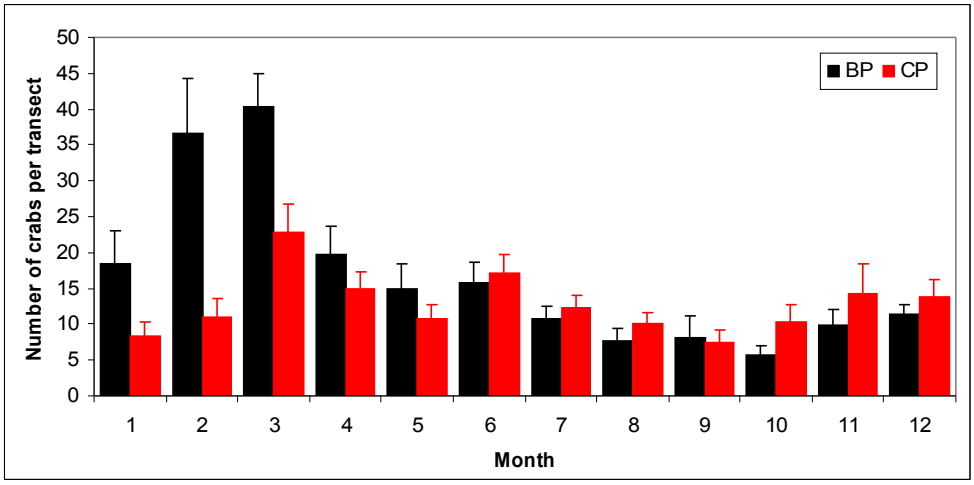

Figure 20. Seasonal signal of average monthly numbers (± SE) of coconut crabs along the BP and CP transects for the 2007-2010 data

Plotting the quarterly average transect counts over time, reveals no obvious pattern other than the consistent peak in numbers encountered on the BP during the first quarter of the year (Figure 21).

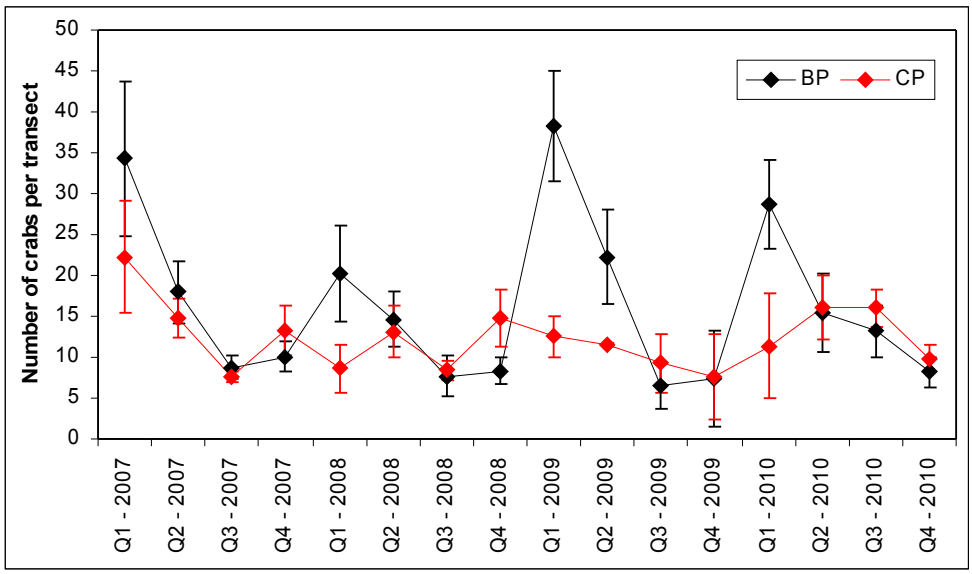

Figure 21. Average number of crabs per quarter (± SE) on the BP (black) and CP (red) transects between 2007 and 2010.

Females are clearly smaller on average than are males, with an average carapace length (± SE) of 30.4 ± 0.28 and 40.6 ± 0.28 for the 2007-2010 data. A plot of their sizes over time, averaged by

quarter, reveals no pattern in the sizes of the females, yet the male sizes seem to show both a seasonal pattern and a decreasing trend over time (Figure 22). The average male size seems to be consistently the largest during the first quarter of the calendar year, which might suggest that certain cohorts (or size ranges) are more active during certain seasons than others. Further investigation showed that average male sizes were notably higher in January-April, than in the remainder of the year (not shown). To investigate which size-classes are driving this seasonal pattern, size frequency distributions were plotted for three trimesters (i.e. 'seasons' of four months each; Figure 23). There is a clear tendency for a greater proportion of larger size-class males to be encountered during the first four months of the year, than in the second and third trimester. As Figure 21 shows that there are also the most crabs during the early part of the year, this suggests that there is a substantial influx (or emergence from burrows) of large males during the first few months of the year. Why these large males appear at this time of year is not clear. As the surface area to volume ratio decreases with size, it is unlikely that these large individuals are more sensitive to humidity or moisture levels than are small crabs. Perhaps this seasonal pattern is related to reproductive requirements, although one might expect these to affect the females more than the males.

Comparing the size-frequency distributions between 2007 and 2010 (Figure 24), provides some insight as to what might be driving the gradual decline in average male sizes seen in Figure 22. The 2010 frequency distribution shape suggests that there are a smaller proportion of larger individuals and correspondingly greater proportions of smaller size-classes. The very pronounced bimodal distribution in the male sizes from 2007 is almost completely lacking in the 2010 sizes, which suggests that either there has been a notably greater mortality rate of large males in recent years, or that the large proportion of large males in 2007 was a result of a particularly strong cohort that has been eroded by natural mortality. To explain these patterns with any confidence, more in-depth analyses and investigation of coconut crab growth rates and other literature would be required. The fact that the female size frequency distribution shows a very prominent cohort of 30-35 mm crabs in 2007, whereas in 2010 the most crabs are in the 35-40 mm size-class, supports the idea that certain years (or perhaps groups of years) produce strong recruitment and that such strong cohorts might affect the size frequency of the sampled population by their sheer numbers.

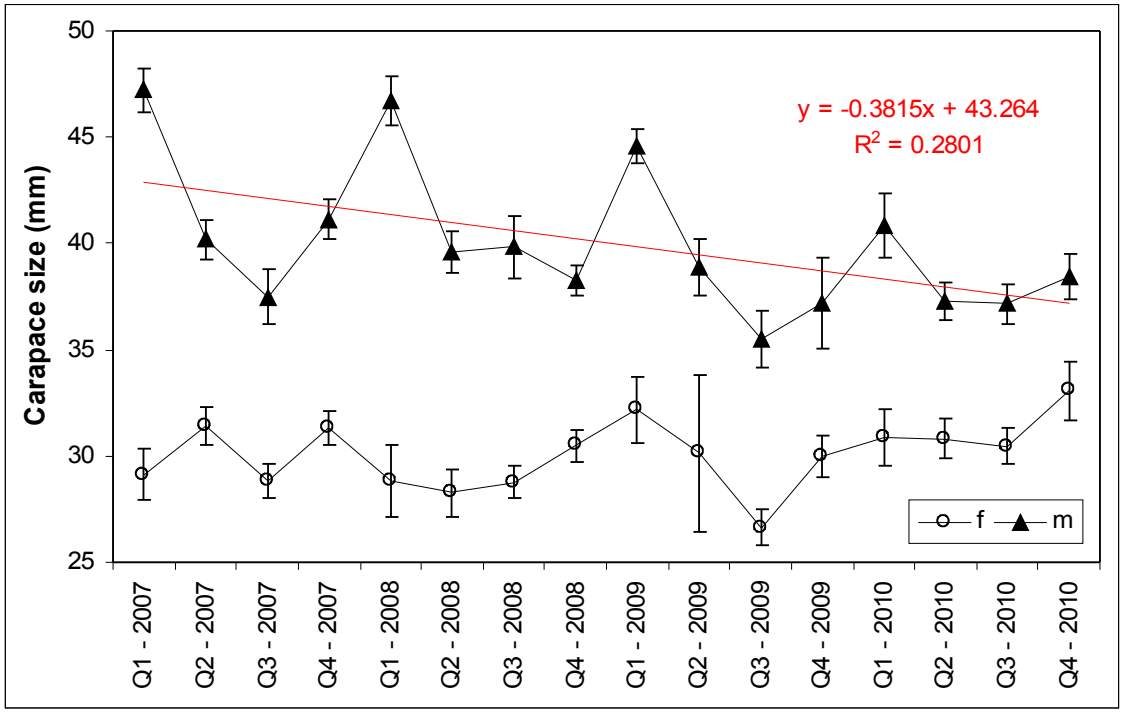

Figure 22. Average quarterly carapace sizes (± SE) of male (m) and female (f) coconut crabs over the period of 2007-2010.

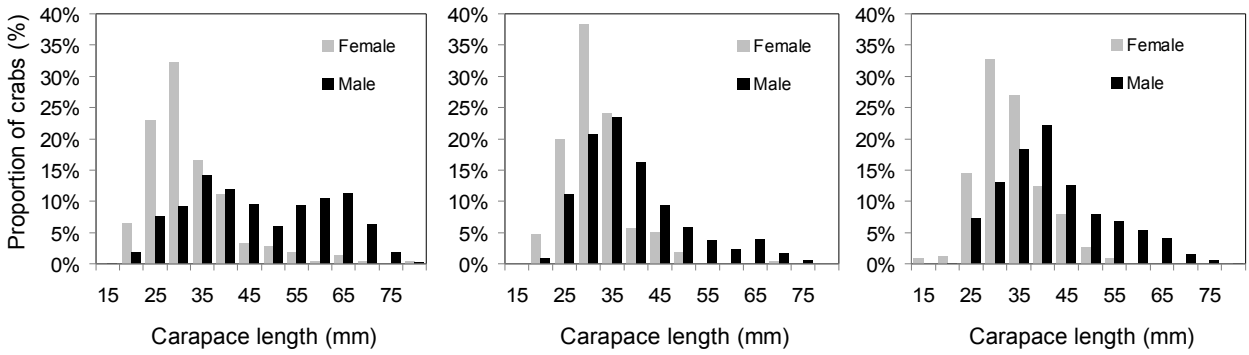

Figure 23. Frequency distribution of coconut crab carapace lengths for the 2007-2010 data, separated into four-month trimesters of January-April (left), May-August (center) and September-December (right).

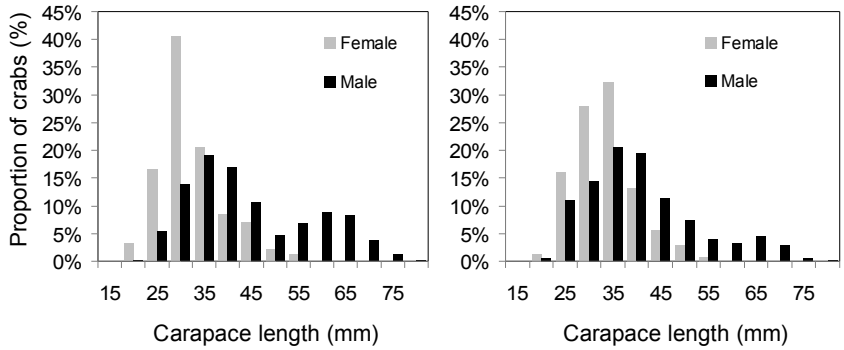

Figure 24. Frequency distribution of coconut crab carapace lengths for 2007 (left) and 2010 (right) data.

It is interesting to note a difference in the average moult score between males and females between November and April (Figure 25). This might potentially indicate specific seasons with a certain degree of synchronous moulting, which differs between males and females, possibly due to seasonal reproductive costs. The 2007-2010 data suggest that females might have a lower average moulting status (i.e. more females than average have moulted recently) during January-March, while males seem to have a higher-than-normal moulting score during March/April (i.e. more males than average have not moulted recently and will likely moult soon). However these patterns are only tentative and require more data to investigate.

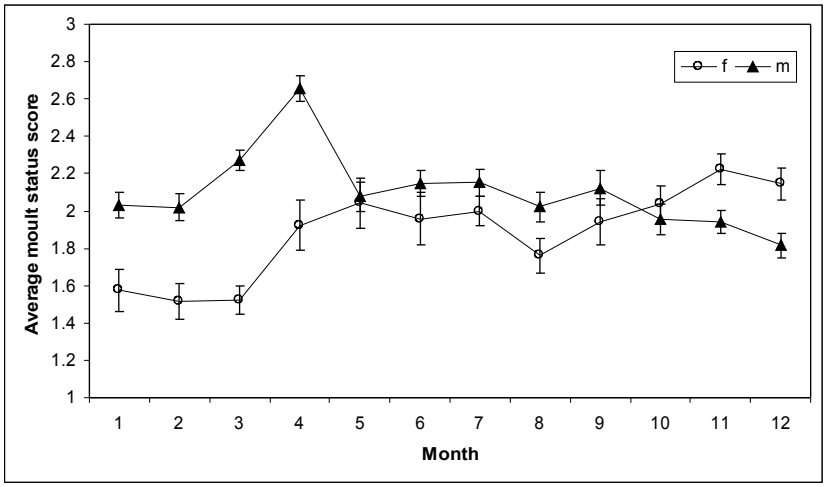

Figure 25. Average moult status per calendar month for the 2007-2010 data.

The break-down of sexes and colour morphs recorded in a pie-chart (Figure 26), highlights the uneven sex ratio and also demonstrates the uneven proportion of blue and orange colour morphs in the coconut crab population on Picard. The male:female sex ratio of the 2007-2010 dataset is

3.3:1, while there are on average five orange crabs recorded for every blue colour morph encountered. What has become clear from experience in the field is that occasionally a crab is encountered which is in between an orange and a blue morph in colour, which is a situation that should be acknowledged and catered for in the protocol and the database. At present, the database only allows for 'orange', 'blue' and 'unknown' records in the colour morph field.

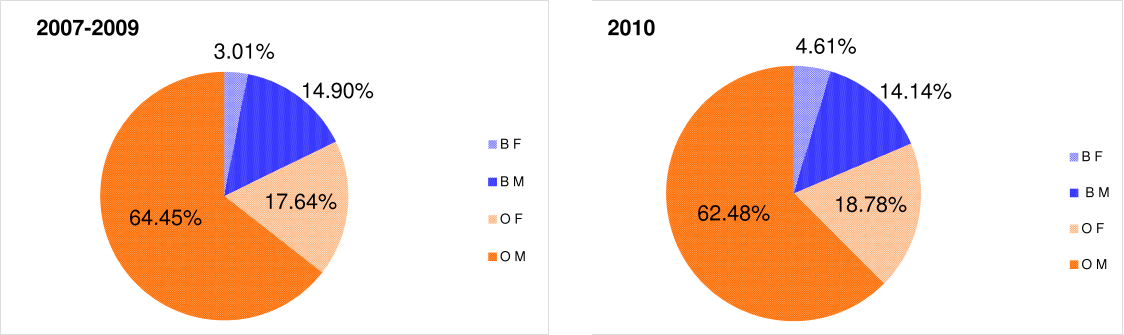

Figure 26. Relative proportions of each sex (M = male, F = female) and colour morph (B = blue, O = orange) within the Picard coconut crab population, showing both the historical breakdown (averaged over 2007 – 2009) and that for 2010.

Recommendations

There is a need to clarify and standardize the judgement/scoring of moult status and to clearly formulate this in a written protocol. The RO recently found Table 5 in the coconut crab MS Access database, which describes how the moult status was apparently assessed in 2006/2007 when the coconut crab monitoring programme was initiated by then RO, Pierre Pistorius. However over time, emphasis seems to have been placed more on the judgement of the abdomen size (which swells as the moult gets 'older'), to the extent that the dactyl was generally not considered in 2010 when the RO was replaced in April. Such lack of consistency in methodology demonstrates the urgent requirement for written protocols for all monitoring programmes.

Table 5. Description of codes used for assessing coconut crab moulting status, as listed in the coconut crab MS Access database.

Code	Name	Description
1	newly moulted	dactyl is needle-sharp, lots of new hairs present
2	recent moult	dactyl looks sharp but doesn't prick the skin, new hairs present
3	old moult	dactyl blunt, worn hairs present
4	very old moult	dactyl very blunt or absent, no hairs present

4.3 Vegetation Phenology Monitoring

Thirty-three plant species have been monitored on Picard (mostly along the Back Path transect) since June 2009, to determine patterns of plant phenology. Six individuals of each species are marked and scored every two weeks for a suite of variables assessing coverage of leaves, flowers, fruit and disease or damage. Two species (*Tournefortia argentea* and *Pandanus tectorius*) are represented by less than six individuals as additional mature specimens have not been found in the vicinity of the Station. The list of species surveyed and the average number of plants surveyed for each species during 2010 is provided in table A1 in Appendix A.

In November 2010, the protocol was simplified slightly (see November 2010 RO report for details) to reduce the substantial fieldwork demand and improve the data quality. Despite these amendments, continuous data for several variables, including young and mature leaves, open/fresh flowers and flower buds, mature fruit and presence of any fruit, insect and fungus damage, as well as the presence of rat damage, have accumulated for well over 20 months.

Old data present in library
Upon request of the ZARP researchers it was checked which old data cards were present in the library. The following boxes with original data cards were found (Table 10). Each box contains between 1000 and 1400 record cards, which means that in total there are approximately 10,000 to 14,000 record cards present in the Aldabra library. The cards are sorted by recording day and in each box the first card contains the following data: (front) date, recorder, time of day, locality, grid ref, abundance, collecting method (recapture, unmarked, death) with an summary of the recording, and cover type of vegetation; (back) geomorphological type, weather, and present plant species. The following cards are the individual records of the measured tortoises with collection method, disc number, locality (grid number), length over curve, weight, width 3rd dorsal scute, sex and notes. The individual recording cards do not have a date, but do have the same CT-number. There is also a copy of all recording cards of the tortoises disked and measured by Gaymer, including some re-sightings of 1971-1972 and 1973 -1974.

Table 10. Details of old tortoise record cards present in Aldabra library.

Box	Census record	Discs	Date from	Date to	Notes
Ald 08	TC01 - TC36	00703 - 01830	15/01/1973	09/03/1973	
Ald 05	TC37 - TC61	01831- 02887	09/03/1973	28/04/1973	
Ald 07	TC62 - TC98	02888 - 03372	30/05/1973	12/06/1973	
Ald 09	TC99 - TC143	03873 - 04856	01/07/1973	01/11/1973	
Ald 11	TC144 - TC179	04857 - 05538	22/11/1973	05/01/1974	
Ald 04	TC180 - TC234		05/01/1974	07/02/1974	
Ald 10	TC235 - TC279	05539 - 05877	09/02/1974	12/03/1974	
Ald 06	TC343 - TC350		07/03/1974	11/05/1974	
Ald 03	TC280 –TC310		25/03/1974	24/04/1974	
Ald 12	TC311 - TC395		30/04/1974	16/09/1974	
Ald 06	TT1 - TT12		18/06/1974	28/06/1974	Tortoise traverses
Ald 06	Exported tortoise		01/03/1978	01/03/1980	Tortoises exported to Curieuse: total of 200 transported individuals (100 in 1978 and 100 in 1980)

4.2. Coconut crabs

The coconut crab (*Birgus latro*) is found on numerous oceanic islands and atolls in the Indo-Pacific region. Coconut crabs play an important part in island ecosystems. For example, as scavengers they remove rotting material and so reduce the number of carrion breeding flies, they help to decompose leaf litter, distribute seeds, provide a food source for birds in the juvenile stage and in turn influence the populations of crab species upon which they prey. They also contribute to soil aeration and erosion through their burrowing activity (Alexander 1976).

However, as a result of over-exploitation and habitat degradation numbers of coconut crabs are declining, with the Indian Ocean being the worst hit. Coconut crabs are now largely confined to three populations centred on the Aldabra group, the Chagos Archipelago and Christmas Island (Lavery *et al*. 1996). On Aldabra Atoll the coconut crab benefits from complete protection, a situation which could provide important baseline data for management plans developed to ensure a sustainable harvesting in areas where the crab is exploited. The IUCN lists the coconut crab as Data Deficient, i.e. data on abundance and/or distribution is lacking (Eldredge 1996). The data collected on Aldabra provide therefore an excellent opportunity to broaden our understanding of the ecology of this species.

Coconut crabs have been monitored since 2006, and were surveyed twice per month on each of the Back Path (BP) and Coastal Path (CP) throughout 2011. On the transects, individuals within a 10-m wide transect are recorded. For this monitoring programme, a new database was created by Philip Haupt (see introduction). Data includes carapace length, colour morph, moult stage and sex. Also the weather circumstances and moon stage (the surveys are done in the evening after sunset) are recorded. The weather circumstances may influence the numbers of crabs encountered, as well as the sex ratios. For example, Figure 29 shows the relationship between moon stage and number of individuals of each sex encountered. It appears that there is a higher chance of encountering male crabs when there is less moonlight, whereas for females there seems to be no relationship. However, this result should be more thoroughly investigated and interpreted with caution: during cloudy evenings, a full moon may be shaded and perceived as 'no moon'. One should confirm whether it is the light intensity or the moon cycle that actually plays a role by gathering the retrospective moon phase data from the internet.

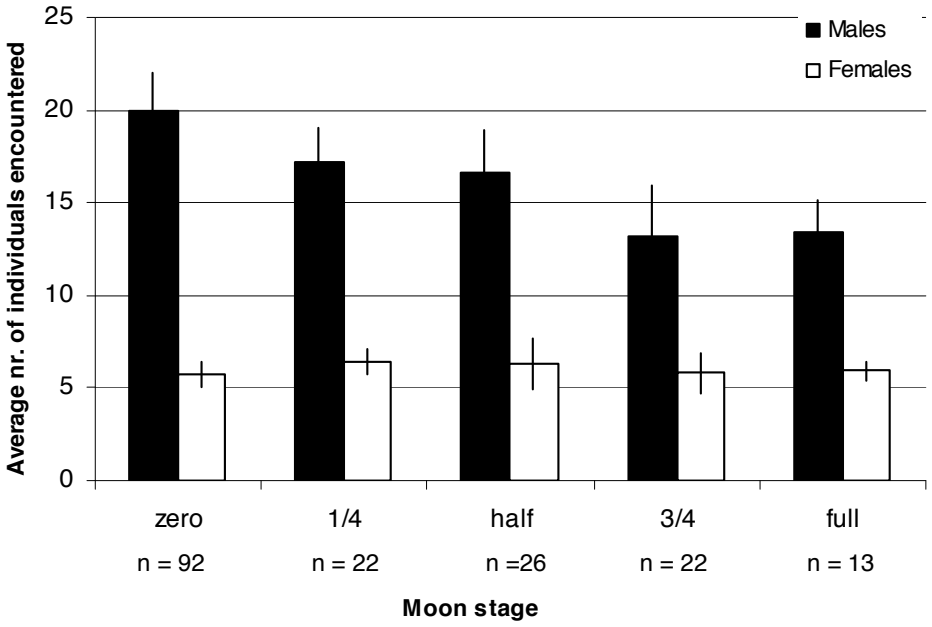

Figure 29. Relationship between moon stage and coconut crabs of each sex encountered (2006-2011)**.**

Numbers of individuals for each sex encountered do also show seasonal patterns, which differ per location (Figure 30). On Back Path there is a strong seasonal pattern in which more males are seen during February and March. On Coastal Path, some of the same peaks occur, but less pronounced. In general, more males are seen than females and fewest crabs are encountered at the end of the dry season. The latter could be expected as the coconut crabs need a humid environment for their breathing organs to function.

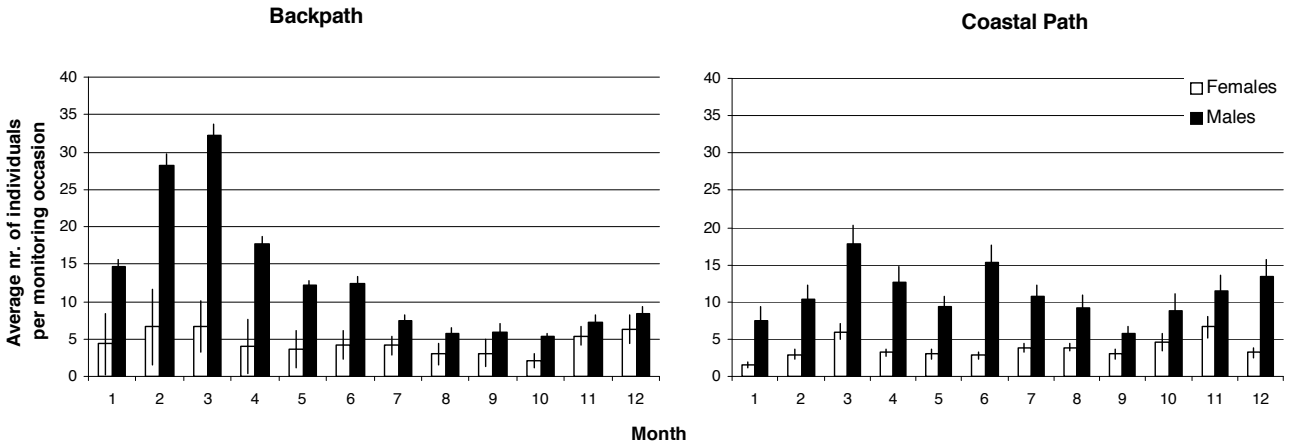

Figure 30. Seasonal patterns of coconut crab encountering rates (separated per sex), based on 2006-2011data.

The thoracic length in millimetres is measured as a reliable proxy for weight (see coconut crab protocol). In general, males are on average larger than females (males: 41.08 ± 0.23 mm, females: 30.68 ± 0.23 mm). There is an interaction effect in which the average sizes per sex differ per location: with larger females are encountered on the Coastal Path whereas larger males are encountered on Back Path (Figure 31; Back Path: females: 29.19 ± 0.28 mm and males 43.11 ± 0.33 mm, Coastal Path: females: 32.5 ± 0.33 mm and males 39.55 ± 0.27 mm).

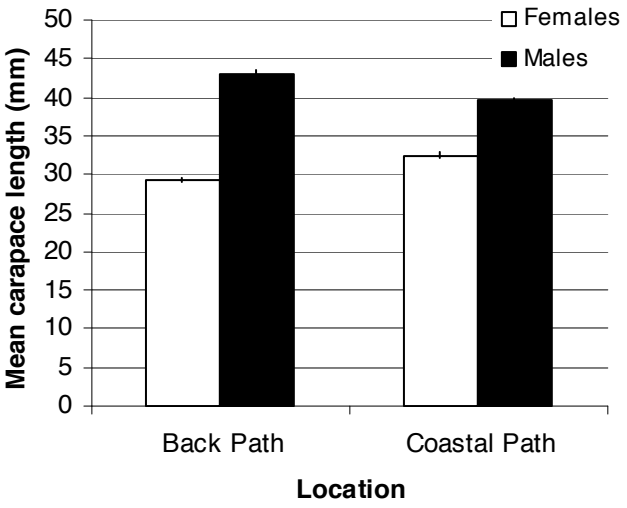

Figure 31. Mean carapace length for male and female coconut crabs encountered on Back Path and Coastal Path, based on data from 2006-2011.

The higher occurrence of larger females on the Coastal Path may be related with the deposition of eggs by large adult females. Females that carry eggs usually remain in crevices and burrows within 100 m of the shore, often at higher than normal densities. When the larvae in the eggs are fully developed the female deposits them in the sea. If this hypothesis is true, larger females would be expected to be seen on the Coastal Path in their egg-carrying period, which is timed on Aldabra between December and February (known from our observations). Figure 32 suggests that there may indeed be a movement of larger females towards the coastal zone, as female carapace sizes found on Coastal Path tend to be largest in December, whereas females on Back Path are smallest around that time. However, this analysis should be repeated using 'distance from sea' rather than transect location, as the Back Path is starting close to the sea, and some females with eggs have been found there.

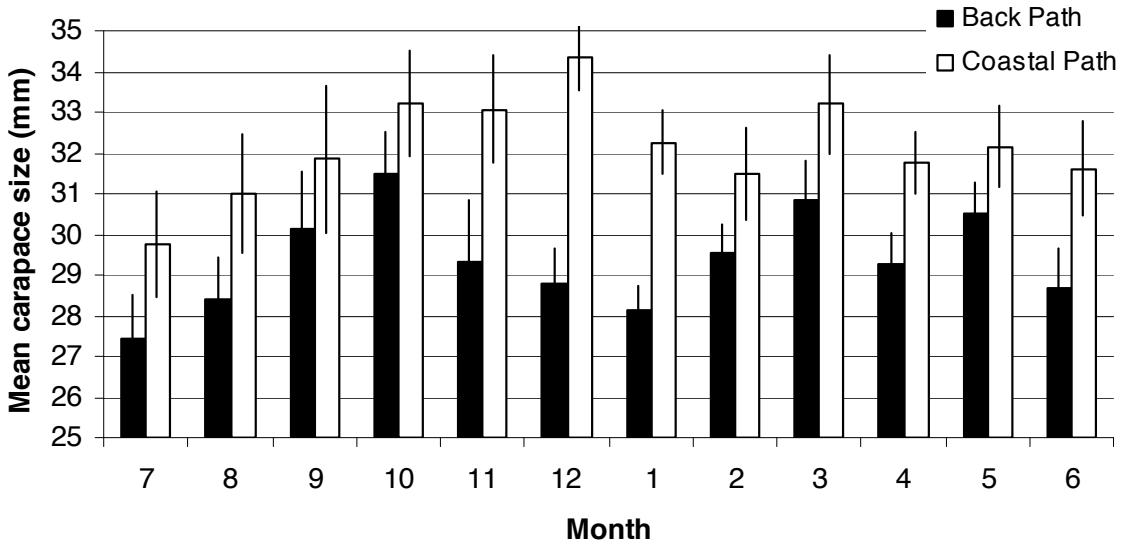

Figure 32. Seasonal patterns of female carapace size on the Back Path and Coastal Path. The egg-laying period, that ranges from December until February is placed in the middle of the timeline. The figure is based on 2006-2011 data.

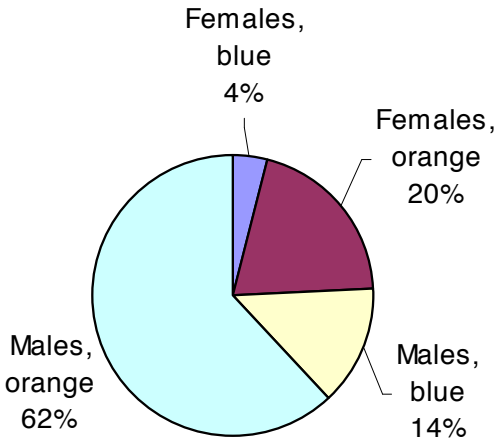

Figure 33. Relative proportions of each sex and colour morph within the Picard coconut crab population, (averaged over 2006 – 2011).

Figure 33 shows the uneven sex ratio and the uneven proportion of blue and orange colour morphs in the Picard coconut crab population. The male:female sex ratio of the 2006-2011 dataset is 3.15:1, while there are on average 4.7 orange crabs recorded for every blue colour morph encountered. Both the uneven sex and colour morph ratio, biased towards males and red respectively, were already noticed in the early 1970s by Grubb (1971) in a small sample, which was explained by the author as a simple mode of colour inheritance with red being dominant over blue. The fact that we find the same bias in a large sample size suggests that this may be representative for at least Picard's population.

Figure 34a shows that the average number of individuals encountered during monitoring trips was rather high in 2011 compared to earlier years, particularly on Coastal Path. The figure suggests an overall increasing population trend over time, yet this has to be further investigated in more detail. The average size of the individuals encountered in 2011 did not differ between both transects, but in comparison with previous years their size on Back Path was rather low and on Coastal Path rather large (Figure 34b).

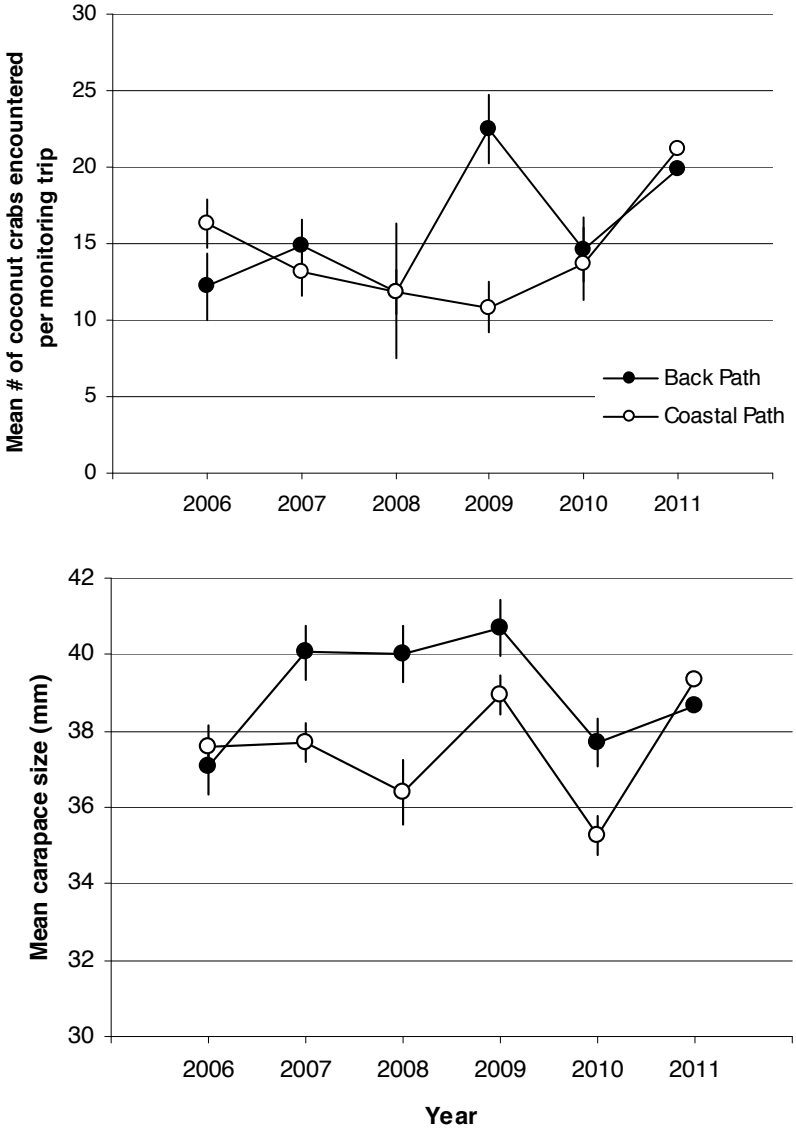

Figure 34. (a) Mean number of individuals encountered per monitoring trip and (b) mean carapace size of coconut crabs on Back Path and Coastal Path during each of the years 2006-2011.

4.3. Vegetation

4.3.1. Phenology transects

Phenology surveys are conducted twice a month, and each of the 33 species surveyed was represented by six individuals throughout. *Pandanus tectorius* and *Tournefortia argentea* are represented by three and five individuals respectively, as additional mature individuals of these species have not been found near the survey path. Throughout the year a few monitored plants died and another plant of the same species was assigned as a replacement. In January one *Clerodendrum glabrum var. minutiflorum* individual and one *Acalypha claoxyloides*, both in zone 2, did not start sprouting following the rains in December. They were dead and were therefore replaced. In November a *Trianolepsis africana subsp. Hildebrandtii* located in zone 1 died and was replaced by a new tree in the same zone in December.

In order to facilitate training of new staff and volunteers, there has been an ongoing effort to take photos of relevant parts of the monitored plant species, which can then be put into a handbook to help identify the relevant flowering and fruiting stages of all monitored species. A large number of photos have been collected and are stored on the Aldabra fileserver (under \Photos –

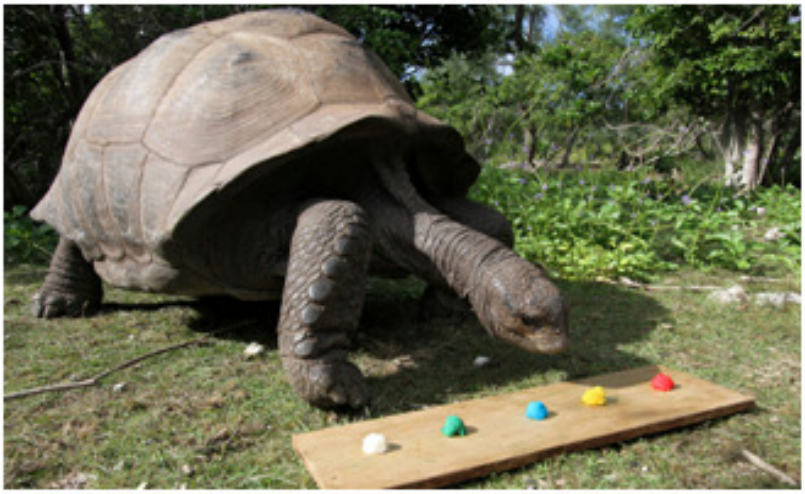

Figure 29. Dennis Hansen conducting a feeding experiment on Aldabra tortoises, who seemed to enjoy the participation (*photographs by Rich Baxter and Dennis Hansen*)..

4.2. Coconut crabs

Since 2006, coconut crabs are surveyed twice per month on both the Backpath and Coastal path (Picard), where all individuals within a 10-m wide transect are recorded. Collected data includes carapace length, colour morph, moult stage and sex. Also the weather circumstances and moon stage (the surveys are done in the evening after sunset) are recorded, of which the correlations with coconut crabs encounter rates are explained in the 2011 ASC Annual report. This report also contains an analysis of the carapace length data.

Seasonal patterns in encounter rates differ between the two locations (Figure 30): on Backpath there is a strong seasonal pattern in which more males are seen during February and March. In contrast, Coastal path no such distinct peaks are seen. In general, more males are seen than females and fewest crabs are encountered at the end of the dry season. The latter could be expected as the coconut crabs need a humid environment for their breathing organs to function.

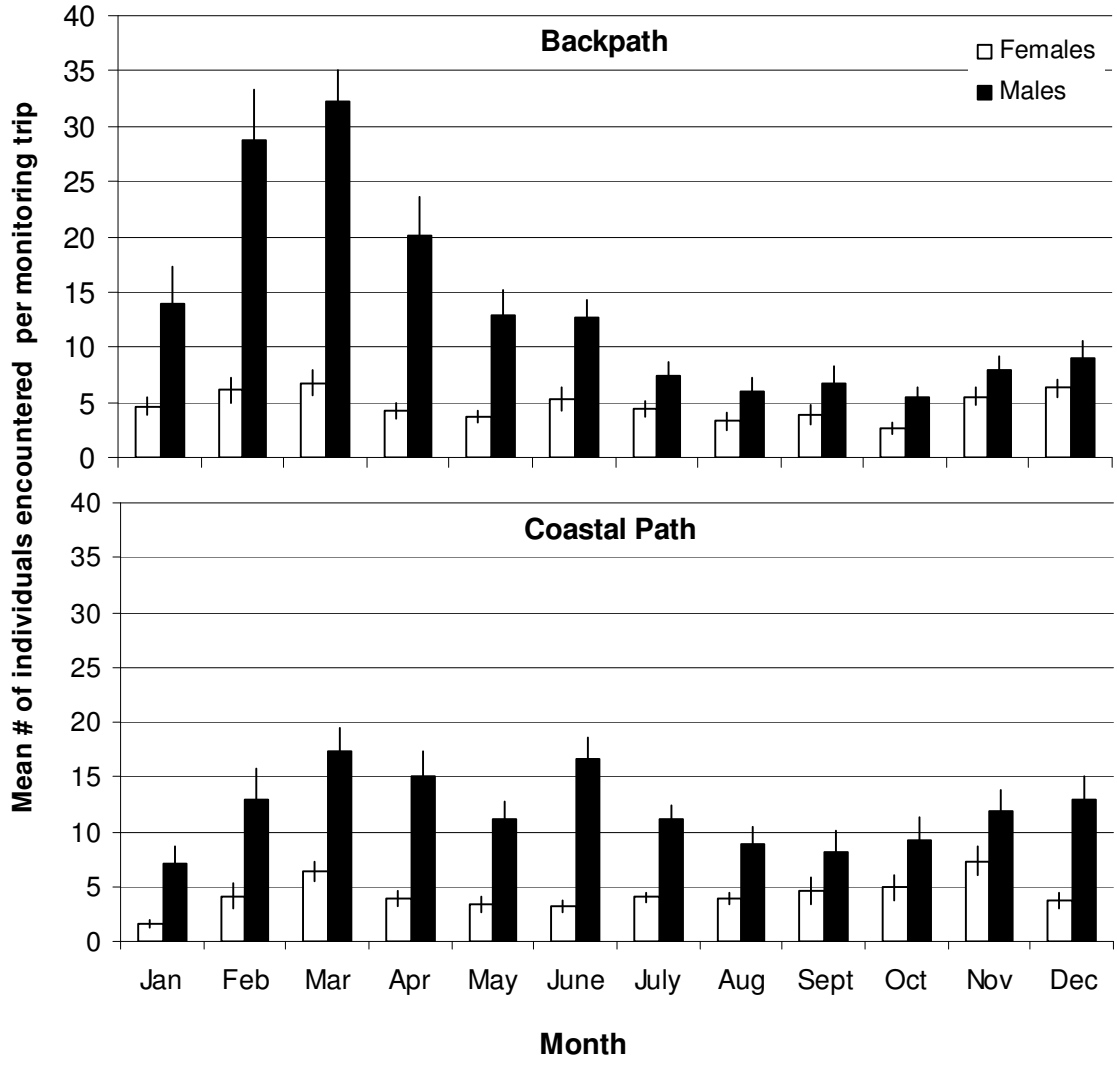

Figure 30. Seasonal patterns of coconut crab encountering rates (separated per sex), based on 2006-2012 data.

Plotting the seasonal patterns over the past six years (Figure 31) shows again that the seasonality is more obvious on the Backpath. Furthermore, encounter rates have been fairly stable on even somewhat increasing over time.

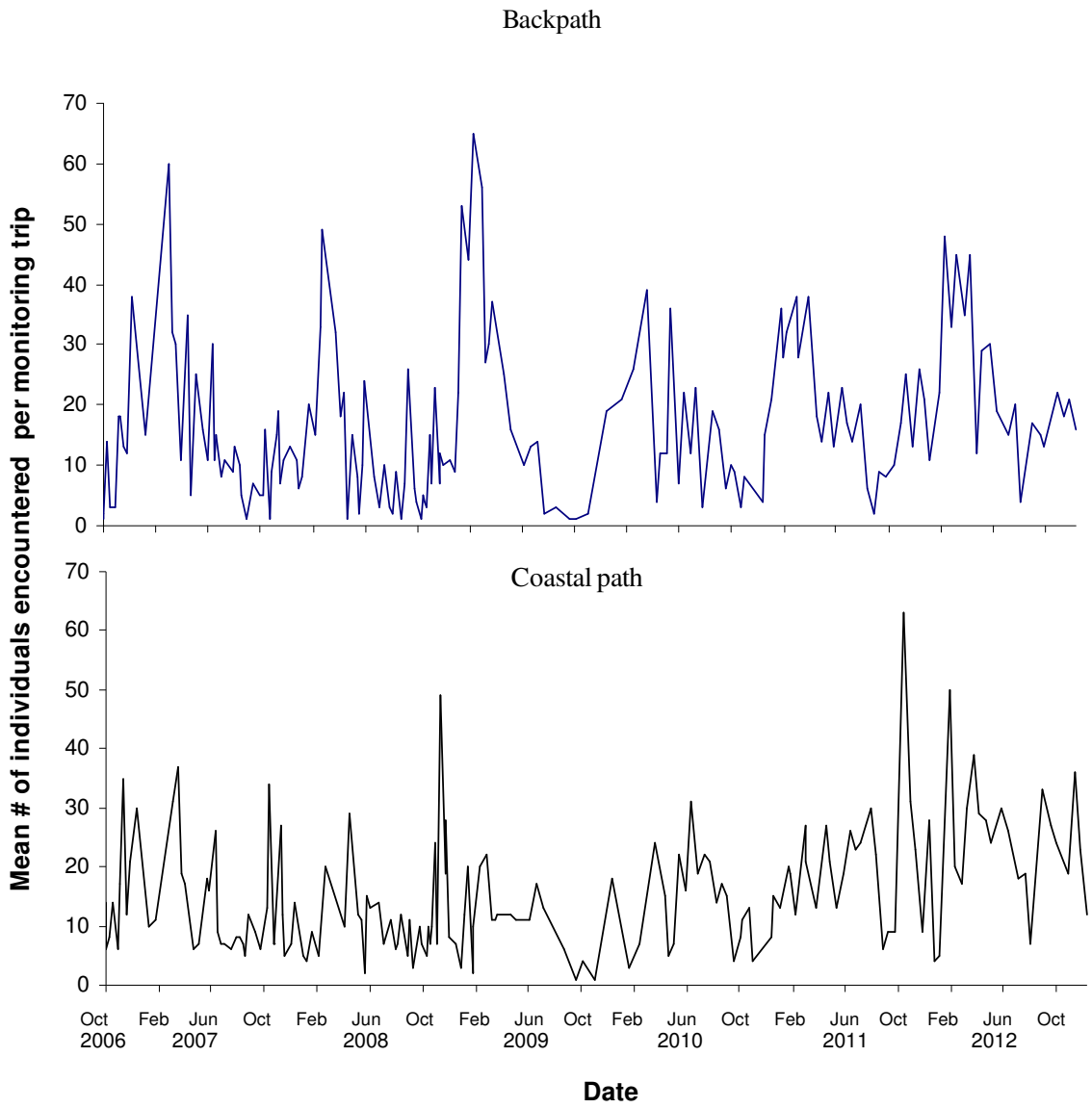

Figure 31. Mean number of individuals encountered per monitoring trip in 2006-2012.

When plotting the same data per year it appears that there is indeed an upward trend in encounter rates, particularly at the Coastal path (Figure 32).

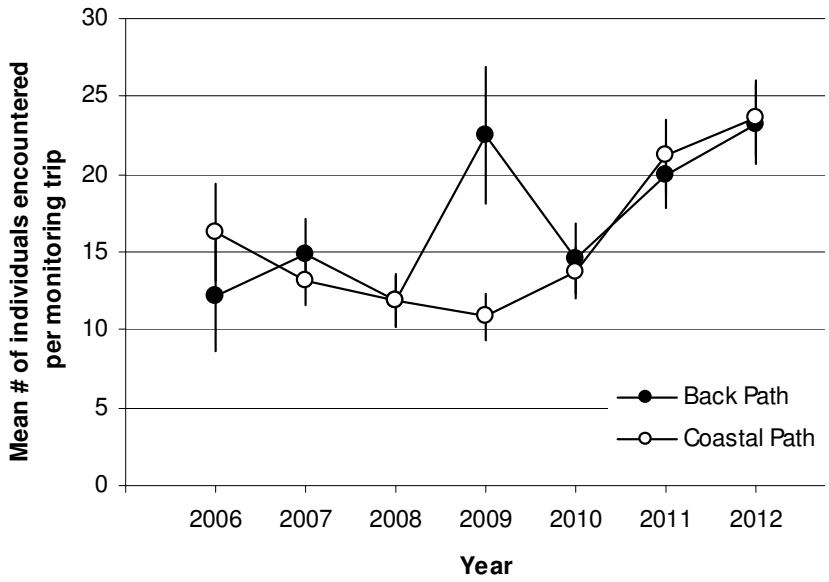

Figure 32. Mean number of individuals encountered per monitoring trip in 2006-2012.

3.4. Coconut crabs *Birgus latro*

Since 2006 coconut crabs have been monitored twice per month on Picard as per the protocol on both Backpath and Coastal path. Consistent with trends observed last year the number of coconut crabs encountered on these transects appears to be increasing, particularly evident on the Coastal Transect (Figure 23). This seven-year dataset has been used to assess seasonal patterns, difference in male/female composition, moult stage and effect of moon phase on encounter rates. It is planned in 2014 that Resident Researcher Janske van de Crommenacker will complete analysis of the coconut crab dataset for publication and this will feed into a review of the monitoring programme.

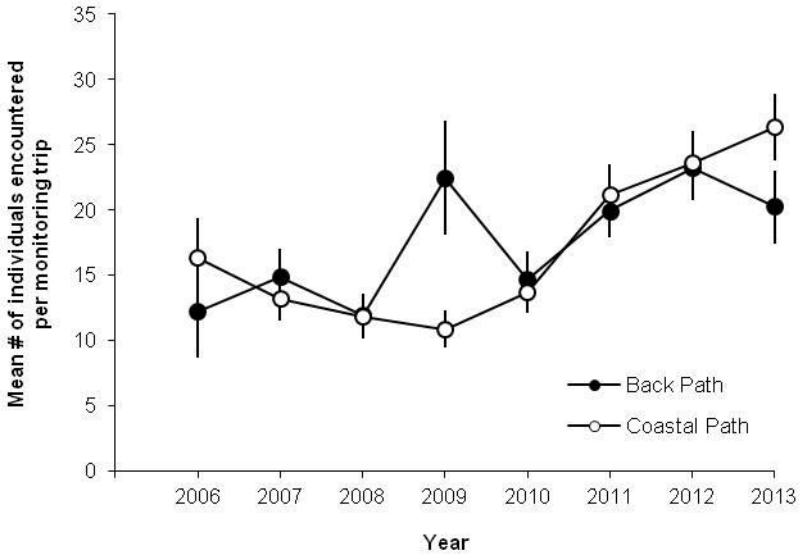

Figure 23. Mean number of coconut crab individuals encountered per monitoring trip in 2006-2013 (± s.e).

Tree ring measurements from the deciduous tree species *Ochna ciliata* and monthly rainfall data from the period 1969–2012 were used to investigate long-term productivity and rainfall trends by John Shekeine (University of Zurich, ZARP MSc student). Due to a lack of consistent growth rings across samples, it was not possible to link the tree ring chronologies to the long-term rainfall record (1969–2012) or, use the tree rings as a proxy to analyse temporal trends in Aldabra's productivity.

John Shekeine's manuscript titled Primary productivity and its correlation with rainfall on Aldabra Atoll should be published in 2015.

3.4. Coconut crabs *Birgus latro*

Since 2006 coconut crabs have been monitored twice per month on Picard as per the protocol on both Backpath and Coastal path. In contrast with the past few years the number of coconut crabs encountered on these transects decreased in 2014, particularly evident on the Backpath Transect (Figure 29). This is not necessarily cause for concern as it appears that in general there were slightly fewer coconut crabs encountered during the second part of the year which could be as a result of weather conditions (dry December) or the timing of the monitoring events. This dataset has been used to assess seasonal patterns, difference in male/female composition, moult stage and effect of moon phase on encounter rates. It is aimed to analyse the coconut crab dataset for publication which will feed into a review of the monitoring programme. It would be advantages to review this monitoring programme in 2015 to ensure that it is fit for purpose to answer important management focused questions and that the resource allocation to this activity is appropriate.

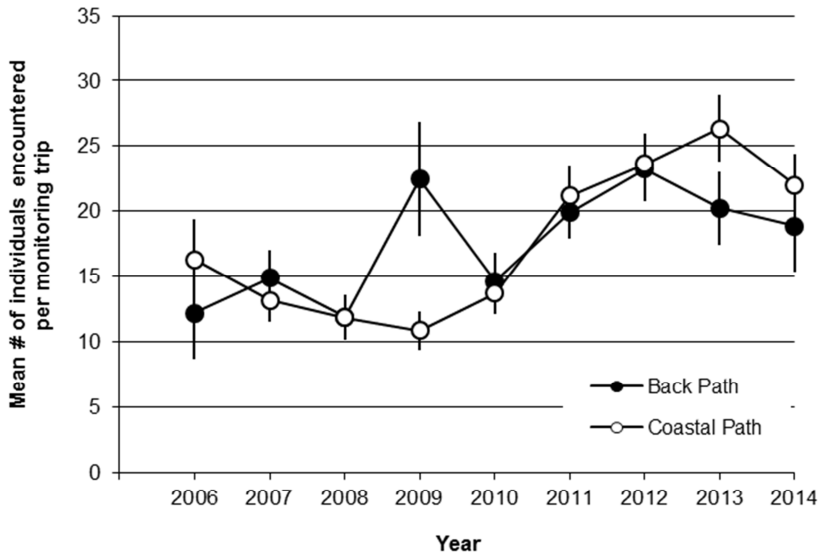

Figure 29. Mean number of coconut crab individuals encountered per monitoring trip in 2006-2014 (± s.e).

3.5. Aldabra Banded Snail (*Rhachistia aldabrae*)

The Aldabra banded snail (*Rhachistia aldabrae,* Figure 30), declared extinct in 2007, was re-discovered alive and well at Aldabra on 23rd August 2014. Before the discovery, the last living individual of this endemic species, was recorded in 1997. Subsequent searches yielded only shell remains and no living specimen has been recorded until now. The snail's apparent demise was linked to declining rainfall on Aldabra (in a paper by Gerlach in 2007) and was widely publicised internationally as one of the first casualties of climate change impacts.