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Field observations provide an insight into the ecology of the Rusty Monitor (*Varanus semiremex*) in South-eastern Queensland, Australia

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ABSTRACT

A southern population of the Rusty Monitor (*Varanus semiremex*) is known to occur at Wild Cattle Creek, Tannum Sands, Queensland. Thorough field observations conducted on foot revealed that individuals are frequently observed active between late September and April. Five distinct adults were identified over a 300 metre length of tidal mangrove habitat. Two confirmed females had a set home range and were recorded active within the same areas during a 29-month period. Both females became gravid and laid eggs between October and December. Hollows in mangrove trees were used as refuge sites and may be occupied over time by several individuals. Crabs were the only prey items observed, in contrast to literature reports of a more varied diet. The monitors were not active swimmers, preferring to forage between tides, but using the water in-transit where necessary. Daily activity commenced early in the summer months but was delayed during autumn and spring. Activity was observed at temperatures as low as 25.5°C. □ *Varanus semiremex*, crab-feeding, activity, home range, thermal regulation, mangrove species.

Varanus semiremex (Peters 1869) is a species of varanid distributed along the coast and neighbouring river systems of Queensland. This species is endemic to Queensland and known to occur from the Gladstone region (South-eastern Queensland) to Cape York (Wilson & Swan 2013; Cogger 2014). It is commonly referred to as the Rusty Monitor due to its rusty colouration under the throat and chest but is quite variable in colour-pattern over its distribution. Cogger (2014) listed *V. semiremex* as inhabiting mangroves and the borders of freshwater streams adjacent to the coast. Jackson (2005) who collected the southern form and bred captive individuals at Australia Zoo suggested that the southern populations are restricted to coastal mangroves, with their habitat being dominated by the Spotted Mangrove *Rhizophora stylosa*

and the Grey Mangrove *Avicennia marina*. Within these habitats the monitors are known to feed on crustaceans, fish, lizards, insects and small mammals (Dunson 1974; Swanson 1976; Ehmman, 1992; Vincent & Wilson 1999; James *et al.* 1992; Jackson 2005; Pianka *et al.* 2004; Cogger 2014).

While much is known about diet, habitat preferences and husbandry of *V. semiremex*, little is known about its natural feeding behaviour, thermal preferences and daily and seasonal activity patterns. Pianka *et al.* (2004) noted that 'this wary and uncommon diurnal monitor is seldom seen', a reference that points to the difficulties in studying this cryptic species. Recent field observations (2013) from the Tannum Sands region revealed that a healthy population of *Varanus semiremex* exists in this area.

Observations of specimens encountered at Tannum Sands site over a 29-month period provide new information on the biology of this species. The observations outlined here add to the known ecology for this species. Whilst this study began as an observational exercise purely for interest, the data accumulated adds significantly to the scant knowledge available for this species and has flow-on conservation applications. No monitors were handled during the study and the utmost care was taken to avoid disturbing the monitors or their habitat.

Study area

Wild Cattle Creek is a tidal salt water creek separating Wild Cattle Island from the mainland. Its mouth is situated south of Tannum Sands (23°57'S, 151°22'E) in Queensland and meanders through to the Colosseum (a bay) some kilometres to the south. Each side of the creek is dominated by a mangrove habitat of which 300 metres on the western side was selected as a study site (Fig. 1). For conservation reasons and the welfare of the monitors the site is not specifically mapped. Numerous species of mangrove trees occur at this locality

including the Red Mangrove (*Rhizophora stylosa*) and larger Grey Mangrove (*Avicennia marina*). Two other species of mangroves the Yellow Mangrove (*Ceriops tagal* var. *australis*) and River Mangrove (*Aegiceras corniculatum*) are also common but restricted to the shoreline. The habitat is consistent with that described in Jackson (2005) as favourable for *V. semiremex* in SEQ.

METHODS

To gain an insight into the behaviour of the Rusty Monitor the designated area was visited 183 times, commencing 16 September 2013 and concluding on the 15 February 2016. Attempts were made to visit the area numerous times each month at close to regular intervals. During these visits, between 1-3 hours typically, the area was surveyed several times and observations of the Rusty Monitor were captured using a high resolution digital camera (Nikon D800) and telephoto lens (Nikon 300 mm with 1.4 tele-converter attached; 420 mm equivalent). To avoid disturbing natural behaviour, specimens were approached cautiously and quietly. Much emphasis has been placed on gaining



FIG. 1. Wild Cattle Creek

acceptance of individuals. No attempts were made to disturb individuals to gain a better image. Brief visits outside the study period were also conducted during September-December 2016.

Identification of individuals

To assist in the identification of individuals, each animal was photographed from multiple angles, with emphasis on obtaining profile shots. An accurate profile was achieved by cropping images down to head shots. Arrangement of head scales, eye ring (complete circle or not), size of tubercles and nostril shape were characteristics that could be used to differentiate individuals. A 10 x 15 cm image of each observation was printed for a direct comparison. These images were used to assess population size and the daily and seasonal movements of individuals.

Observations. To minimise disturbance specimens were approached cautiously and quietly. Specimens were followed while they foraged and images were taken showing both foraging behaviour and the range of prey items consumed. The 420 mm lens equivalent enabled images to be taken from a reasonable distance (typically 6 metres). Each time a specimen was photographed the time was recorded with the image file and the location was later plotted using a Garmin GPS (sites A-Z). Due to the inaccuracy of the GPS used (generally +/- 5 metres) the site was properly mapped out later by using a tape measure and the trilateration method (mapping an area by the use of triangles).

Sex. The sex of two females was determined by closely examining a series of images (taken over a few weeks) that display a pre-partum and post-partum state. No males were confirmed,

TABLE 1. Commencement of activity temperatures and times throughout Autumn, Spring and Summer.

Temperature	Time	Date
28°C	11:47 am	18 April 2014
26°C	9:36 am	30 September 2013
30°C	9:01 am	29 October 2014
28°C	8:22 am	3 December 2014

although specimen 4 (Fig.2.) had head scaring and a more pronounced head structure which is consistent with an adult male.

Thermal Information. Tree hollow, basking site and active foraging temperatures were measured at Site B, a mangrove tree frequently used. Three 'J' type thermocouples were setup to record these temperatures by use of a Fluke, 10 Channel, Digital Thermometer. The long thermocouple leads allowed temperatures to be recorded 12 metres away and out of direct sight. Daily temperatures were also recorded from the Bureau of Meteorology (20 kilometres distant). To establish the minimum foraging temperature of animals, a temperature data logger was placed in the shade of a mangrove at the study site to measure more specific temperatures.

RESULTS AND DISCUSSION

Study Population. Between site A and site H (approximately 300 metres) eight individuals were positively identified by comparing digital images of 126 observations (Fig. 2). Five adults were identified along with two sub-adults and a juvenile. Specimens were placed into these categories by an estimation of age, overall size and strength of lip barring (strong in juveniles). Photographs of uncertain individuals were recorded during behaviour and daily activity assessments.

Daily Activity/Thermal Preferences. Rusty Monitor individuals were diurnally active and basked in the morning sunlight from an elevated position (Fig. 3). Commencement of activity varied between seasons and was delayed when the weather had cooled in autumn; refer Table 1.

An example of thermal activity is given in Fig 4. Direct foraging into the mudflats only occurred during the warmer months (21 observations). During the cooler months, specimens restricted their foraging to the shoreline (3 observations). Avoiding the wet mud and shaded areas of the mangrove habitat during the cooler months is behaviour that would assist in maintaining a suitable body temperature. Most of the shoreline habitat in the study area is sandy and is in direct sunlight from midday onwards. A

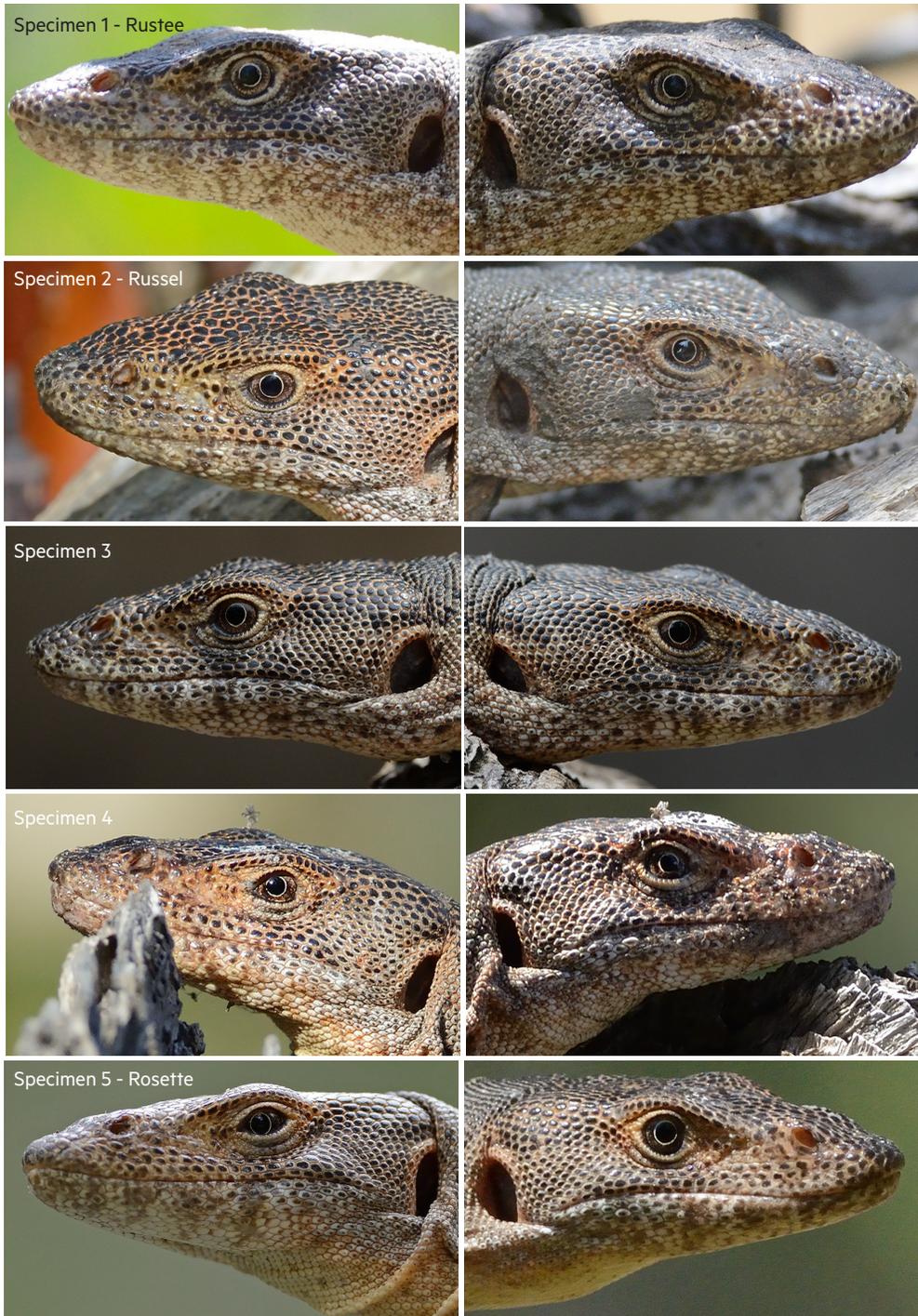


FIG. 2 Left and right head views of five adults identified in this study. Top-bottom, specimens 1-5.



FIG. 3. *Varanus semiremex* basking.

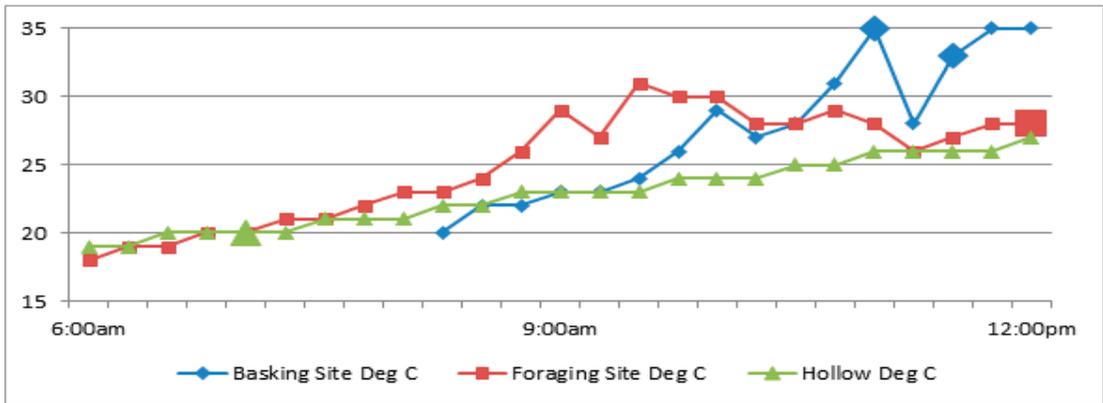


FIG. 4. Microhabitat temperatures measured at site B on 18th April 2014. Larger data points highlight the animal's emergence from hollow (triangle), basking next to thermocouple (diamonds) and commencement of foraging (square), respectively.

detailed record of daily temperatures measured throughout the study are listed in Table 3.

Seasonal Activity. Rusty Monitors were observed active from mid-September until late April (47 observations). During late autumn and early winter, activity was reduced to the

occasional head basking (the animal poked its head out of its shelter site but did not emerge completely). No activity was recorded from mid-June to early September when temperatures were cooler (34 observations, Fig. 5). Activity resumed in mid-September

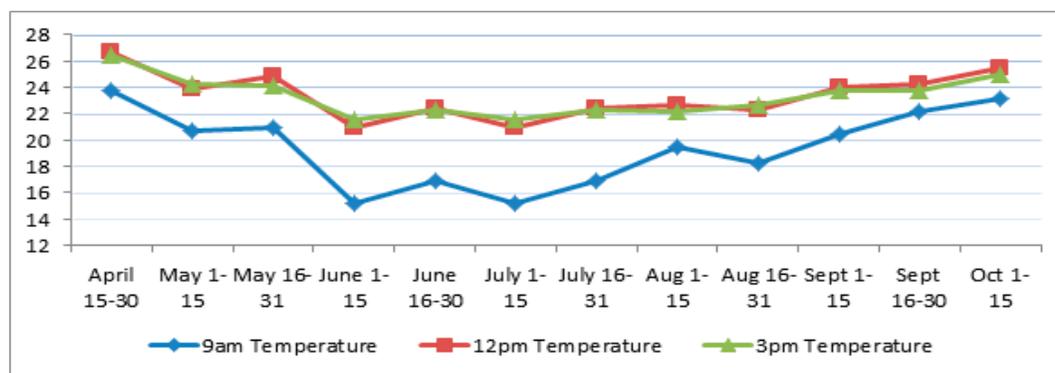


FIG. 5. Fortnightly average temperatures at Gladstone, 2014 from Bureau of Meteorology.

when the daily temperature range had risen to a minimum of 15°C and maximum of 27°C. The lowest measured air temperature (at site) when an individual was active was 25.5°C, recorded at 10:50am during late September 2014. Figure 5 displays average fortnightly temperatures at 9am, 12pm and 3pm, showing the decline in available thermal energy at 9am and 12pm from late May until late August.

Refuge Sites. Hollows in large mangrove trees were used as semi-permanent refuge sites. Other hollows in stumps and living mangrove trees, many below high tide level, were used as temporary refuge sites. Site H, a hollow log that was frequently used by Specimen 1, is below water level during king tides. Site H was avoided as a sheltering site during this period, but frequently used at other times (18 observations). Table 2 briefly describes the refuge sites throughout the study area. Refuge site usage is also displayed in table 2.

Semi-aquatic Behaviour. (Fig 6) Monitors were seen to enter the water rarely (7% of observations) and only during the warmer months (9 observations, December-March; Figures 6A, B). While there are few observations of this activity due to varying tidal heights and times (only a high tide that engulfs the mangrove flat and overlaps foraging time), the animals are very capable swimmers. For example, I observed an individual climbing down a mangrove tree and swimming to another tree

to pursue a crab. Close examination of images from two observations showed that as the monitors swam, all limbs were held against the body (in a crocodile-like manner) whilst the head and mouth were kept above water. The tail was moved in lateral undulations providing forward propulsion. Various individuals were also seen perched on isolated logs during high tide levels (3 observations). This study confirms *V. semiremex* favours semi-aquatic environments, although there is no indication of underwater foraging behaviour such as Merten's Water Monitor, *V. mertensi* (Swanson 1976).

Feeding Behaviour. (Figs 7A-F) A broad range of prey items are recorded for the Rusty Monitor (Dunson 1974; Swanson 1976; Ehmann 1992; Vincent & Wilson 1999; James *et al.* 1992; Jackson 2005; Pianka *et al.* 2004; Cogger 2014). However, only crabs were observed as prey items during this study even though a number of other potential prey species (mudskippers, mud lobsters, fish) also inhabit the site. Crabs were actively foraged for and pursued in the open or dug from burrows (14 observations). A range of crabs species were eaten at different tide times. At high tide *Metopograpsus frontalis* often perches on the trunk of mangrove trees and debris above the water level and; it is highly likely this is the crab species consumed in at least 2 observations. During outgoing tides, the Purple and Cream Shore Crab (*Pseudohelice subquadrata*) was extracted from the sandy substrate surrounding the buttressed base and

TABLE 2. Site usage; number of times used by each individual during the study period.

Site	Rustee Spec. 1	Rosette Spec. 5	Russel Spec. 2
A Grey Mangrove	1	-	-
A1 Yellow Mangrove	1	-	-
S Red Mangrove	-	1	-
B Red Mangrove/hollow	6	15	-
R Red Mangrove	1	2	-
U Red Mangrove/hollow	3	5	-
T Grey Mangrove/hollow	2	2	1
Z Grey Mangrove/hollow	1	-	-
K Stump/ hollow	1	10	2
L Grey Mangrove/hollow	3	3	1
C Grey Mangrove/hollow	-	4	2
V Grey Mangrove	-	1	-
P Red Mangrove	-	2	1
J Stump/ hollow	-	5	-
Y Log/ hollow	-	2	-
X Stump	1	-	-
Q Red Mangrove	1	-	3
N Red Mangrove	-	-	-
M Grey Mangrove/hollow	-	-	-
D Log/ hollow	3	-	1
W Red Mangrove	1	-	-
G Grey Mangrove/hollow	5	-	2
E Red Mangrove	-	-	-
F Felled Mangrove	-	-	2
O Red Mangrove/hollow	-	-	1
I Red Mangrove/hollow	1	-	-
H Log/ hollow	18	-	-

root system of the Yellow Mangrove (*Ceriops tagal* var. *australis*, 1 observation, Figs 7A and 7B). Other crab species inhabiting the mud flats were pulled from their burrows during foraging (2 observations, Figs 7C, 7D). In one

observation a crab evaded capture by moving between entrances of a 'V' shaped tunnel (defence behaviour). When a crab was pursued around the trunk of a tree and the monitor moved into a lateral position, the monitor wrapped its tail around the tree trunk to assist balance (1 observation). Crabs were swallowed whole and were often rotated until their limbs were on each side of the goanna's jaw (3 observations, crab limbs protruding from monitor's mouth). One swallowed crab was regurgitated and crushed against the log numerous times before being re-swallowed (Figs 7E, 7F).

A small hollow stump next to site K (1 m high) was used as a vantage point (2 observations). Two individuals used this site on separate occasions and were observed attentively watching the ground below. When a suitable prey item was spotted, the monitor slowly moved forward before dropping to the ground below and actively pursuing its victim.

Salt Excretion. It is well documented that the Rusty Monitor responds to the high salt intake from feeding on saltwater crabs by expelling excess salt through the nostrils from specialised nasal salt excretion glands (Dunson 1974; Heatwole 1976; Ehmann 1992; Vincent & Wilson 1999). Adult specimens encountered during this study were all observed sneezing and often to the degree of releasing a visible spray. While all adults conformed to this behaviour, there is no mention of regular sneezing in captive individuals that were held at Australia Zoo during their breeding program (Jackson 2005). It is fair to surmise that the fresh water and prey provided to captive individuals (mainly fish, prawns and crickets with some cockroaches and the occasional pink mouse) contain much lower salt levels than the crabs eaten (often with a mouth full of moist sand) from a tidal mangrove flat; hence, the need to purposely sneeze for salt excretion would be reduced.

Sexing of Individuals and Longevity. *Varanus semiremex* and other pygmy goannas are notoriously difficult to sex by the usual method of determining males by gently exposing the hemipenis (Jackson 2005; K. Aland pers. com.). However, this level of disturbance was not



FIGS. 6A, B. Swimming behaviour of *Varanus semiremex*; head is clearly held out of the water and limbs tucked against the body.



FIGS. 7A-F. *Varanus semiremex* feeding behaviour, A-B, observed along sandy shoreline; C-D, within the mangrove flats; E-F, on a fallen mangrove tree.



FIGS. 8A-G. Pre-partum and post-partum changes within female *Varanus semiremex*. A-C, display Rustee (Spec. 1) in a pre-partum and post-partum state; D-G, display Rosette (Spec. 5) in a similar pre-partum and post-partum state.

appropriate for this study. Instead, two females were able to be identified by a series of images displaying the changes that occur during the pre-partum and post-partum state. While the sex of two other adults was undetermined, one individual with snout scarring (consistent with intra-specific aggression), a more pronounced

head structure and colourful throat (Fig. 2, specimen 4) is likely to be a male. Intra-specific aggression between males is known in the varanid family and often results in a scarred or injured individual (King & Green 1999). Longevity for the two females was calculated as a minimum of 3¾ years (specimen 5) and

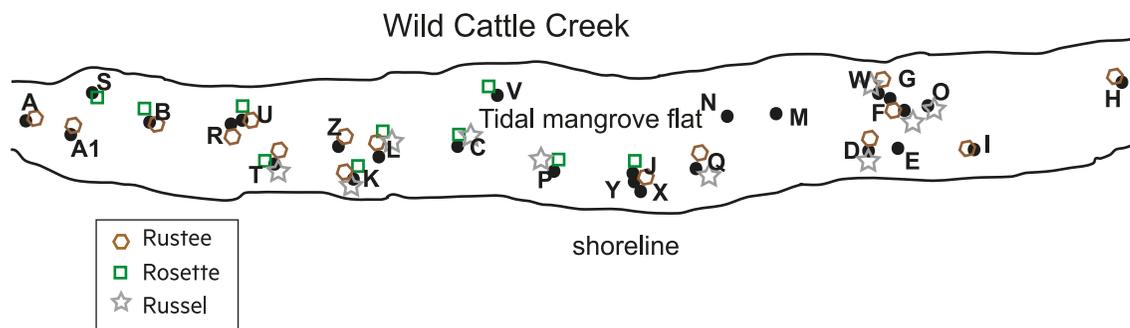


FIG. 9. A scaled representation of sites A-Z within the study site. Distance between site A and H is approximately 293 metres. The grey lines are an estimation of shoreline and creek bank. Site A is deemed a northern extremity of the study site and site H a southern extremity.

4¼ years (specimen 1). This was established from head images taken throughout the study period and brief visits to the study site during September–December 2016. Both specimens were large adults and at least 1-year-old when first encountered. Jackson, 2005 measured the growth rate of captive hatchlings and concluded that specimens reached maturity after 15 months. The last observations of Specimen 5 and Specimen 1 occurred on the 28th and 31st December 2016 respectively. Due to the lack of long term observations of the other 3 adults, it was not possible to determine their age.

Egg Deposition. Two individuals underwent changes in morphology consistent with developing and laying eggs. Protruding hips, a drawn in tail base, distension in the posterior portion of the abdomen and lumps protruding from the belly are all typical signs of a gravid female. (Jackson 2005; K. Aland pers. com.). On the 26th and 28th of September 2015, Rustee (specimen 1) was the first specimen observed at site H in what appeared to be a pre-partum state (Fig. 8A-B). Two weeks later, 12th of October 2015, Rustee was again observed at site H but in an apparently depleted post-partum state (Fig. 8C).

Rosette (specimen 5) was photographed in an apparent pre-partum state on two occasions, first at site U on the 10th December 2015 and six days later at site J on 16th December 2015

(Fig. 8D-E). On the 24th of December 2015, Rosette was photographed again at site U in an obvious post-partum state (Figs. 8F, G). Figures 8C and 8F display both Rustee and Rosette in a very similar state. It is not known where either of these individuals laid their eggs; however, during the study there were no observations of any active individuals venturing to potential ground egg-laying sites. Jackson (2005) used nest boxes replicating a hollow log to successfully breed captive *Varanus semiremex*. As such, the egg deposition of wild *V. semiremex* probably occurs in mangrove tree hollows between late September and December.

Movements and home range. Monitors often moved between shelter sites and readily sought refuge in hollows that were previously occupied by other individuals (Fig. 9. Tables 2, 3). Foraging distance and time has been measured at 20 metres in 6 minutes.

The maximum linear distance travelled in a 24-hour period was ~182 metres and was recorded when Rustee ventured from site A (1st February 2015) to site Q (2nd February 2015); refer Fig. 9. Short term movements were recorded for both Rustee (specimen 1) and Rosette (specimen 5).

Rustee's movements over 13 days (28th January–10th February 2015; Table 3) included site W→ (4days) A→ (1 Day) X→ (4 days) G→ (4 days) L.

Rosette's movements over 9 days (27th November–6th December 2014; Table 3) included

Field observations of the Rusty Monitor in SEQ

TABLE 3. Site selection, temperatures and movements of specimens 1, 2 and 5. Highlighted sites in grey indicate when individuals were observed at more than one site during an observation day.

d= distance travelled in metres from first location of previous observation day.

T= min/max temperatures in Deg. C BOM Gladstone, temperatures in bold were measured at an interval of 3 hours that overlap observation (BOM) and temperatures with (*) represent specific temperatures measured at site.

RUSTEE - specimen 1											
Date	Site	d	T	Date	Site	d	T	Date	Site	d	T
24/09/13	H	-	24/26	28/09/13	H	-	25/28	13/10/13	H	-	25/27
14/10/13	H	-	29/29	30/03/14	I	43	27/29	24/09/14	H	43	23/23
07/10/14	G	62	24/26	31/10/14	H	62	26/27	03/12/14	G	62	22/28
08/12/14	D	15	28/31	11/12/14	L	131	30/32	12/12/14	R	40	26/27
22/12/14	T→U	15	26/29	28/01/15	W	163	27/29	01/02/15	A	229	29/33
02/02/15	X→Q	166	26/31	06/02/15	G	71	27/28	10/02/15	L	137	27/29
28/02/15	B	62	27/30	02/03/15	G	198	24/28	05/03/15	L	137	28/32
06/03/15	B→A1	62	29/31	10/03/15	K→Z→B	57	31/31	15/03/15	B	57	26/28
16/03/15	B	-	27/30	13/09/15	H	260	16/26	14/09/15	H	-	15/26
17/09/15	H	-	15/30	18/09/15	H	-	17/28	24/09/15	H	-	12/24
26/09/15	H	-	12/26	28/09/15	H	-	25/25	12/10/15	H	-	18/27
05/12/15	H	-	20/31	06/12/15	H	-	21/31	21/12/15	H	-	23/30
30/12/15	D	69	20/30	03/01/16	D	-	24/29	16/01/16	B	192	23/31
18/01/16	U	25	22/30	01/02/16	H	235	27/33	10/02/16	T→U	227	23/31
15/02/16	G	165	-								
RUSSEL - specimen 2											
Date	Site	d	T	Date	Site	d	T	Date	Site	d	T
04/10/13	D		21/25	09/01/14	F→G	14	24/24	02/10/14	G→F	6	23/26
22/10/14	O	12	25/26	02/12/14	Q	64	23/26	03/12/14	Q	-	28/29
04/12/14	Q	-	27/29	12/12/14	C→P	64	26/27	16/12/14	K	30	28/30
06/02/15	C→L→K→T	30	27/28								
ROSETTE - specimen 5											
Date	Site	d	T	Date	Site	d	T	Date	Site	d	T
12/04/14	B	-	27/28	17/04/14	B	-	26/28	10/09/14	L	62	25/25
11/09/14	L	-	23/28	13/09/14	B	62	23/23	14/09/14	B	-	22/24
15/09/14	B	-	26*	18/09/14	B	-	23/26	24/09/14	K	57	23/23
28/09/14	K	-	16/26*	29/09/14	K	-	23/24	03/10/14	K	-	27/28*
07/10/14	K	-	24/26	08/10/14	K	-	22/27	11/10/14	K	-	22/25
29/10/14	P→J	54	23/30	27/11/14	B	110	29/28	29/11/14	K	57	25/26
03/12/14	B	57	22/28	05/12/14	L	62	27/27	06/12/14	K	10	25/26
17/12/14	R	35	27/28*	20/12/14	S	40	29/30	31/12/14	C→V	99	25/30
27/01/15	B	83	29/30	28/01/15	B	-	27/29	10/02/15	Y→J	131	27/30
24/02/15	B→T	131	27/30	02/03/15	B	-	28/32	06/03/15	Y	131	29/31
10/03/15	P→J	21	28/31	02/10/15	B	110	15/27	07/10/15	B	-	16/27
07/12/15	U	25	22/29	10/12/15	U	-	23/30	16/12/15	J	105	21/30
24/12/15	U	105	23/31	03/01/16	U	-	24/29	12/01/16	C	58	22/31
16/01/16	J	48	23/31	21/01/16	U	105	20/31	22/01/16	B	25	22/32
27/01/16	K	57	26/32	30/01/16	C	30	27/33	10/02/16	R→T	60	23/31
15/02/16	C	60	-								

venturing from site B→ (2days) K→ (4days) B→ (2days) L→ (1 day) K. While it was not possible to determine the movements of specimens between the days of recorded movements, the data do point out that specimens moved back and forth between sites.

Rustee a female that was commonly encountered during the study (43 observation days), had a preference for site H (refer Fig. 9) and the southern portion of the study site (28 observation days). During September-October over four consecutive years (2013, 2014, 2015 & 2016) Rustee was photographed perched on this site. Only on 15 observation days was Rustee observed venturing into areas usually inhabited by Rosette, another female that favoured site B and the northern half of the study site.

The recorded movements (46 observation days) of Rosette are more restricted than Rustee's with a strong preference for the northern section of the study area (north of site P, Fig. 9). Rosette was observed venturing to or further south than site P on only 6 observation days. Rosette was not recorded south of site Y. The habitat north of site A changes dramatically and is very unlikely to be suitable for foraging; hence, Rosette's movements do suggest a small home range of <0.6 hectares (estimated by using the shoreline and mangrove margins; Figs 1, 9). Due to site H being situated on the southern boundary of the study area, it was not possible to estimate Rustee's home range; however, the movements recorded in Table 3 support the probability of a home range well in excess of 1.0 hectare. A third adult Russel (Fig. 2, specimen 2) was observed ten times during the study (04/10/13-06/02/15) and was documented venturing between sites O and T (Table 3). Two other adults have been observed within the study site, but lack of observations has not enabled an assessment of long term movements. The long term movements of specimens 1, 2 and 5 are listed in Table 3.

Conspecific Interactions

Rustee and Rosette were both observed on 12 occasions and were usually spaced well apart (≥ 54 metres, 10 observations). Only once were

both specimens observed in close proximity of each other (3 metres). On this occasion, Rustee tilted the head to watch Rosette below venture past but no intra-specific aggression was triggered between these females. Russel's activity has been observed on the same days as Rustee and/or Rosette, with the minimum distance between individuals exceeding 54 metres. Specimen 2 has not been observed since February 2015.

Predation. Although no predation on *V. semiremex* was observed during this study, numerous large predators, known to feed on reptiles, were observed within the immediate and adjacent areas. These include large birds of prey, two species of pythons and large species of monitors. However, indirect predation behaviour was observed during the study. On the 10th of March 2015 a large Coastal Carpet Python was observed investigating a tree hollow which had been occupied by a monitor 22 minutes earlier. A Rusty Monitor perched high on site K, a large dead tree stump, was observed retreating into its hollow as a Brahminy Kite flew overhead. A similar observation was noted when a specimen on site H clearly tilted its head and watched a bird of prey overhead. These final two observations show that Rusty Monitors are aware of potential aerial threats.

CONCLUSION

The Tannum Sands population of the Rusty Monitor (*Varanus semiremex*) appears to be totally restricted to the inter-tidal, mangrove habitat and shoreline of Wild Cattle Creek. No observation of activity venturing into neighbouring bushland was observed. Foraging activity was observed during the day when the air temperature was 25.5°C and above and occurred between September and May. Only crabs were recorded as prey items, highlighting the importance of a healthy mangrove habitat and water quality to support an abundant population of crabs for a sustainable rusty monitor population. There is no fresh water run off purposely channelled into the habitat and cane toads are rarely encountered. Specimens regularly sneeze, a response well documented

as a means of expelling salt (Dunson 1974). *Varanus semiremex* is a wary monitor with keen eyesight and is very observant to threats, both on the ground and aerial. This monitor is a capable swimmer but there has been no indication of true aquatic behaviour. To list *V. semiremex* as a semi-aquatic species is probably an overstatement of its true behaviour. The tail has a small degree of prehensile ability and is occasionally wrapped around a tree for support. The trunk and main branches of the Grey Mangrove and Red Mangrove trees were used frequently as basking sites, while the hollows of mature trees and logs offered temporary and semi-permanent refuge sites. No specimens were observed retreating into a burrow.

Apart from the breeding interactions with males, the two females studied closely lived solitary lives and had a small home range. Breeding occurred in late spring and early summer. Both females deposited eggs between late September and late December.

Male Rusty Monitors were not identified during the study and may be less detectable than the females. If consistent with other varanids, the males are likely to have a larger home range (Heatwole 1976). A larger home range of a male would reduce the probability of an encounter throughout the study site. The strong bias of records of the two females confirmed (77%) and the notion that an adult male was amongst the other 3 adults observed (23%) support this likelihood, particularly when both females bred during the study period. Continuity of the mangrove habitat along Wild Cattle Creek is essential to provide connectivity of the population. The home range of a male Rusty Monitor needs to be studied closely, probably by the use of telemetry.

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