A preliminary assessment of the natural history and conservation status of the Jardine River Turtle (*Emydura subglobosa subglobosa*) in northern Australia

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Abstract

This paper details work that has been carried out on the Jardine River Turtle (*Emydura subglobosa subglobosa*) in Australia in 2014 and 2015. Over these two years surveys have confirmed that this is an elusive and rare species of freshwater turtle in Australia seemingly confined to a very few localities in and adjacent to the Jardine River on Cape York. Details of sites surveyed, methodology and survey effort are detailed as are the results of more intensive monitoring work that has been carried out at two of the four known sites. Summary data are presented for 26 Jardine River Turtles that have been weighed, measured and individually marked as part of this monitoring program. Preliminary identification of three potential threats to the turtle in the area, feral pig predation of nests, poaching for the southern pet markets, and the impacts of climate change on the length and intensity of the dry season, are also detailed.

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Introduction

The Jardine River or Painted Turtle (*Emydura subglobosa subglobosa*) is a small, short neck turtle that occurs in the freshwater swamps, wetlands and river systems of coastal New Guinea and the northern tip of Cape York Peninsula in Australia. The known Australian distribution is restricted to the Jardine River drainage (Cann 1978; Rhodin 1993; Cann 1998; Georges *et al*. 2006; Wilson & Swan 2013) and is only known from a few localities in the middle reaches of the river (Covacevich 1987; Cann 1998; Schaffer *et al.* 2009; Freeman *et al*. unpubl. data; Gary Wright pers. comm.).

It was first recorded in Australia in the early 1970s and had only been captured and sighted fewer than 10 times until the last confirmed sighting in 1996 (Cann 1998; Schaffer *et al*. 2009; Gary Wright pers. comm.). Always considered rare, early observations suggested that it had suffered a significant decline in population size. For example, over the five years between 2003 and 2008, the naturalist and guide Gary Wright, an experienced observer of Jardine River Turtles, spent approximately 300 hours on parts of the river where they were once commonly sighted and observed and recorded none (pers. comm.). In November 2008, an expedition with the specific

aim of ascertaining the current status of the Jardine River Turtle surveyed approximately 40 km of the Jardine River using baited traps for a total sampling effort of 2,318 trap hours (Schaffer *et al*. 2009). This work targeted areas that were known to have had Jardine River Turtles in the past, but failed to capture or sight any freshwater turtles. A survey in 2013 also failed to find any sign of it. Up until August 2014, the last confirmed sighting in Australia was 1996. In August 2014, surveys carried out by Origin Energy staff and rangers from the Apudthama Land and Sea rangers with the assistance of Threatened Species staff re-discovered this turtle at four sites, the first confirmed sightings in Australia since 1996 (Freeman *et al*. 2015). This was followed up in September 2014 and October 2015 with monitoring trips where turtles were marked, weighed and measured.

While this turtle is still considered widespread in Papua New Guinea it is the subject of intense hunting pressure (Georges *et al*. 2006). In contrast the Jardine River population is the subject of little or no hunting. It is currently listed as "Vulnerable" under the Queensland Nature Conservation Act (NCA) 1992. However, in light of data collected during the current survey this may be further revised with the turtle possibly being listed as Endangered in Australia in the near future.

This paper summarises the results of field surveys and monitoring carried out on the Jardine River Turtle in 2014 and 2015 and details the implications of these results for management of this turtle in Australia.

Methods

In August 2014 and October 2015 traps were used to sample suitable habitat that had been identified prior to the survey dates.

Survey area

In 2014 the survey area encompassed the lower and middle reaches of the Jardine River and included side lagoons, waterholes and swamp areas as well as parts of Crystal Creek, a catchment south of the Jardine River. Surveys were also carried out on perched lakes, dams and creek systems to the north of the Jardine River. In 2015 further sites were surveyed upstream of the most easterly sites checked in 2014 (Fig. 1).

Trapping techniques

Baited Cathedral turtle traps were used. Bait used included tinned sardines in oil and bread; tinned sardine-based cat food and bread and decomposed fish scraps. In 2014 the use of the latter bait ceased when it became apparent that this type of bait was particularly attractive to Estuarine Crocodiles (*Crocodylus porosus*) which resulted in the destruction of three turtle traps (Fig. 2).

As the primary aim of the survey was to locate the turtle, traps were set on the basis of what was most likely to achieve this aim by targeting specific habitats that were considered most likely to have this species or habitats where they had been recorded in the past. These included the lower and middle reaches of the Jardine River, as well as side lagoons and waterholes through this area and waterholes and creeks in Bamaga and towards the tip of Cape York.

During the August 2015 survey traps were used to sample 58 sites over two time periods (5th to the 14th and the 26th to the 29th). One site was sampled twice over the two survey periods. In October 2015 (21st to the 28th) a further 27 sites were checked that had been previously identified as potential habitat from helicopter in June. By October five of these sites had become completely dry so no traps were set at them.

The number of traps at any given site varied between one and four depending on the area of suitable habitat observed and practicality of access. The traps were set for periods of one to four days for a total of 198 trap nights over the two years. These sites varied from riverine habitat and individual waterholes (largely open water not connected to the main river channel) to lagoons (open water areas connected to the river) and vegetated swamps (shallow water areas with little or no open water).

Population monitoring

In addition to surveys, in September 2014 and October 2015 a monitoring program was implemented at specific sites. In September 2014, two of the four sites with Jardine River Turtle were re-visited with the specific aim of permanently marking and measuring Jardine River Turtles. Two traps were set at each of the two sites over a

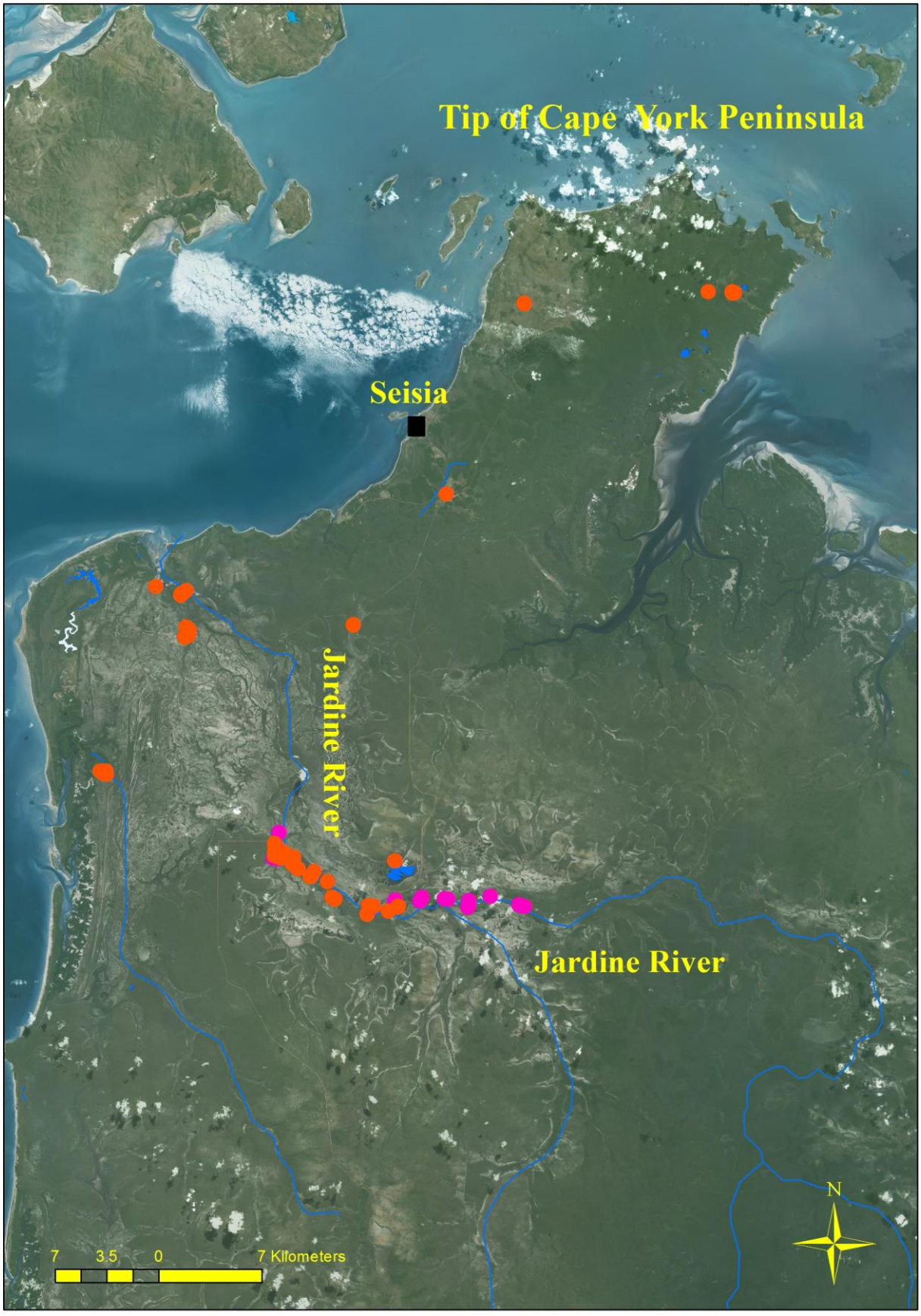

Figure 1. Sites surveyed for Jardine River Turtle.
Red dots: sites surveyed in August 2014. Purple dots: sites surveyed in October 2015.

Figure 2. Examining estuarine crocodile damage to turtle trap.
Photo: John Cann.

period of 10 days for a total of 40 trap nights (4-14 September 2014). Only two of the four sites were revisited due to logistical difficulties accessing the other two sites. In October 2015 this was repeated with these two sites being revisited with the same number of traps being set for four nights.

For each animal captured during the monitoring, the following measurements were taken: head length (HL), head width (HW), straight carapace length (SCL) and width (SCW), plastron length (PL) and width (PW) and tail to carapace edge (TCL). These were measured to the nearest millimetre using vernier callipers. Weight was measured to the nearest gram using a digital balance. All females captured were palpated to ascertain if they were gravid. Turtles were individually scute notched and flipper tagged and an injectable PIT tag was inserted under the left anterior carapace as illustrated in Hamann *et al*. (2007).

Samples were also taken for DNA analysis, with two slivers of tissue (approx. 3x1mm in length) collected from the rear flippers of 16 turtles. One set was sent to University of Canberra researchers the other was lodged with the Queensland Museum. This material will be used to help clarify the taxonomic relationships within northern Australia *Emydura* turtles. This research will potentially have significant implications for the conservation management of this turtle in Australia. Once all data collection was completed, turtles were released at the site of capture.

External damage to limbs, carapace, plastron and head was recorded for each individual. Turtles were then classified into one of three broad damage categories using the following classification scheme (Table 1).

Table 1. Definitions of broad damage categories allocated to each turtle.

No damage (does not include normal "wear and tear")
No more than minor scratches on carapace and\or plastron
No damage to limbs, claws or head.
Chips on marginal scales small <0.5cm in depth and <0.5cm in width
Minor damage Turtles with one or more of the following:
Major scratches on carapace and\or plastron (can include mating scratches on female carapace)
Minor damage to limbs and\or loss of one or more claws and\or minor damage to head
Chips on marginal scales >0.5cm in depth and > 0.5cm in width but no larger than a single scale in overall size
Major damage Turtles with one or more of the following:
Major scratches and\or healed or unhealed factures on carapace and\or plastron
Major damage to and\or loss of limbs, major damage to head
Chips on marginal scales larger than single scales

Results

Survey results

Over the course of the survey in August 2014 of a total of 38 turtle captures, 26 of which were Jardine River Turtles (Figs. 3 & 4), three were Saw Shells (*Wollumbinia latisternum*) and three were Northern Long- neck (*Chelodina oblonga*). The

Figure 3. Large female Jardine River Turtle from the northern tip of Cape York Peninsula.
It was captured during the September 2014 monitoring. Photo: Alastair Freeman.

Figure 4. Male Jardine River Turtle from the northern tip of Cape York Peninsula.
It was captured during the September 2014 monitoring. Photo: Alastair Freeman.

number of Jardine River Turtles captured at each of the four sites during the August surveys varied considerably with 21 (81%) turtles being captured at one site, three (12%) at another and one at each of the other two sites (8%). All four sites were off river waterholes and swamps (Table 2).

In October 2015 no turtles were captured at any of the survey sites visited all of which were off-river waterholes or swamps. One individual Jardine River Turtle was sighted at one site but was not captured in a trap. The surveys during this time were impacted by the very dry conditions prevalent. Five sites that had been identified as suitable in June of 2015 were completely dry with no traps being set.

Monitoring results

Monitoring in September 2014 concentrated on the two sites (JWH1 and JWH2 – Table 2) where most of the turtle had been captured during the August surveys. Over the course of 20 trap nights a total of 25 individuals were captured, 22 (88%) of which were caught at JWH1. Of these 22 individuals eight were recaptured once and two were recaptured twice during the course of the monitoring. There were no recaptures at JWH2. In October 2015 monitoring concentrated on the same two sites as in 2014 however, the results were considerably different. Waterhole JWH2 was completely dry with no traps set, JWH1 had 2 traps set for 4 nights with limited success. A total of four turtles were captured one of which was recaptured over the course of the monitoring. Of the five captures of four Jardine River Turtles at WH1 in 2015, one of these was a new unmarked individual and three were previously caught in 2014 at the same site. One turtle was re-caught during the course of the trapping. A comparison of capture rates between 2014 and 2015 for WH1 shows that in 2014 3.2 turtles were captured per night per trap as opposed to 0.6 in 2015.

Table 2. Habitat descriptions for the four sites where Jardine River Turtles were captured.

		No. of Jardine River Turtles captured		
Site	**Description**	**Aug. 2014**	**Sept. 2014**	**Oct. 2015**
JWH1	Discrete, clear water deep waterhole (>1.6m). *Melaleuca* sp. distributed around edge, shallow areas with *Eleocharis sphacelata* (tall spike rush), Clearwater in deeper (>1m) parts of the waterhole. Thick bottom layer of algae in clear water areas. Recent fire scars evident on trees standing in water. Moderate levels of pig damage evident in 2014 and 2015 around edge. Still with good area of water in October 2015.	21	22	4
JWH2	Shallow (<50cm in depth) treed swamp with thick coverage of *Melaleuca* sp. and *Barringtonia acutangula* (freshwater mangrove). Recent fire scars evident on trees standing in water. In October 2015 this site had no water.	3	3	0
JWH3	Narrow waterhole 30X10m in size part of a chain of waterholes. Surrounded in parts by the native sedge *Lepironia articulate* and paperbarks (*Malaleuca* sp.). In October 2015 this waterhole had been reduced to a shallow pool (<40cm in depth) of stagnant water with significant pig damage around fringes.	1	no traps set	0
JWH4	Thin oxbow/channel 10m wide very long, part of chain of waterholes Surrounded in parts by the native sedge *Lepironia articulate* and paperbarks (*Malaleuca* sp.). Scattered water lilies (*Nymphaea* sp.) on surface. In October 2015 this waterhole had been reduced to a shallow pool (<40cm in depth) of stagnant water with significant pig damage around fringes.	1	no traps set	0

Based on the ratio of tail length to SCL over the two years of monitoring sixteen Jardine River Turtles were identified as female and ten male (Fig. 5).

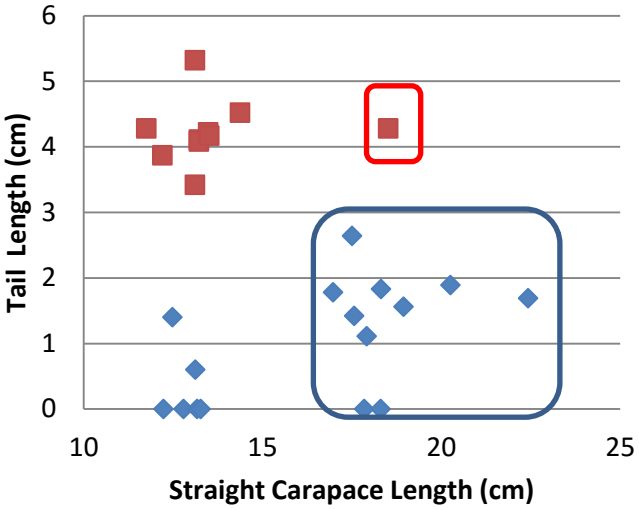

Figure 5. Relationship between carapace and tail length as an indicator of gender.
Red - male; blue – female. Includes all individuals captured in 2014 and 2015 (n=26) excluding recaptures. Adults indicated by polygons, based on a Straight Carapace Length of at least 15 cm (Georges *et al.* 2006).

Mean SCL and weight of males was smaller than that of the females captured (Tables 3 & 4). There was a bias towards females, with female captures exceeding males by a ratio of 1.7:1, however the small sample sizes preclude any statistical analysis.

In 2014 two of the female turtles captured were gravid, one had a SCL of 18.31 cm the other 20.25 cm. No gravid females were captured in 2015. In Jardine River Turtles from Papua New Guinea sexual maturity in both males and females is reached at a carapace length of 14-15 cm (Georges *et al*. 2006). If we assume this is the same in the northern Australia population ten of the 16 females measured (Fig. 5; Table 5) and one of the nine males captured were adult (Fig. 5). We review this point in the discussion.

The only adult male that was measured had a SCL of 18.51 cm.

The current dataset indicates that there are gaps in the population structure with certain age classes not represented at all in the capture statistics (Fig. 5). For example, no turtles with a SCL smaller than 11.75 cm SCL, no female with a SCL between 13.27 cm and 16.97 cm and no males with a SCL between 14.37 cm and 18.51 cm were recorded.

Table 3. Summary statistics for Straight Carapace Length (in cm) by gender for all Jardine River Turtles measured in 2014 and 2015.
Recaptured individuals are not included.

	Mean	Max.	Min.	SD
Male (n=10)	13.65	18.51	11.75	1.85
Female (n=16)	16.44	22.42	12.23	3.15

Table 4. Summary statistics for weight (in g) by gender for all Jardine River Turtles measured in 2014 and 2015.
Recaptured individuals are not included.

	Mean	Max.	Min.	SD
Male (n=10)	312.7	1000.0	175.0	244.07
Female (n=16)	538.4	1115.0	190.0	302.9

Table 5. Summary statistics for Straight Carapace Length (in cm) of adult female Jardine River Turtles measured in 2014 and 2015.
Recaptured individuals are not included.

	Mean	Max.	Min.	SD
Female (n=10)	18.60	22.42	16.97	1.62

No turtle captured suffered from major damage with 21 individuals classified as having “minor” damage and five; “none”. Sixty five percent (n=17) of the turtles measured had fresh shell rot infections in small or moderate amounts on their carapace while a further five showed healed scarring from the condition (Fig. 6).

Habitat

In 2014 all four sites where the Jardine River Turtle were caught were off river waterholes. However, between the different sites there was significant variation in habitat (Table 2; and see Figs. 7-9).

Two of the waterholes (JWH 1 and JWH 2) had no connection to the main channel of the Jardine River but would be connected to the river during the monsoonal wet season. In 2015 one individual was sighted up Pack Saddle Creek in a small wetland area adjacent to the creek.

Figure 6. Healed shell rot scars on Jardine River Turtle.
Photo: Alastair Freeman.

Discussion

Observations made during the August 2014 and October 2015 surveys support the view that the Jardine River Turtle is extremely rare in Australia. The current surveys located this turtle at only five sites despite searches through the lower and middle reaches of the Jardine River, surrounding swamps and waterholes. Two sites (JWH3 and JWH4) were off river waterholes associated with drainage channels that would connect to the Jardine River during the monsoonal wet season; one site (JWH2) was a shallow treed swamp off river and one site was associated with a perennial creek that feeds into the Jardine River. The most important site from which the vast majority of Jardine River Turtles have been captured is a distinct waterhole with clear, moderately deep water which may be connected to the main channel of the river during the wet season for short periods of time. In October 2015 this was also the site that retained the most water and was still in relatively good condition when compared to the three other known sites from 2014.

Overall the habitat where Jardine River Turtles were recorded was not dissimilar to that which had been recorded for this turtle in New Guinea, where they have been observed in "... shallow lentic ponds ..." (Rhodin 1993, p. 47) and "... seasonally inundated wetlands ..." (Georges *et al*. 2006, p. 378) and also matches the description of the habitat where the first Jardine River Turtle was discovered in 1972 in Australia of a "... small, shallow, temporary lagoon …" (Covacevich *et al*. 1982, p. 286). Some years later the same lagoon was trapped by researchers who failed to catch any turtle (Cann 1998) which is indicative that these dry season habitats are at times ephemeral. This is supported by the presence of submerged *Melaleuca* in these waterholes. While paperbarks can live for months and even years with submerged roots they do require dry periods to survive and for seedlings to germinate (Romanowski 2013). In 2015 the seasonal rainfall recorded on the tip of Cape York in both winter and spring was below average (Australian Bureau of Meteorology). In response to these conditions one of the known sites from 2014 was completely dried out (Fig. 9) while a further two of the four known sites were reduced to shallow pools of stagnant water. All the sites where Jardine River Turtles were recorded also had damage attributable to feral pigs.

Despite being common in the Jardine River and surrounding wetlands, there were no estuarine crocodiles (*Crocodylus porosus*) present at two of the four sites where the Jardine River Turtle occurred, including JWH1 the site where the vast majority of all captures occurred. This was confirmed through spotlighting, daytime observation and the absence of sign (e.g. slides). The presence or absence of these known turtle predators may be an important factor in whether individual turtles can survive the dry season in these off river refugia. Other than those turtles captured in 1972 in a shallow lagoon, previous successful surveys during the dry season have tended to catch or observe this turtle in the main channel or in waterholes directly connected to the main channel, however never in numbers of more than one or two individuals. The availability of off river, crocodile-free waterholes that do not dry out may be an important habitat feature for this turtle in northern Australia during the dry season. The idea that it is the isolated off river waterholes that are most important for this turtle during the dry season contrasts with previous observations that suggested the Jardine River Turtles move back into the main channel of the river during the dry season (Cann 1998; Schaffer *et al*. 2009). In reality it is probably a combination of both with some individuals moving back in to the river while others congregate in off river water holes during the dry season. Furthermore some individuals may

Figure 7. Waterhole JWH 1 in September 2014.
Note *Melaleuca* sp. around the edge and spike rush in the centre. The depth of the open water in the foreground had prevented expansion of the spike rush into this part of the waterhole.
Photo: Alastair Freeman.

Figure 8. Waterhole JWH 2 in September 2014.
This is a shallow water swamp with little open water, most of the swamp area being occupied by *Melaleuca* sp. and *Barringtonia acutangula.* A turtle trap can be seen in the centre of the picture.
Photo: Alastair Freeman.

Figure 9. Waterhole JWH 2 in October 2015 showing the trap site that was used in the previous year's fieldwork (see Fig. 8).
Photo: Alastair Freeman.

aestivate. This strategy commonly recorded in some species of Australian long neck turtle has also been observed. although rarely, in some Australian short neck species (Cann 1998) and cannot be completely dismissed as a coping strategy for Jardine River Turtles remaining in dried out waterholes and swamps. In October 2015 intensive searches of JWH2 (Fig. 9) failed to find any sign of aestivating turtles. While the relative importance of any of these strategies to the population as a whole is currently unknown it does have significant ramifications for the conservation management of the species and should be investigated further. In particular telemetry studies that help to establish habitat use and patterns of movement for this species should be seen as a research priority.

During the wet season adjacent water holes are re-connected to the main channel of the river and the turtles can potentially range widely through the river system. In February 2015 after a significant flood event in the area one of the marked turtles was observed 450 m from WH1 and just over one kilometre from WH2 immediately adjacent to the main channel of the river on land (Sebasio pers. obs.). In Papua New Guinea, this species has also been recorded in estuarine areas as well as freshwater swamps (Carla Eisemberg pers. comm.). Whether turtles from the Jardine River do the same is unknown although trapping at the very lower reaches of the river carried out during the current survey failed to uncover any.

The maximum observed size for females at 22.42 cm SCL was less than that recorded for Papua New Guinea females (Georges *et al*. 2006) but very similar to that recorded previously for the northern Australian Jardine River Turtles (Cann 1998). At 18.51 cm SCL, the only adult male captured was larger than any previously measured male Jardine River Turtle in New Guinea (Georges *et al*. 2006). For the purposes of the present analysis we have taken the size at maturity (14-15 cm carapace length) recorded from dissected turtles collected in Papua New Guinea (Georges *et al*. 2006), however, the long tail lengths recorded in smaller males in the present study do suggest that the northern Australia turtles may reach maturity at a smaller carapace length (<12 cm SCL). However, without access to dead turtles for dissection or the means to carry out internal examination of reproductive organs this is speculation.

The limited amount of population data collected indicates that the Australian population of the Jardine River Turtle may not successfully reproduce every year with gaps in size (age) classes indicative of these unsuccessful years. The reason that this may occur is currently unknown, it may be related to environmental conditions such as the impact on dry season refugia of particularly severe drought years or high levels of nest predation. Trapping is also not the most effective method for catching the very smallest size classes (AB Freeman pers. obs.) in turtles so may be underestimating the presence of this age group. Although the presence of only two gravid individuals out of a total of 10 adult females in August 2014, none in 2015 and no signs of nesting or indication that nesting had taken place at WH1 and WH2 in 2014 or WH1 In 2015 may mean that there has been a lack of successful nesting taking place in the area.

Despite residing in an environment with large predators of turtles and subject to seasonal flooding none of the turtles that were captured had significant levels of external damage. Many of the turtles captured did have a form of "shell rot" as well as having many healed scars indicative of past infections. Such an infection can be bacterial or fungal and maybe related to poor water quality, diet and/or stress all of which may be issues for turtles forced to congregate in dry season refugia. While it was commonly observed in the turtles during the current surveys it is probably not a significant threat. The turtles had long healed shell rot scars which would indicate that this is not a one off occurrence and indeed maybe a regular condition in dry season refugia.

Conservation issues and management

Three main threats to Jardine River Turtles in Australia were identified.

Feral pigs

Feral Pigs (*Sus scrofa*) are a major threat to successful nesting in turtles, both marine and freshwater (Cann 1998; Environment Australia 2003; Doherty 2005; Fordham *et al*. 2006). Such predation can result in an adult biased population structure with the smallest cohorts being underrepresented in surveys and hence amongst turtles captured for measuring, as was seen in the current surveys. Recent feral pig digging was also apparent adjacent to the waterholes where the

Jardine River Turtles were recorded although there was no sign of predated nests in 2014 and 2015

Currently, a limited level of pig control using hunting with dogs is implemented by Apudthama Land and Sea rangers at the two most important sites for the turtle (JWH1 and 2). This current *ad hoc* hunting should be expanded into a more integrated program using a variety of techniques. It may be necessary to use a combination of baiting, trapping, ground and aerial shooting to achieve the appropriate level of control. Such a program should target known dry season refugia during the nesting season (September to November). Fencing important waterhole habitats is also an option for pig control. However, because of monsoonal flooding such fencing should be temporary, designed so that it can be easily assembled at the start of the dry season and disassembled at the end. This is particularly important as we currently have no idea of the Jardine River Turtle's patterns of movement within the wider riverine system over the wet season, until this is known permanent fencing should be avoided. Recent research has identified significant freshwater turtle mortality associated with management fences. Ferronato *et al*. (2014) documented direct and indirect mortality to Snake-necked Turtles (*C. longicollis*) that became trapped behind a management fence when trying to disperse between wetlands subsequently dying from overheating and predation. The Northern Long-neck that occurs at two of the four Jardine River Turtle sites is known to make similar dispersal journeys between wetlands (Cann 1998).

Poaching

This turtle is popular in the pet trade in Australia because of its distinctive pattern and colouration. Initially the demand for this turtle was met with animals sourced from West Papua/Irian Jaya. Today the Australian captive population is thought to be entirely of New Guinea origin although turtles are no longer imported from there and the demand for captive Jardine River Turtles is meet by Australian breeders. Poaching of turtles for the pet trade has been identified as a potential threat although, as yet, the level of threat (if at all) is unknown. However, with such a small known population the removal of even a small number of individuals from the wild is potentially a significant threat. A program of regular patrols by Apudthama Land and Sea rangers of sites that have this turtle should be instigated particularly during the main tourist season in the region which takes place over the dry season (June to September).

Climate Change?

Observations from this work would indicate that dry season, off river refugia may be important to this species. These refugia by their very nature are likely to be ephemeral with the length of time they retain water dependent on the length and intensity of the dry season. Climate change modelling predicts that the climate of northern Cape York will be subject to more frequent and intense drought conditions with potential evaporation increasing 7 to 14% by 2070 (Queensland Government 2009). Such conditions will reduce amount of dry season refugia available to the Jardine River Turtles as the number of ephemeral waterholes that can retain water in any given dry season is reduced. In October 2015 below average rainfall had resulted in least one of the four known Jardine River Turtle sites found in 2014 to be completely dried out (Fig. 9) and reduced two others to small stagnant pools.

Monitoring of known dry season refugia may be needed and if widespread drought conditions are occurring, direct translocation of individual turtles from waterholes that are drying up to more substantive bodies of water may be necessary. However, as our understanding of the ecology of this species is poor and the impact of translocation on individual turtles unknown, such a management option should only be considered as a last resort.

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