

# Clarification of field characters for three freshwater sharks and a photographic atlas of *Glyphis glyphis* and *G. garricki* from the Adelaide River, Northern Territory, Australia

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## ABSTRACT

Eighty-two *Glyphis glyphis*, one *G. garricki* and two *Carcharhinus leucas* were caught at six localities in the Adelaide River on 66 gill-netting trips from mid-May to mid-December during 2001, 2003–05 and 2009. Photographs are presented that differentiate these euryhaline sharks. The small second dorsal fin of *C. leucas* clearly separates it from *Glyphis* species. The waterline (i.e. junction of dark dorsal and pale ventral colouration) on *G. glyphis* extends just under the eye whereas it extends well below the lower margin of the eye in *G. garricki*. Photographs showing shark bite marks on other species are presented. Because of the presence of *G. glyphis* under 610 mm TL with umbilical scars, it is postulated that Marrakai Creek is a nursery area and an important juvenile habitat of this species especially from September–December.

KEYWORDS: Adelaide River, Bull Shark, Northern River Shark, Speartooth Shark, *Carcharhinus leucas*, *Glyphis garricki*, *Glyphis glyphis*.

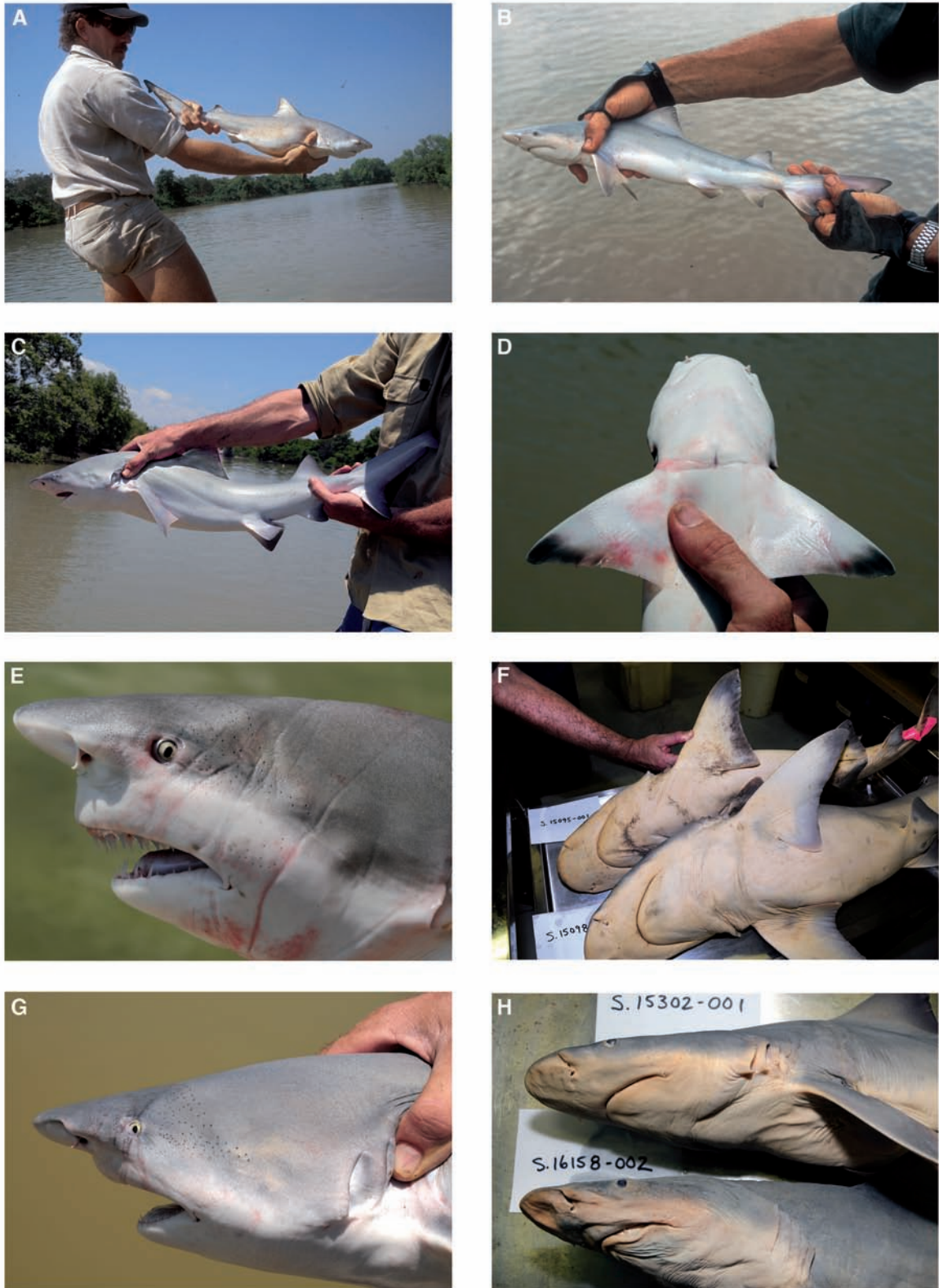
## INTRODUCTION

Thirty-one of the 54 known species of whaler sharks (family Carcharhinidae) are found in Australia and three of these can occur far up rivers well into fresh water (Last & Stevens 2009). Prior to the commencement of Nurseryfish (*Kurtus gulliveri*) life history studies in 2001 (Berra 2003; Berra *et al.* 2007 and papers cited therein), the Speartooth Shark (*Glyphis* sp. A) and the Northern River Shark (*Glyphis* sp. C) (Last & Stevens 1994) were undocumented from the Adelaide River. *Glyphis* sp. A was subsequently determined to be conspecific with *Glyphis glyphis* (Müller & Henle, 1839) and *Glyphis* sp. C was described as a new species, *G. garricki* (Compagno, White & Last, 2008). DNA barcoding, based on mitochondrial cytochrome oxidase I gene (cox 1) sequences supported the taxonomic placement and separation of the two species of *Glyphis* (Wynen *et al.* 2009).

The cosmopolitan Bull Shark, *Carcharhinus leucas* (Müller & Henle, 1839) (Fig. 1A), is known from many of Australia's northern rivers including the Ord, Daly, Adelaide, and East Alligator (Berra 2007; Last & Stevens 2009). *Carcharhinus amboinensis* (Müller & Henle, 1839) is morphologically very similar to the Bull Shark, but much less likely to be found upstream in fresh water (Last & Stevens 2009). The extent of Speartooth Shark, *G. glyphis* (Fig. 1B), distribution is unknown, but it has been taken from

the Alligator Rivers of the Northern Territory in addition to the Adelaide River, as well as from the Bizant and Wenlock Rivers of Queensland and the Fly River in southern New Guinea (Peverell *et al.* 2006; Compagno *et al.* 2008; Pillans *et al.* 2009). The Northern River Shark, *Glyphis garricki* (Fig. 1C), has an uncertain distribution in parts of southern New Guinea and northern Australia including the entrance to Cambridge Gulf, King Sound, Ord River and Doctors Creek in Western Australia, and the Adelaide, East, and South Alligator Rivers in the Northern Territory (Thorburn & Morgan 2004; Compagno *et al.* 2008; Pillans *et al.* 2009).

Compagno *et al.* (2008) recognised five species of *Glyphis*: *G. gangeticus*, *G. glyphis*, *G. siamensis*, *G. garricki*, and an undescribed species from Borneo (*Glyphis* sp. B). The latter has recently been described as *G. fowlerae* (Compagno *et al.* 2010). Compagno *et al.* (2008) provided a comprehensive review of *G. glyphis*, described *G. garricki* and listed many internal and external taxonomic characteristics that distinguish the species. However, a few published characters used to distinguish *G. glyphis* from *G. garricki* are problematical to apply in the field in some cases (Compagno *et al.* 2005, 2008; Last & Stevens 2009; Wynen *et al.* 2009). The purposes of this paper are to clearly state and illustrate how to distinguish the shark species likely to be found in fresh water in the Adelaide River using only field characters on living specimens and to present a record of photographs of *Glyphis*.



**Fig. 1.** Sharks from freshwater reaches of Northern Territory rivers: **A**, *Carcharhinus leucas* (Bull Shark), Beatrice Creek, Adelaide River, 27 July 2001, released; **B**, *Glyphis glyphis* (Speartooth Shark), Adelaide River, 7.2 km downstream from boat ramp, 17 October 2003, released; **C**, *Glyphis garricki* (Northern River Shark), Marrakai Creek, Adelaide River, 26 October 2009, released; **D**, *Glyphis glyphis*, Marrakai Creek, Adelaide River, 26 October 2009, released. Note umbilical scar and black tips of ventral surface of pectoral fins; **E**, *Glyphis glyphis*, Marrakai Creek, Adelaide River, 26 October 2009, released. Note elongate, smooth lower jaw teeth, pointed snout and position of waterline at eye; **F**, Top, *Glyphis glyphis* (S. 15095-001) West Alligator River, 1 June, 1999. Bottom, *Glyphis garricki* (S. 15098-001), Smith's Landing, East Alligator River, 10 June, 1999. Note dark pigment on the ventral surface of the pectoral fins of both species and the position of the waterline on the ventral aspect of the head; **G**, *Glyphis garricki*, Marrakai Creek, Adelaide River, 26 October 2009, 930 mm TL, released. Note the waterline (grey pigment) well below the lower eye margin. Compare to **E**; **H**, *Glyphis garricki* (S. 15302-001) Cooper Creek, East Alligator River, 25 February 2001; (S. 16158-002) Adelaide River, 27 February 2004. Note waterline well below the lower eye margin in preserved specimens. All photographs: author.

## METHODS

Four and five inch mesh (101–127 mm) monofilament gill nets were set, usually on rising neap tides, on 66 occasions at localities in the Adelaide River (Fig. 2) and its tributaries in various months of the dry season during 2001 (27 trips May–November), 2003 (17 trips October–November), 2004 (9 trips July–August), 2005 (9 trips November–December), and 2009 (4 trips September–October). Since Nurseryfish were the object of the study, sharks were generally counted, sometimes photographed, and immediately released alive without sexing or precise measurement. Marrakai Creek ( $12^{\circ}40.86'S$ ,  $131^{\circ}20.1'E$ ) was the most commonly sampled locality since it consistently yielded Nurseryfish. Sharks were netted as by-catch. Three male and two female *G. glyphis* were deposited in the Museum and Art Gallery of the Northern Territory, Darwin (NTM). Their registration numbers are S.15304-001, S.15305-001, S.15351-001, S.16262-001 and S.16255-001. Four additional specimens of *G. glyphis* (S.15095-001, S.15299-001, S.15301-001, S.15303-001) and four specimens of *G. garricki* (S.15098-001, S.15302-001, S.16158-001, -002) at the NTM were also examined and photographed.

## RESULTS

Eighty-two *Glyphis glyphis*, one *G. garricki* (930 mm TL) and two *Carcharhinus leucas* were netted at six localities (Fig. 2). The total length (TL) of *G. glyphis* specimens that were measured ranged from 540 to 1010 mm. Three live specimens of *G. glyphis* were taken to the aquarium at the Territory Wildlife Park. They survived the month-long quarantine period in approx. 7 ppt brackish water, but died when transferred to completely fresh water. The vast majority of the netted *G. glyphis* were smaller than 1 m TL. The largest specimen was estimated at less than 2 m TL. Other estimated specimens include one approx. 1300 mm TL, and five were approx. 1 m TL. Umbilical scars were present on the smallest specimens 540–610 mm TL (Fig. 1D). During the 2009 Nurseryfish collections, six *G. glyphis* (4F: 2M) 760–1010 mm TL were tagged as part of the “Estimating fishing-related mortality and designing sustainable management protocols for shark fisheries in Northern Australia” by Northern Territory Fisheries (Department of Resources). To date, 12 *Glyphis* have been tagged, and no recaptures have been recorded as of July 2010 (Grant Johnson pers. comm.).

Interestingly, the two *G. glyphis* taken from the lower reaches of the Adelaide River at E and F Creeks (Fig. 2) were caught on 18 May 2001. In spite of 15 subsequent netting trips from 29 May through 30 August, no *Glyphis* were taken upstream in Marrakai Creek until 11 September 2001. A total of four *G. glyphis* were taken in September, 22 in October, 35 in November and 19 in December of all years. The single *G. garricki* was caught on 26 October

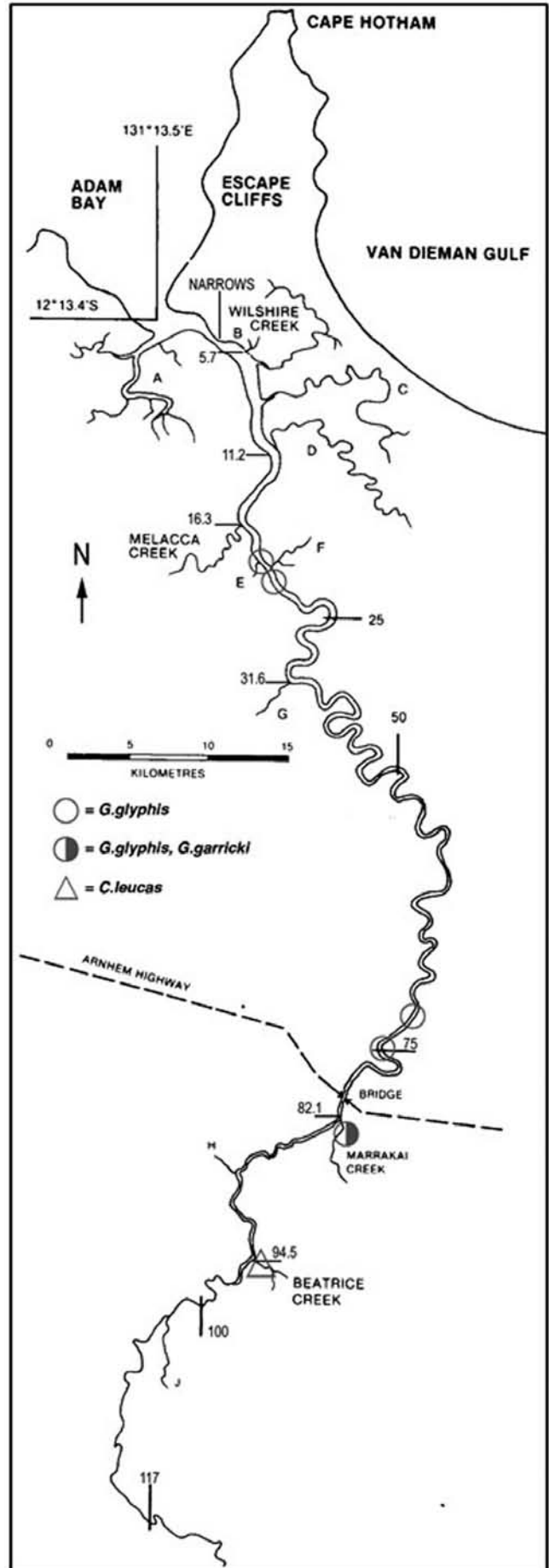


Fig 2. Map of Adelaide River showing location of collections.

2009 and the two Bull Sharks were caught at Beatrice Creek (Fig. 2) on 27 July 2001.

*Glyphis* can be distinguished from the Bull Shark by the large size of the second dorsal fin of *Glyphis* relative to the first dorsal fin (Last & Stevens 2009) (Fig. 1A–C). The height of the second dorsal fin of *Glyphis* is at least half the height of the first dorsal fin, whereas in the Bull Shark, the second dorsal fin is only one-third as high as the first dorsal fin. *Glyphis* caught in the Adelaide River are relatively sleek and silvery-grey with a bright white ventral surface, whereas Bull Sharks tend to be more robust-bodied and brownish grey (Figs 1A–C). The *Glyphis* snout is slightly pointed (Fig. 1E), as opposed to the bluntly rounded snout of Bull Sharks, and the eye of *Glyphis* is smaller than the eye of a similar sized Bull Shark (Peverell *et al.* 2006). The lower jaw teeth of *Glyphis* are smooth and narrow, hence the vernacular name “spartooth” (Fig. 1E), whereas Bull Sharks have serrated, triangular, stout lower jaw teeth (Last & Stevens 2009).

The most useful field character for separating *G. glyphis* from *G. garricki* is the relationship between the waterline (i.e. the junction of dark and light or dorsal and ventral colour delineation) and the eye (Compagno *et al.* 2008). In *G. glyphis* the waterline is at the lower margin of the eye (Fig. 1B,E) and is not visible in a ventral view of the head (Fig. 1F). In *G. garricki* the waterline extends well below the lower margin of the eye by at least an eye diameter (Fig. 1G), and is visible in a ventral view of the head (Fig. 1F). This character is visible in life and persists in preserved specimens (Fig. 1H). However, the colour paintings in Compagno *et al.*'s (2005) field guide show the waterline of *G. garricki* (G. sp. C) and *G. glyphis* (G. sp. A) as identical. Drawings in more recent publications have corrected this inaccuracy (Compagno *et al.* 2008).

Compagno *et al.* (2008) and Last & Stevens (2009), stated that *G. glyphis* has a black blotch at the ventral tip of the pectoral fin and that *G. garricki* lacks this blotch. Wynen *et al.* (2009: Table 2) erroneously reversed this characteristic. The living and preserved specimens of *G. glyphis* I have observed from the Adelaide River definitely have a black blotch at the distal end of the ventral aspect of the pectoral fin (Fig. 1D). However, the one living and four preserved specimens of *G. garricki* examined also have dusky pigment on the apex of the ventral pectoral fin (Fig. 1F, bottom). It is not quite as dark as on *G. glyphis* (Fig. 1, top), but this distinction may be too subtle to be applied in the field.

Shark predation is a fact of life faced by fishes in the freshwater reaches of the Adelaide River. Figure 3 shows damage probably inflicted by *Glyphis* on several species. It is not possible to determine if the bites occurred while the specimens were trapped in the gill net, or if the fish

became trapped after being bitten. However, the former seems most likely.

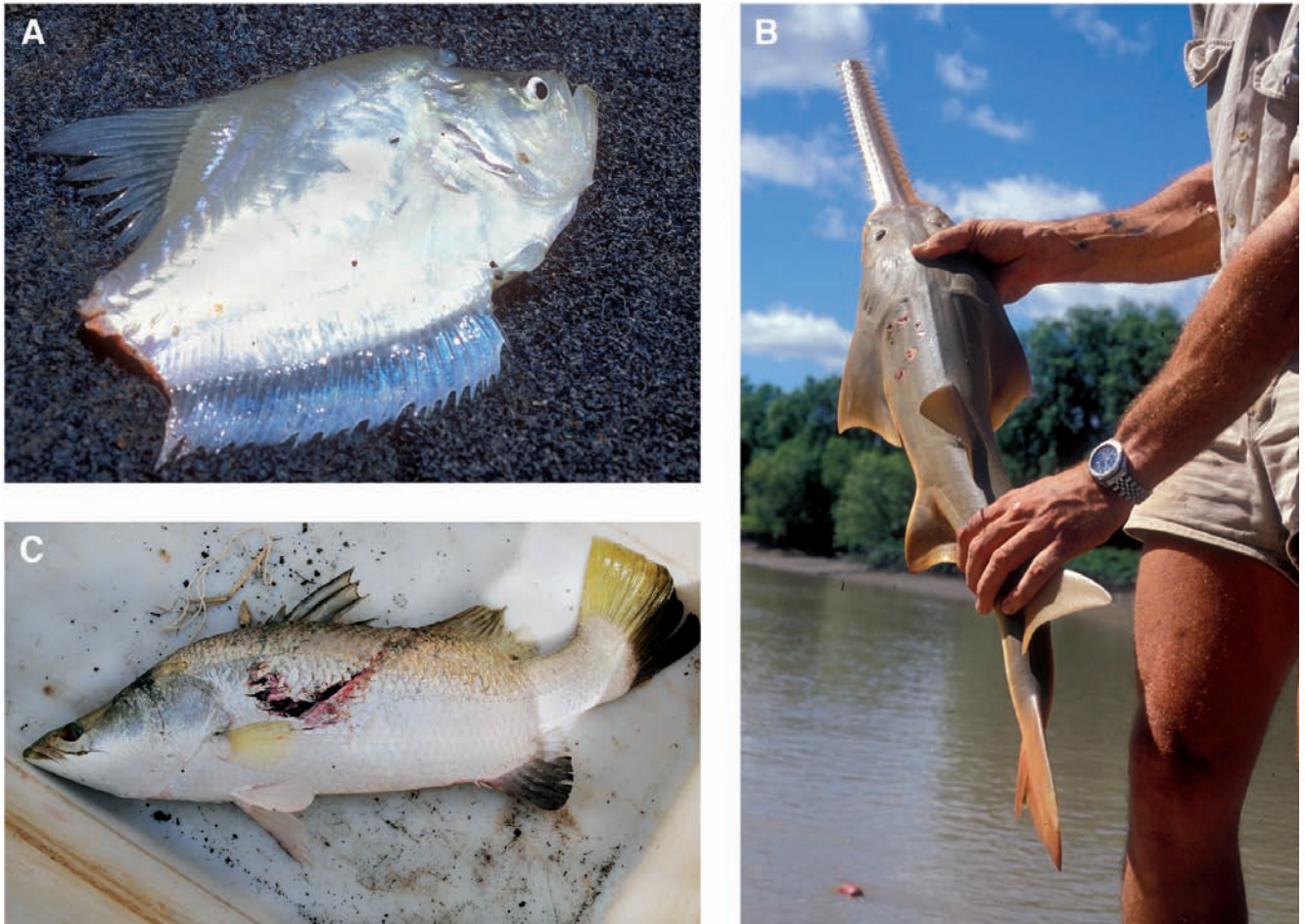
SIMPLIFIED KEY TO THE SHARK SPECIES IN FRESH WATER IN THE ADELAIDE RIVER

- 1a. Second dorsal fin approx. one-third height of first dorsal fin; lower jaw teeth triangular and serrated ...  
.....*Carcharhinus leucas* (Bull Shark)
- 1b. Second dorsal fin approx. one-half height of first dorsal fin; lower jaw teeth elongate and smooth ..... 2
- 2a. Waterline extends just below ventral edge of eye; waterline pigment not visible in ventral view .....  
..... *Glyphis glyphis* (Spartooth Shark)
- 2b. Waterline extends at least one eye diameter below ventral edge of eye; waterline pigment visible in ventral view .....  
..... *Glyphis garricki* (Northern River Shark)

DISCUSSION

Although little is known of the biology of *Glyphis glyphis*, it is relatively common in the Adelaide River and easily distinguished from the Bull Shark. It occurs sympatrically with its less common congener *G. garricki*, from which it can be distinguished by the location of the waterline relative to the eye. On 26 October 2009, 3.25 hours of netting produced 11 *G. glyphis* and one *G. garricki*. Although the author cannot rule out the possibility that a specimen might have been captured more than once, this seems to approximate the perception of their relative occurrence. The numerical tagging program begun by Northern Territory Fisheries (Department of Resources) will hopefully lead to a greater understanding of the movements and life history of both species of *Glyphis*, subjects addressed by Pillans *et al.* (2009).

Since many of the small *G. glyphis* bore umbilical scars and were under 610 mm TL it is likely that Marrakai Creek is a nursery ground as well as an important juvenile habitat for this species. The months of September to December appear to be the time of their greatest abundance in Marrakai Creek, however, field work in the wet season (January–April) is nearly impossible there. Thorburn & Rowland (2008) demonstrated that the rivers of northern Australia act as nurseries for juvenile Bull Sharks, *C. leucas*. Although the specimens caught in the Adelaide River were only small due to the gill net mesh size, on 8 December 2005 nine *Glyphis* were netted in 2.5 hours and one was estimated at 2 m. When the net was lifted, only the head was visible and it quickly tore through the net and submerged.



**Fig. 3.** Shark bites: **A**, *Kurtus gulliveri* (Nurseryfish), Marrakai Creek, Adelaide River, 24 November 2005; **B**, *Pristis microdon* (Freshwater Sawfish) Marrakai Creek, 15 June 2001, released. Note crescent-shaped bite above left pectoral fin; **C**, *Lates calcarifer* (Barramundi), Marrakai Creek, 29 September, 2009. All photographs: author.

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#### REFERENCES

- Berra, T.M. 2003. Nurseryfish, *Kurtus gulliveri* (Perciformes: Kurtidae), from northern Australia: redescription, distribution, egg mass, and comparison with *K. indicus* from southeast Asia. *Ichthyological Exploration of Freshwaters* **14**: 295–306.
- Berra, T.M. 2007. *Freshwater fish distribution*. University of Chicago Press: Chicago.
- Berra, T.M., Gomelsky, B., Thompson, B.A. & Wedd, D. 2007. Reproductive anatomy, gonad development and spawning seasonality of nurseryfish, *Kurtus gulliveri* (Perciformes: Kurtidae). *Australian Journal of Zoology* **55**: 211–217.
- Compagno, L., Dando, M. & Fowler, S. 2005. *Sharks of the world*. Princeton University Press: Princeton, New Jersey.
- Compagno, L.J.V., White, W.T. & Last, P.R. 2008. *Glyphis garricki* sp. nov., a new species of river shark (Carcharhiniformes: Carcharinidae) from northern Australia and Papua New Guinea, with a redescription of *Glyphis glyphis* (Müller & Henle, 1839). Pp. 203–225. In: Last, P.R., White, W.T. & Pogonoski, J.J. (eds). *Descriptions of new Australian chondrichthyans*. CSIRO Marine and Atmospheric Research Paper No. 22.
- Compagno, L.J.V., White, W.T. & Cavanagh, R.D. 2010. *Glyphis fowlerae* sp. nov., a new species of river shark (Carcharhiniformes; Carcharinidae) from northeastern Borneo. Pp. 29–44. In: P.R. Last, P.R., White, W.T. & Pogonoski, J.J. (eds) *Description of new sharks and rays from Borneo*. CSIRO Marine and Atmospheric Research paper 032. 165 pp.

- Last, P.R. & Stevens, J.D. 1994. *Sharks and rays of Australia*. CSIRO Publishing: Melbourne.
- Last, P.R. & Stevens, J.D. 2009. *Sharks and rays of Australia*. 2nd ed. CSIRO Publishing: Melbourne.
- Peverell, S.C., McPherson, G.R., Garrett, R.N. & Gribble, N.A. 2006. New records of the river shark *Glyphis* (Carcharhinidae) reported from Cape York Peninsula, northern Australia. *Zootaxa* **1233**: 53–68.
- Pillans, R.D., Stevens, J.D., Kyne, P.M. & Salini, J. 2009. Observations on the distribution, biology, short-term movements and habitat requirements of river sharks *Glyphis* spp. in northern Australia. *Endangered Species Research* **10**: 321–332.
- Thorburn, D.C. & Morgan, D.L. 2004. The northern river shark *Glyphis* sp. C (Carcharhinidae) discovered in Western Australia. *Zootaxa* **685**: 1–8.
- Thorburn, D.C. & Rowland, A.J. 2008. Juvenile bull sharks *Carcharhinus leucas* (Valenciennes, 1839) in northern Australian rivers. *The Beagle: Records of the Museums and Art Galleries of the Northern Territory* **24**: 79–86.
- Wynen, L., Larson, H., Thorburn, D., Peverell, S., Morgan, D., Field, I. & Gibb, K. 2009. Mitochondrial DNA supports the identification of two endangered river sharks (*Glyphis glyphis* and *Glyphis garricki*) across northern Australia. *Marine and Freshwater Research* **60**: 554–562.

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