Conservation program for the Manning River helmeted turtle – survey and monitoring

Report on turtle trapping in 2018-19

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1. Introduction

The Manning River helmeted turtle or Manning River sawshelled turtle (*Myuchelys purvisi*) is endemic to the Manning River and its tributaries in eastern New South Wales (NSW). It is listed as endangered under the NSW Biodiversity Conservation Act 2016 but data deficient in the IUCN Red List of Threatened Species. It is not listed under the Australian Environment Protection and Biodiversity Conservation Act 1999.

Very little is known concerning the biology, ecology or conservation of *M. purvisi.* Clutch sizes of 7-23 eggs have been reported (Cann and Sadlier 2018) and its omnivorous diet includes algae, aquatic macrophytes, fallen terrestrial fruits and a variety of aquatic insects (Allanson and Georges 1999). The few historical (pre-2000) locality records in the NSW BioNet data base are mainly from the Barnard River and its junction with the Manning River, as well as the Walcrow River. Anecdotal information suggests that the abundance of *M. purvisi* has declined in recent years (e.g. Cann and Sadlier 2018).

The NSW Government's Saving Our Species (SoS) program includes *M. purvisi*, and aims to ensure the survival of the species in the wild. *M. purvisi* has been assigned to the data-deficient-species management stream under the SoS framework, and consequently it is necessary clarify its distribution, status, biology, ecology and vulnerability to threats, so that management actions can be more precisely targeted. Accordingly, the NSW Office of Environment and Heritage (OEH) has established a project to determine the distribution, abundance and population structure of the species. The objectives of this project are to:

1. Improve understanding of the distribution of *Myuchelys purvisi*
2. Improve understanding of the distribution of the turtle *Emydura macquarii* in the Manning River system
3. Establish the extent, prevalence and severity of threats to *Myuchelys purvisi*
4. Provide a basis for development of site-based management actions
5. Contribute to movement of this species out of the data-deficient management stream.

The turtle trapping program described in this report is a contribution to the overall OEH project.

2. Materials and methods

2.1. Site selection

Nineteen survey sites in the south and east of the Manning River basin (Table 1) were selected from a list of potential sites provided by Andrew Steed, OEH. An additional ten sites were inspected (Table 2), but were considered unsuitable for trapping because of a lack of deep, still or slow-flowing water, which provides essential daytime habitat for *M. purvisi*.

2.2. Survey methods

Turtle trapping was undertaken in early autumn, late spring and early summer, when *M. purvisi* is likely to be active and feeding. Up to 10 'cathedral' nets were deployed at each site, and one or two fyke nets were set at sites where bedform, substrata and current velocity were suitable. The cathedral nets were telescoping vertical cylinders 1 m wide and 2 m high when fully extended, constructed of 13 and 25 mm mesh, with three entrance funnels near the base measuring 300 mm wide and 40 mm high at their centres (Figure 1). They were normally baited with ~150 g of sheep liver, but occasionally with a similar amount of sheep heart or with a punctured 125-g tin of sardines. They were set in still or slowly flowing water 1-2 m deep, with their bases resting on the stream bed and their tops floating so that captured animals could breathe air. Baits were replenished as consumed, and replaced completely between sites or after 24 hours at a site. Fyke nets (13 mm mesh; 1 m high and 3 m long, with two wings 10 m long) were unbaited and placed at a depth of ~0.8 m to allow air breathing by captured animals (Figure 2). Nets were placed ~15 m or farther apart and were cleared at an average interval of 2.5 h during daylight hours and 12.0 h if set overnight from late evening to early morning. Precise locations of all nets were recorded with a geographic positioning system device.

Trapping effort per site varied substantially (Table 1), partly because the number of nets that could be set was constrained to a variable degree by the number of suitable setting points within a practical walking distance of the vehicle access point and on land with public access or where landowner approval had been obtained. In addition, overnight trapping was not undertaken at most sites where fyke nets could not be set, because overnight trapping with cathedral nets had a very low success rate for turtles, but instead caught numerous eels (*Anguilla* spp.) (see Results). Moreover, overnight trapping was avoided on the lower Manning River after initial experience of overnight catches of bullrout (*Notesthes robustus*), which possess venomous spines that might pose a hazard to other captured fauna. However, some sites were sampled on two or three occasions to increase overall effort. Average effort was 122 trap-hours per site with a range of 18-309 trap-hours (Table 1).

Captured turtles were identified and mature or maturing males were distinguished by their elongated and widened tails. For *Chelodina longicollis*, plastron shape was also used to recognise males, because tail morphology is only weakly sexually dimorphic in that species (Chessman 1978). Mature females could not be entirely separated from immature turtles of both sexes because the body size at which male tails enlarge varies among individuals. All turtles were examined for external abnormalities, measured with vernier calipers for straight-line medial carapace and plastron lengths, weighed with digital scales, marked with varying combinations of notches in marginal scutes so that they could be identified if recaptured, and released as soon as possible near the point of capture. Captured animals other than turtles were identified to species or genus and released immediately at the point of capture.

5. Results

The survey yielded 320 turtle captures, comprising 215 *C. longicollis*, 68 *E. macquarii* and 37 *M. purvisi* (Table 3). The captures represented 292 individuals, with 26 turtles caught twice and one caught three times. Some 10% of *C. longicollis* and 10% of *E. macquarii* were recaptured but only 6% of *M. purvisi*. *C. longicollis* was caught at 17 sites, *E. macquarii* at eight sites, and *M. purvisi* at 10 sites. Only one site yielded no turtles: the Manning River at Archinals Road (Table 3).

All captures of *E. macquarii* were effected with cathedral nets but six *C. longicollis* and six *M. purvisi* were caught in fyke nets. Cathedral nets caught an average of 0.14 turtles per trap hour and fyke nets an average of 0.11 turtles per trap hour. For cathedral nets, daylight-only trapping yielded an average of 0.22 turtles per trap hour whereas overnight trapping yielded an average of only 0.02 turtles per trap hour. For fyke nets, daylight-only trapping yielded no turtles and overnight trapping yielded an average of 0.13 turtles per trap hour. Catch rates of all three turtle species for daylight-only trapping with cathedral nets, which was employed at all sites, varied substantially (Table 4).

As well as turtles, five platypus (*Ornithorhynchus anatinus*), 141 eels (*Anguilla* spp.), three gudgeons (*Gobiomorphus* sp.), five Australian bass (*Macquaria novemaculeata*), nine bullrout

(*Notesthes robustus*), seven eel-tailed catfish (*Tandanus tandanus*) and 14 giant spiny crayfish (*Euastacus spinifer*) were captured. In addition, holes were chewed in a cathedral net in the Manning River at Wirradgurie, suggesting a capture and subsequent escape of a water rat (*Hydromys chrysogaster*). All platypus and the great majority of fish were captured in nets set overnight.

Captures of all three turtle species spanned a wide range of carapace lengths, although no *C. longicollis* smaller than 99 mm were captured (Figure 3). For *M. purvisi*, the size distribution was bimodal and all individuals identified as males were much smaller than the largest specimens captured, indicating that maximum size in this species is strongly sexually dimorphic. The smallest *M. purvisi* captured had a carapace length of 67 mm (Figure 4).

The distribution of carapace lengths for *E. macquarii* (Figure 3) included a much larger proportion of small turtles than typically recorded elsewhere (e.g. Chessman 2011, 2015). One female *E. macquarii* from the Nowendoc River at Rotating House was much larger than any other *E. macquarii* captured, with a carapace length of 284 mm. Two specimens of *E. macquarii* captured in the Manning River at Kimbriki had a pair of small plates forming a partial shield on the top of the head (Figure 5).

4. Discussion

4.1. Turtle capture rate and influential factors

Despite the occurrence of apparently suitable habitat at all sites surveyed, the average capture rate of *M. purvisi* was less than a fifth of that of *C. longicollis* and only about half that of *E. macquarii*. These results suggest that *M. purvisi* is generally rare in the east and south of the Manning River system. However, the lower recapture rate of *M. purvisi* also suggests that it has a lower propensity to enter baited traps than the other two species, and consequently its relative abundance may be under-represented.

Redleaf Environmental (2018) undertook a complementary survey in the north of the Manning River system in April 2018, using cathedral nets, fyke nets and snorkelling, and captured 21 *M. purvisi*, only three of which were taken in cathedral nets and none in fyke nets. In another complementary survey, Spark (2018) trapped at 11 sites in the west of the Manning River system using cathedral nets, modified crab nets and fyke nets, although his cathedral nets were of a somewhat different design from those used in the present survey. He caught 40 *M. purvisi* in fyke nets, 20 in crab nets and only two in cathedral nets. Collectively, results of the three surveys suggest that *M. purvisi* is not captured with a high frequency in cathedral nets anywhere in the Manning River system, whereas its catchability in fyke nets appears to be variable. It is unclear why crab nets should be more successful than cathedral nets since both operate by using a bait to attract turtles into a funnel trap.

C. longicollis and *E. macquarii* were both caught in large numbers in the present survey, although *E. macquarii* had a high capture rate at only three sites. By comparison, Redleaf Environmental (2018) caught only 22 *C. longicollis* and 1 *E. macquarii*, whereas Spark (2018) caught just 10 *C. longicollis* and no *E. macquarii.* It thus appears that the relative abundances of the three turtle species vary substantially among regions of the Manning River system, with *M. purvisi* predominating in the west and north and the other species in the south and east. This pattern may be long-standing since historical records of *M. purvisi* are mainly from the north and west.

One factor that probably reduced the effectiveness of cathedral nets for all species, in the present survey at least, was the large number of eels caught in overnight trapping. Eels frequently consumed all bait in the traps, and their presence probably also acted as a deterrent to the entry of turtles.

Diving (e.g. snorkelling) would likely be a suitable method for surveying *M. purvisi* at many of the sites that were trapped in the present survey, if undertaken at times when flows are low and water clarity is high. However, extensive beds or submerged macrophytes and filamentous algae, logs, rocks and leaf litter were present at most sites and could provide substantial cover, making many turtles difficult to detect.

4.2. Size distribution of turtle species

All three species had a broad size distribution indicating ongoing recruitment of juveniles. However, *E. macquarii* had by far the highest proportion of small turtles, indicating that this species is reproducing very successfully in the Manning River.

4.3. Threats to Myuchelys purvisi

Direct evidence of factors that may threaten the persistence of *M. purvisi* in the wild is lacking. However, several potential threats can be identified on the basis of observations during the survey and information on other species of Australian freshwater turtles. These are described below in deceasing order of likely importance.

4.3.1. Competition with *Emydura macquarii*

The Macquarie turtle has almost certainly been introduced to the Manning River system, possibly through the release of unwanted pet turtles since the species is widely available in the pet trade. Historical (pre-2000) records of *E. macquarii* from the Manning River and its tributaries are lacking, in contrast to most other major coastal rivers in north-eastern NSW. In addition, the late Professor John Legler of the University of Utah, who surveyed turtles extensively in north-eastern NSW in the 1970s, reported that the genera *Emydura* and *Elseya* were never found in the same eastern drainage system south of 29°31' latitude (Legler 1981) (*Myuchelys* then being considered part of *Elseya*). The present author trapped *E. macquarii* in the Manning River at Tiri in 2013 and 2015, and Dr John Harris caught *E. macquarii* in the Manning River near Wingham at about the same time (J. Harris, personal communication). Those discoveries plus results of the present survey and that of Redleaf Environmental (2018) show that *E. macquarii* is now widespread in the Manning River system. The unusual size distribution of *E. macquarii* found in the present study, with some males maturing at a very small size and one female reaching a very large size, suggests that there have been introductions of turtles originating from different populations, such as the small-bodied population of the Macleay River and the large-bodied populations of the Murray-Darling basin (Judge 2001).

A similar situation exists in the Bellinger River system where *Myuchelys georgesi* is endemic and existed in the absence of other short-necked turtle species until the introduction of *E. macquarii*, probably first in the 1980s and several times since (Georges *et al*. 2011, 2018). It is unlikely to be a coincidence that south of the Richmond River system, *Myuchelys* spp. occur only in river systems from which *E. macquarii* was absent until recently. The two genera have a high potential for interspecific competition because of a similarity in diet (Spencer *et al*. 2014), and *E. macquarii* may be a superior competitor because of high fecundity and fast maturation (Chessman 2015). The small size and therefore apparently young age of most *E. macquarii* caught in the Manning River system suggest that the species is increasing rapidly in abundance and will likely continue to multiply and spread and place growing competitive pressure on *M. purvisi*.

4.3.2. Hybridisation with *Emydura macquarii*

Genetic studies have demonstrated considerable hybridisation and introgression between *M. georgesi* and *E. macquarii* in the Bellinger River system (Georges *et al*. 2018) and the potential therefore exists for similar phenomena in the Manning River system. Turtles caught in recent Manning River surveys have not been genetically tested but as described above, two specimens identified as *E. macquarii* in the present survey had a partial head shield, which may be a characteristic of *Emydura-Myuchelys* hybrids (Georges *et al*. 2007). As *E. macquarii* spreads and multiplies in the Manning River system, there is a potential for hybridisation and introgression to lead to 'genetic swamping' of the apparently declining *M. purvisi* population (cf. Georges *et al*. 2018).

4.3.3. Nest predation by introduced predators

Although no data are available on predation of *M. purvisi* nests, studies of other turtle species in south-eastern Australia have reported nest predation rates of 50-96%, with the principal predator being the introduced red fox (*Vulpes vulpes*) (Chessman 2018). As foxes are ubiquitous in south-eastern mainland Australia, it is likely that fox predation is also high for *M. purvisi* nests. However, it is possible that dingoes or wild dogs, which occur in parts of the Manning River catchment, may suppress fox numbers in some areas and help to reduce predation rates (Thompson 1983; Letnic *et al*. 2011). The detection of juveniles of all three species in the combined results of the present survey and those of Redleaf Environmental (2018) and Spark (2018) indicates that foxes do not totally prevent hatchling recruitment.

4.3.4. Disease

In early 2015, epidemic disease apparently caused by a previously unknown virus resulted in mortality of about 90% of the entire population of *M. georgesi* in the Bellinger River system, including nearly all adults (Zhang *et al*. 2018; Chessman *et al*. in prep.). This event highlights the risk that diseases may pose to Australian freshwater turtle populations. As yet the Bellinger River virus has not been detected in the Manning River system. However, disease needs to be considered as a possible contributor to the unexplained apparent decline of *M. purvisi* populations in recent times, and as a threat to future persistence.

4.3.5. Geomorphic change

Trapping results and general observations indicate that *M. purvisi* requires deep water (> 1 m) for daytime habitat from whence it ventures out to forge in shallower water overnight. Geomorphic changes in rivers of eastern Australia since European settlement have often included widening and shallowing, resulting in losses of deep pools (e.g. Brierley *et al*. 1999; Cohen 2003). This process is likely to have occurred in some areas of the Manning River system and could have reduced habitat availability for *M. purvisi*.

4.3.6. Climate change

Freshwater temperatures in south-eastern Australia are projected to rise as a result of global warming by about 1-3°C by 2071-2100 relative to 1971-2000, depending on the climate model and emissions scenario (van Vliet *et al*. 2013). Higher temperatures are typically beneficial to freshwater turtles, because warmer waters tend to have greater food productivity or allow a longer growing season and more rapid food digestion (Gibbons 1970; Thornhill 1982; Frazer et al. 1993; Ashton et al. 2015). However, an increased frequency and severity of drought and declining river flows have also been projected for south-eastern Australia (van Vliet *et al*. 2013; Zhao and Dai 2015). Drought conditions could impact adversely on *M. purvisi* by reducing available habitat and causing greater crowding of *M. purvisi* and other turtle species in shrinking pools, resulting in greater competition for food.

4.3.7. Scarcity of nesting sites

Australian chelid turtles generally nest in area frees of tall, dense ground vegetation (e.g. Spencer and Thompson 2003; Booth 2010; Petrov *et al*. 2018). In parts of the Manning River system, banks are thickly clothed with dense vegetation, especially introduced weeds (e.g. Figure 6), which may limit the availability of suitable nesting sites. However, turtles in such areas may simply move elsewhere to nest.

5. Conclusions

Although *M. purvisi* is moderately abundant in some parts of the Manning River system, overall it appears to be scarce, with circumstantial evidence of major population decrease from unknown causes. Further surveys, including by diving where conditions are suitable, would be useful to further elucidate the distribution and population status of both *M. purvisi* and *E. macquarii*.

The introduction and spread of *E. macquarii* poses a severe threat of further decline of *M. purvisi* resulting from competition and hybridisation, although these processes are likely to take several decades to play out across the whole river system. Control of *E. macquarii* across the whole Manning River system would be difficult because of the size of the river system, lack of road access to many areas, and the capacity of *E. macquarii* males in particular for long-distance movements. Local control should be possible but would need to be sustained. Effective control of nest predators, especially foxes, is also problematic over such a large area, particularly as a high level of fox reduction may be needed to reduce predation rates (Robley *et al*. 2016). The risk to *M. purvisi* from disease (e.g. Bellinger River virus infection) is currently unknown and therefore very difficult to manage.

Proposed captive breeding of *M. purvisi* and head-starting prior to release (i.e. captive rearing to a predator-resistant body size), together with local control of *E. macquarii* where necessary, may be an effective way to sustain *M. purvisi* in selected areas where the species would otherwise suffer local extinction. However, monitoring of released individuals, for example by radio-tracking, would be important in order to understand their survival, movements and growth in different environments with different established turtle and predator populations.

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Table 1. Sites surveyed

Site No.	Location	Elevation (m)	Mean trap latitude (GDA94)	Mean trap longitude (GDA94)	Dates trapped	Trap hours (cathedral nets)	Trap hours (fyke nets)	Trap hours (total)
1	Barnard River, Bretti	109	-31.7838	151.9107	29 Mar 2019	86	0	86
2	Barnard River, Kauthi South	111	-31.7779	151.9044	6 Apr 2019	60	0	60
3	Barrington River, Rocky Crossing	134	-32.0375	151.8707	17 Apr 2018 3 Dec 2018	111	0	111
4	Bobin Creek, Bobin Creek Road	139	-31.6860	152.2682	23 Nov 2018 24 Nov 2018	72	0	72
5	Dingo Creek, Robinsons Road	58	-31.7921	152.3300	22 Nov 2018 23 Nov 2018	191	24	215
6	Gloucester River, Doon Ayr	57	-31.8921	152.0939	19 Apr 2018 2 Dec 2018 3 Dec 2018	204	11	215
7	Gloucester River, Faulkland Road	139	-32.0610	151.8800	18 Apr 2018 8 Apr 2019	124	0	124
8	Gloucester River, Wirradgurie	64	-31.9092	152.0605	4 Dec 2018 5 Dec 2018	160	0	160
9	Manning River, Archinals Road	31	-31.9160	152.2157	18 Nov 2018 19 Nov 2018	31	23	54
10	Manning River, Charity Creek	27	-31.9007	152.2390	19 Nov 2018 20 Nov 2018	87	0	87
11	Manning River, Cundle Flat	88	-31.8087	151.9821	3 Apr 2019	30	0	30
12	Manning River, Deadbird	208	-31.8355	151.8142	27 Mar 2019 28 Mar 2019	77	0	77
13	Manning River, Dewitt	240	-31.8114	151.7980	25 Mar 2019 26 Mar 2019 27 Mar 2019	261	48	309
14	Manning River, Karaak Flat site 1	23	-31.9301	152.2933	21 Nov 2018	18	0	18
15	Manning River, Karaak Flat site 2	23	-31.9240	152.2968	24 Nov 2018	32	0	32
16	Manning River, Kimbriki	25	-31.9338	152.2856	20 Nov 2018 21 Nov 2018 1 Apr 2019 5 Apr 2019	297	0	297
17	Manning River, Tigrah Road	96	-31.7923	151.9370	28 Mar 2019 7 Apr 2019	87	0	87
18	Manning River, Tiri Road	47	-31.8378	152.0927	4 Apr 2019	61	0	61
19	Nowendoc River, Rotating House	70	-31.8061	152.0551	2 Apr 2019 3 Apr 2019	222	0	222

Table 2. Sites visited but not surveyed

Site No.	Location
20	Barrington River, Barrington River Lodge Outdoor Centre
21	Barrington River, Poleys Place campground
22	Barrington River, Steps of Girrba campground
23	Gloucester River, Gloucester Park, Gloucester
24	Gloucester River, Gloucester Tops Riverside Caravan Park
25	Manning River, Claremont
26	Manning River, Tibbuc (Goldthorpe/Sutherland property)
27	Manning River, Tibbuc (Lewis property)
28	Manning River, Tibbuc (Robinson property)
29	Nowendoc River, Caffreys Flat (Falla property)

Table 3. Numbers of captures of each species at each survey site

Site No.	Location	*Chelodina longicollis*	*Emydura macquarii*	*Myuchelys purvisi*
1	Barnard River, Bretti	18	1	3
2	Barnard River, Kauthi South	2	0	2
3	Barrington River, Rocky Crossing	3	1	0
4	Bobin Creek, Bobin Creek Road	2	0	0
5	Dingo Creek, Robinsons Road	1	1	0
6	Gloucester River, Doon Ayr	17	0	0
7	Gloucester River, Faulkland Road	18	0	1
8	Gloucester River, Wirradgurie	3	0	0
9	Manning River, Archinals Road	0	0	0
10	Manning River, Charity Creek	4	0	1
11	Manning River, Cundle Flat	0	0	4
12	Manning River, Deadbird	5	0	1
13	Manning River, Dewitt	9	2	10
14	Manning River, Karaak Flat site 1	1	3	2
15	Manning River, Karaak Flat site 2	4	0	0
16	Manning River, Kimbriki	34	43	5
17	Manning River, Tigrah Road	42	0	8
18	Manning River, Tiri Road	18	16	0
19	Nowendoc River, Rotating House	34	1	0

Table 4. Capture rates (individuals per trap-hour) of each species at each survey site for trapping with cathedral nets during daylight hours only

Site No.	Location	*Chelodina longicollis*	*Emydura macquarii*	*Myuchelys purvisi*
1	Barnard River, Bretti	0.21	0.01	0.04
2	Barnard River, Kauthi South	0.03	0.00	0.03
3	Barrington River, Rocky Crossing	0.03	0.01	0.00
4	Bobin Creek, Bobin Creek Road	0.08	0.00	0.00
5	Dingo Creek, Robinsons Road	0.00	0.00	0.00
6	Gloucester River, Doon Ayr	0.09	0.00	0.00
7	Gloucester River, Faulkland Road	0.14	0.00	0.01
8	Gloucester River, Wirradgurie	0.03	0.00	0.00
9	Manning River, Archinals Road	0.00	0.00	0.00
10	Manning River, Charity Creek	0.10	0.00	0.03
11	Manning River, Cundle Flat	0.00	0.00	0.13
12	Manning River, Deadbird	0.03	0.00	0.03
13	Manning River, Dewitt	0.07	0.02	0.02
14	Manning River, Karaak Flat site 1	0.06	0.17	0.11
15	Manning River, Karaak Flat site 2	0.13	0.00	0.00
16	Manning River, Kimbriki	0.17	0.23	0.03
17	Manning River, Tigrah Road	0.48	0.00	0.09
18	Manning River, Tiri Road	0.30	0.26	0.00
19	Nowendoc River, Rotating House	0.34	0.01	0.00

Figure 1. Cathedral net

Figure 2. Fyke nets set in Dingo Creek

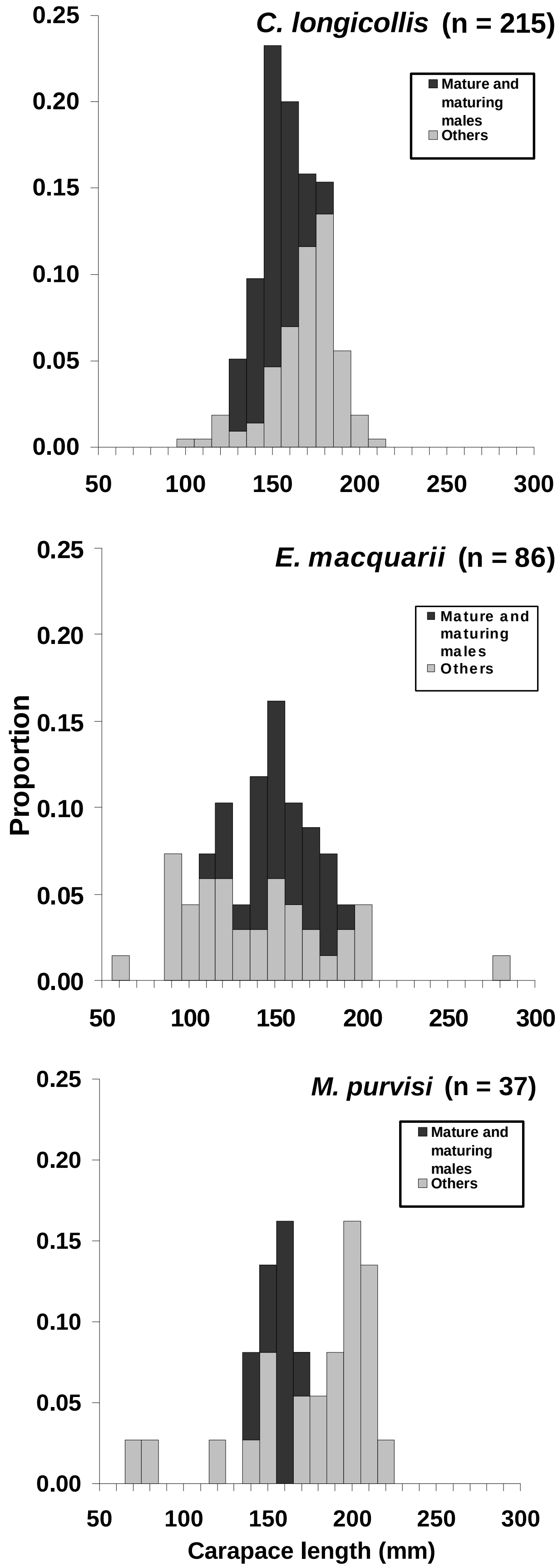

Figure 3. Frequency distributions of carapace lengths (rounded to the nearest 10 mm) of *Chelodina longicollis*, *Emydura macquarii* and *Myuchelys purvisi* captured in the Manning River system in 2018-19

Figure 4. Juvenile *Myuchelys purvisi* from the Manning River at Kimbriki

Figure 5. ***Emydura macquarii*** **with a partial head shield from the Manning River at Kimbricki**

Figure 6. Dense ground vegetation on the bank of the Barrington River at Rocky Crossing

Appendix – Photographs of sites where *M. purvisi* was caught

Barnard River, Bretti

Barnard River, Kauthi South


Gloucester River, Faulkland Road


Manning River, Charity Creek


Manning River, Cundle Flat


Manning River, Deadbird


Manning River, Dewitt


Manning River, Karaak Flat site 1

Manning River, Kimbriki (in the distance)

Manning River, Tigrah Road