SUMMARY OF HUNTER RIVER CATCHMENT TURTLE SURVEY RESULTS

For

Hunter Local Land Services

By

North West Ecological Services

26TH SEPT & 7TH OCT 2020 and

18TH & 22nd Jan 2021

Goulburn River National Park turtle trapping site, typical shallow long holes

ACKNOWLEDGMENTS

The turtle surveys were assisted by Zac Petersen, Lachlan, Zac, & Ruby Spark, and Clive, Van, Vaughn & Kaia Stanton. The support team were Anthea Slack and Catherine Conroy (Hunter LLS), Tim Faulkner (Aussie Ark), Andrew Steed (DPIE –EES) and project co-ordinator /manager was Lyndel Wilson Hunter LLS. Thanks to Jane Hall at Taronga and Kate Parrish DPIE for their turtle care and health assessments.

This project was supported by Hunter Local Land Services through the Hunter Catchments Contribution program.

Access to the streams was granted by the following land managers;

Goulburn River - National Parks and Wildlife Service, Dan Robinson, Bob and Carolyn Thurston, and Crown Lands.

Krui River - Bob and Carolyn Thurston, Tony and Jo Obrien, and Wallings Pastoral Company.

Munmurra River - Wallings Pastoral Company and Paul Martin.

Halls Creek – Adam and Wendy Stair, Troy and Lisa Rudd, Justin and Jennifer O'Connell, and James and Meredith Munro.

Wybong Creek - Kerrie and Paul Eather.

Merriwa River – Pinnacle Fine Foods.

Hunter River - Jon Embury, Richard Bell, and WaterNSW.

Wollombi Brook - Cybele Orton.

Pages River - Peter Haydon and Crown Lands.

Glenbawn Dam - WaterNSW

Dart Brook – The Paradice Family and Crown Lands.

The turtle catchers who assisted on the Goulburn River survey were Clive, Van, Vaughn & Kaia Stanton and Zac and Lachlan Spark.

Table of Contents

EXECUTIVE SUMMARY

During the drought of 2019 there were numerous dead Hunter River Short-neck turtles found in the Pages, Isis and Hunter Rivers which had dried up to just a few of the deepest holes. The sight of numerous dead turtles raised alarm bells and questions about how common they were and how significant the drought mortality was to the long-term viability of the population. John Cann reported a similar mass mortality event in the early 2000's of hundreds of turtles dying in the Wybong catchment. With turtles declining in other areas of Australia it was recommended to Hunter Local Land Services to seek funding for a turtle survey across the catchment that would inform the current status of the species.

North West Ecological Services was contracted for the project.

The project was broken into three parts. The first was site selection and seeking landholder approval to survey on the selected properties. Second was the survey of twenty five locations. And third was the reporting of the survey to summarise the findings and make recommendations to guide conservation actions, further surveys, and monitoring projects for the species. Hunter LLS had input into site selection to target their priority streams with the intention of using the turtle survey to gain landholder interest and involvement in the protection of streams.

The first draft of potential turtle survey sites was produced by searching google satellite images taken during the worst of the drought when the rivers were dry except for the deepest holes. The lot and DP numbers of the land on which those holes occurred were sent to Scone and Singleton councils requesting the addresses of the owners to whom letters were sent requesting permission to survey turtles on their property. There was a good response and there were multiple sites to choose from for most streams except for the lower Hunter and Wollombi Brook which only had two replies and the Dart Brook and Bow Rivers that had no replies.

The surveys began on the 18th September 2020 at Goulburn River NP and continued in the western half of the catchment up until the 8th of October 2020. In that time the Goulburn, Krui, Merriwa, Munmurra, Halls Creek, Wybong Creek, Hunter and Wollombi Brook streams were surveyed. The standard effort per site was 8 – 9 traps set for 1 night in holes deeper than 1.2m.

The second lot of surveys began on the 18th of January 2021and continued to the 22nd January 2021; that survey focused on a cross section of streams in the eastern half of the catchment.

For both surveys most of the rivers were running with average flows, some had a slight fresh in them with dirty water, most of the gravel bed streams were clear.

The objective of the survey was to catch and record as many turtles as possible across as many streams of the catchment as possible. Turtles were marked with an individual number using a set of drill holes into the scutes on the margin of the carapace as shown in Figure 8. The turtles were weighed and measured for carapace length and width and plastron length. The health of each animal was assessed including their eyes, and any damage recorded. Up to three turtles at each site were also swabbed for viral analysis conducted by DPIE. Each adult female was palpated to determine if it was carrying eggs and if so how close it was to laying them.

Results

The trapping effort of 146 trap nights at 25 locations captured 1261 Hunter River Short-neck Turtles and 35 Eastern Long-neck turtles. That number was considered a very high success rate as compared to similar turtle trapping efforts conducted by NWES in the Manning, Namoi and Gwydir catchments. The low number of Eastern Long-necks and the high number of Hunter

River Short-neck Turtles were both very surprising. It seems that the streams are the domain of the Hunter River Short-neck Turtle and the Eastern Long-necks are excluded to the smallest creeks and dams.

The mix of age and size classes of Hunter River Short-neck Turtles indicated a healthy population that is breeding sufficiently to maintain the population.

The health check found very few issues associated with eyes and skin lesions. A few were missing limbs; most likely a result from predator attack. Shell damage was more common as a result of impacts or predators chewing the carapace margin.

From the number of dead turtle shells found in 2019 & 2020, it is obvious that the extreme drought did have a significant impact on the population. A similar mass mortality event was reported by John Cann in the Wybong Creek back in 2000.

It is likely that after a few years of average seasons they will become more abundant than the numbers recorded on this occasion.

There was no evidence found to indicate that nest predation from foxes or pigs are a problem. At this stage of our understanding of threats, it is likely that drought, climate change and sedimentation of holes are likely to be the main threats to aquatic life in the Hunter catchment. In the future disease and hybridisation with *E. m. macquarii* may be a threat.

Management actions that will likely reduce those threats include:

- fencing out rivers to exclude stock will increase ground cover vegetation along the banks and reduce erosion into the streams
- protecting refuge holes from grazing will enhance water quality and protect foraging habitat during droughts.
- increasing riparian native vegetation by undertaking revegetation and/or allowing natural regeneration of native species will further serve to protect riverbanks and habitat.
- water extraction during droughts can have a serious impact on refuge holes; even low volumes can once flows stop. Cease to pump orders need to be made early enough to ensure holes last as long as possible. Incentives to use underground water to provide off stream water points would provide more permanent water supply and protect streams.
- spring fed holes should be protected as they have the highest conservation value. During the peak of the drought several were identified in the Isis River that were conserving fish, turtles, frogs, and aquatic invertebrates. It is critical that those be fenced to exclude stock from destroying the water quality, fringing vegetation, and eroding the banks.

In addition to the turtles trapped, five species of native fish and three species of exotic fish were caught. It seems that European Carp and Goldfish are widespread in the Hunter catchment.

Frogs were surveyed most nights to see whether Booroolong Frogs occurred. They were found at one location above Glenbawn Dam in the Hunter River in a large riffle on Belford Park. None were found in the western half of the catchment despite there being excellent habitat in streams like the Wybong Creek, and none were found where they were known to occur prior to the drought in the Pages River at Gundy in 2017.

No Platypus or Water Rats were observed, however a few landholders reported seeing them. They are obviously in low abundance, as they are regularly trapped when turtle surveying in the Manning, Namoi and Gwydir Rivers. They would be most likely to occur in the clear gravel bed streams.

Figure 1. Hunter Catchment and the BioNet Records for Hunter River Turtle *Emydura macquarii gunabarra*

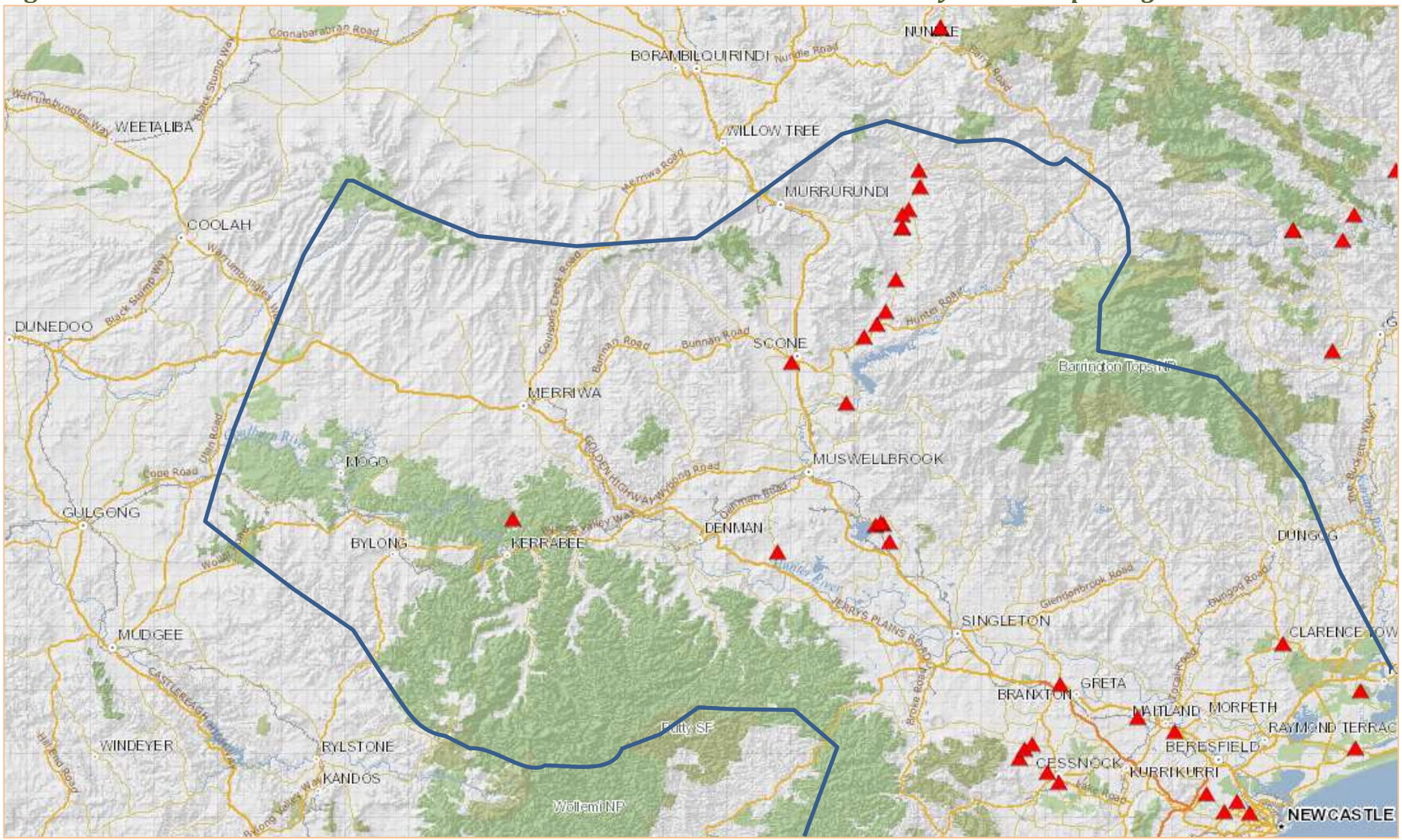
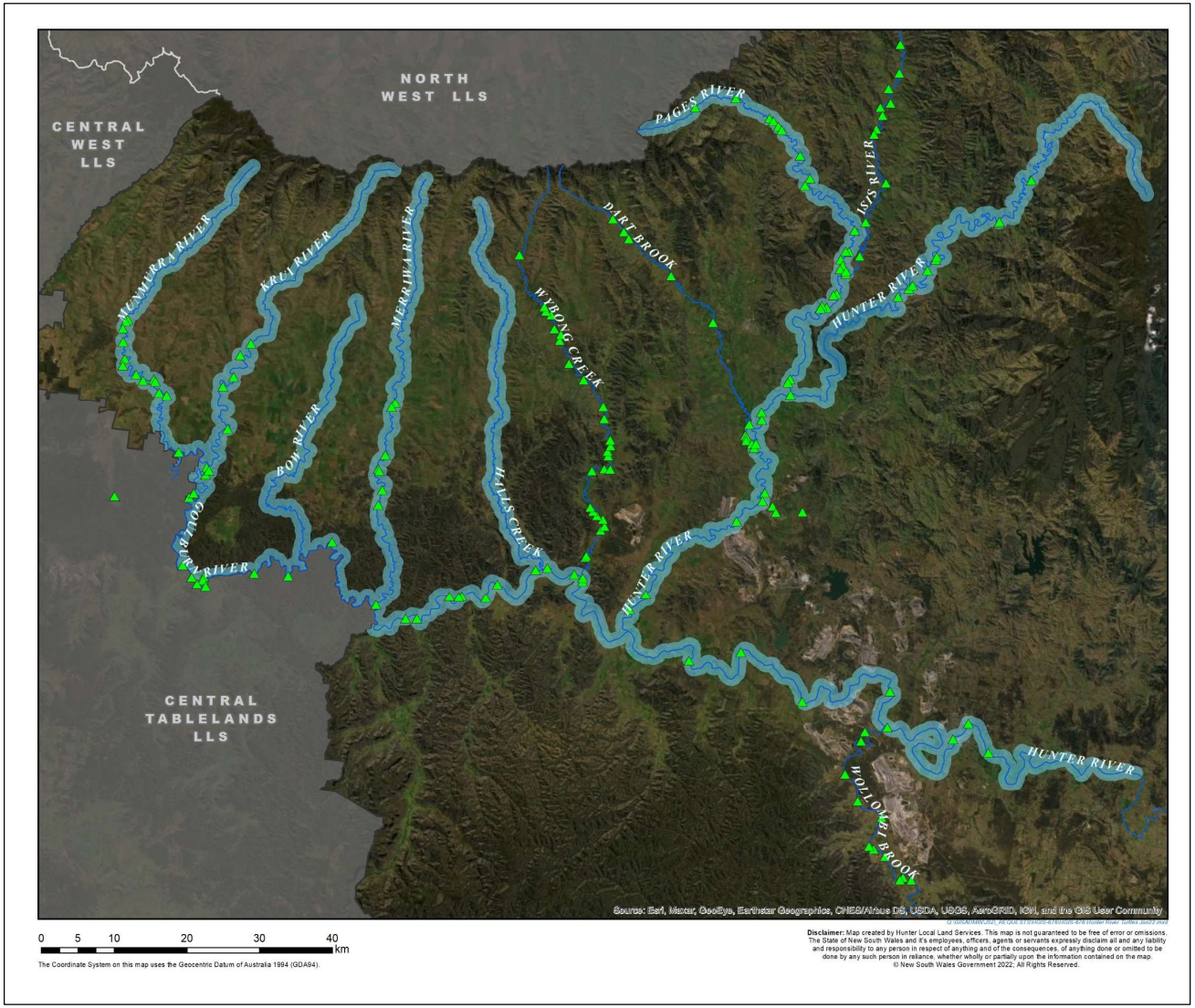


Figure 2. Selection of Turtle survey sites targeted the LLS priority streams in the Hunter Catchment where there were large holes in the drought, shown as ▲



1.0 BACKGROUND

The Hunter Catchment

The Hunter River Short-neck Turtle is endemic to the Hunter River catchment which is the largest coastal catchment in NSW, with an area of about 21,500 square kilometres. The Goulburn River is the largest of the tributaries, accounting for 40% of the catchment area but only 23% of the flow. The upper catchment is predominantly rich basalt grazing country where clear flowing gravel bed streams are highly ephemeral. In the most intensively grazed and cleared areas of the upper catchment many of the rivers are highly degraded by sedimentation, eutrophication and weed invasion.

In the western half of the catchment those streams run south into the Goulburn River through bushland and sandstone ridges. There the rivers change dramatically to be broad shallow sandy streams with occasional rock outcrops.

The eastern half of the catchment is rich grazing country where all the streams have a gravel bed. Spring fed sections occur that are associated with connections to underground streams; the largest of which is in the Timor locality where there is a major limestone ridge. The Glenbawn Dam regulates the stream flow to capture peak flows and releases water according to user needs. The Hunter River below the dam is highly degraded due to the heavily modified flow regime.

The land adjoining the mid to lower elevations of the Hunter River is intensively farmed alluvial flats that grow crops with irrigation from the river. Dairy and beef grazing together with other agricultural activities, power generation, urban development and mining comprise the variety of land uses in the area all being potential sources of water pollutants. Further turtle survey effort is required in that lower catchment region to establish turtle abundance and the health of the aquatic ecosystem in general.

There had been no systematic turtle surveys in the catchment; there were just 30 opportunistic BioNet Atlas records, mostly in the eastern half of the catchment as shown in Figure 1.

1.1 Project brief

During the drought of 2019 there were numerous Hunter River Short-neck turtles found dead in the Pages, Isis and Hunter Rivers that had dried up to just a few of the deepest holes. The sight of numerous dead turtles raised questions about how common they were and how significant the drought mortality was to the long-term viability of the population. With turtles declining elsewhere in Australia it was recommended to Hunter Local Land Services to seek funding for a turtle survey across the catchment that would inform the current status of the species.

By the end of 2019 the trees on the hills in the upper catchment were defoliating and some were dying due to the extreme hot and dry period.

The photo below shows trees dying in the Isis River catchment where numerous dead turtles were found in dry river beds.

A view down the Pages River valley showing the severity of the drought in December 2019.

Turtles died intact: any predators around must have had enough to eat, two were sent to Taronga for post mortem, histopathology, and screening for Bellinger River Virus

The dry Pages River below Gundy, where numerous dead turtles were found.

Along both the Isis and Pages River the landholders had dug holes in the river bed to get water for stock.

Those holes became a refuge for many aquatic species that would have otherwise died. There were roughly twenty Hunter River Short-neck turtles in this hole; by night they were out on the banks foraging. Predation by eels is likely a problem for the smaller turtles; the holes need some shelter habitat.

1.2 Species profile

Hunter River Short-necked Turtle – *Emydura macquarii gunabarra* Cann 1998- Profile from Cann & Sadlier 2017

The Hunter River Short-neck Turtle is a sub species of the Macquarie Short-necked Turtle *Emydura macquarii macquarii* that occurs throughout the Murray Darling basin. There are four sub-species of the Macquarie Short-necked Turtle that are endemic to coastal catchments.

- *Emydura macquarii dharuk* in the Nepean catchment
- *Emydura macquarii gunabarra* in the Hunter catchment
- *Emydura macquarii dharra* in the Macleay catchment
- *Emydura macquarii binjing* in the Clarence catchment

The name '*gunabarra*' is the modern day spelling of the Aboriginal name given to the Hunter River.

The main difference observed between *E. m. gunabarra* and *E. m. macquarii* is the smaller size of the adult males and females of *E. m. gunabarra*. *E. m. gunabarra* also have more obvious parallel striations and midline furrow or depression on the carapace, barely visible barbels, no upturned edge of the carapace, a single yellow stripe on the neck, dark throat, and juveniles lack the serrated edge to the carapace and ridgeline. Both turtles are shown on page 15.

John Cann (2017) states that *E. m. gunabarra* is distinguished from the other sub-species by the adults having a shell that when viewed from above is an even sided oval in shape, with only a slight expansion at the rear from the marginal shield M8 back. There is no obvious upward turn at the anterior edge of the carapace along marginal shields M4 - 7 and marginal shields M3 – 7 drop down. The rear edge of the carapace is slightly flared from marginal shields M7-12 and rises over the hind limb with M12 on the same plane as the preceding marginal shields.

Females are noticeably flat in cross section, a large female has a carapace length of 257mm, and adult males are typically smaller up to 227mm. This survey recorded female's carapace length up to 266mm and 2.153kg weight, and adult males up to a carapace length of 220mm and 1.138 kg.

The carapace of most adults is markedly and densely striated in texture with large individuals having strong longitudinal striations down the central shields and lateral shields, tending to parallel the outer margins of the lateral shields, and to a lesser extent also along the inner lateral margin of the posterior marginal shields. There is an obvious narrow crease/furrow running down central shields C2 – C4. The carapace of juveniles is significantly wider anteriorly and posteriorly than in adults. Unlike most other juvenile *Emydura macquarii* from east flowing drainages, the juvenile *E. m. gunabarra* do not have a pronounced median ridge down the centre of the carapace except as hatchlings and its presence has been lost by the time they have reached 80mm in carapace length. The skin on the crown of the head is smooth but with a hard cap. The neck has small widely scattered rounded and raised tubercles and the anterior edge of the chin has two extremely small barbels. The photos in this report show the facial markings and colourations of both *E. m. gunabarra* and *E. m. macquarii*.

Females lay 7 – 18 eggs in loamy soil on the river banks between Oct and January. Hatching occurs in 53 days at 28C. John Cann has observed evidence of nest predation being common along the water's edge but none were observed dug up during this survey.

The diet of *E. m. gunabarra* is described by John Cann as omnivorous; the contents of two turtles stomachs were examined and found to contain filamentous algae and weed with no animal matter, however the species is known to feed aggressively on meat in captivity and the heart and liver bait obviously attracted them into the traps.

Top photo of *Emydura macquarii gunabarra* from Pages Creek Hunter catchment

Below: *Emydura macquarii macquarii* from inland Namoi catchment. Very similar but larger, has small barbels, often with a second yellow stripe on the throat, often with raised edge of the carapace, has random carapace striations, less defined midline furrow or crease, similar neck tubercules.

Above: *Emydura macquarii gunabarra* 1124, head plates are obscure in juveniles and sub-adults. Striations and midline furrow are more obvious

Below: *Emydura macquarii gunabarra* adult female 1170 has defined head plates and midline furrow or depression

Head plates were obvious on adult turtles

Throughout the survey attention was given to the possibility of a hybrid or introduced *Emydura macquarii macquarii* occurring as a result of released pets. In the future hybridisation with *E. m. macquarii* may be a threat. Only one turtle was suspected to be a hybrid; this female below (1138) was a bit different. She was larger, deeper, the edge of the carapace was less flat, but she had normal colour marking and her carapace had the distinct furrow down the centre. She was losing the striations on her carapace, and she had defined plates on the back of her head.

The suspected hybrid 1138 shown on the right side of the photos below paired with *E. m. gunbarra*; it may be that she was just old and her carapace had begun to warp with age

The suspected hybrid 1138 shown on the right side of the photos below paired with *E. m. gunbarra*

Eastern Long-neck Turtle *Chelodina longicollis* number 27 at Pages River. Only 35 were captured during the survey; it seems that the streams are dominated by Hunter River Short-neck turtles. It is likely that *Chelodina longicollis* left the river holes after the drought to reside in farm dams and small creeks.

Figure 3. The twenty five turtle survey sites across the Hunter River Catchment

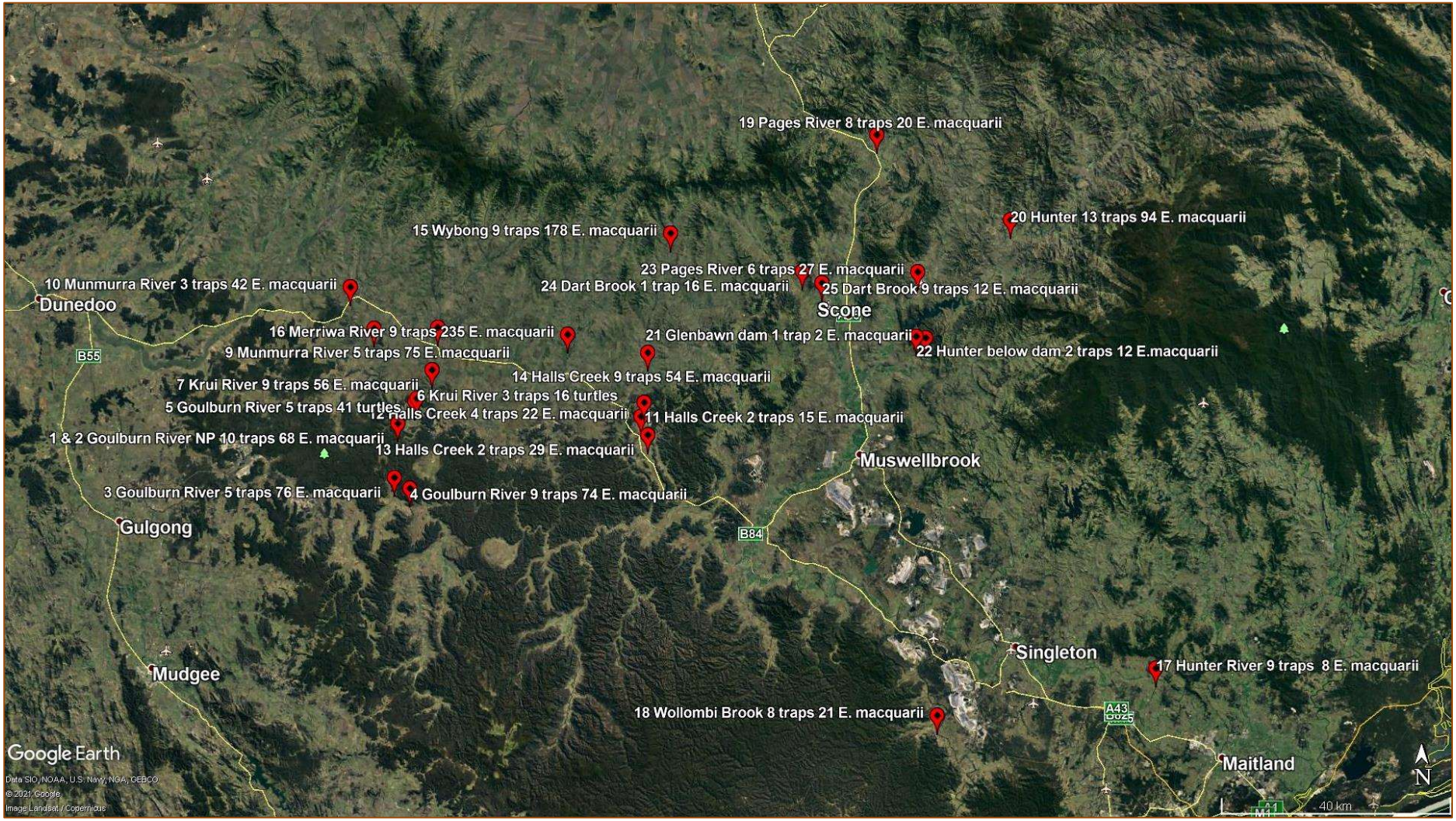


Figure 4. The turtle survey sites across the eastern half of the Hunter River Catchment

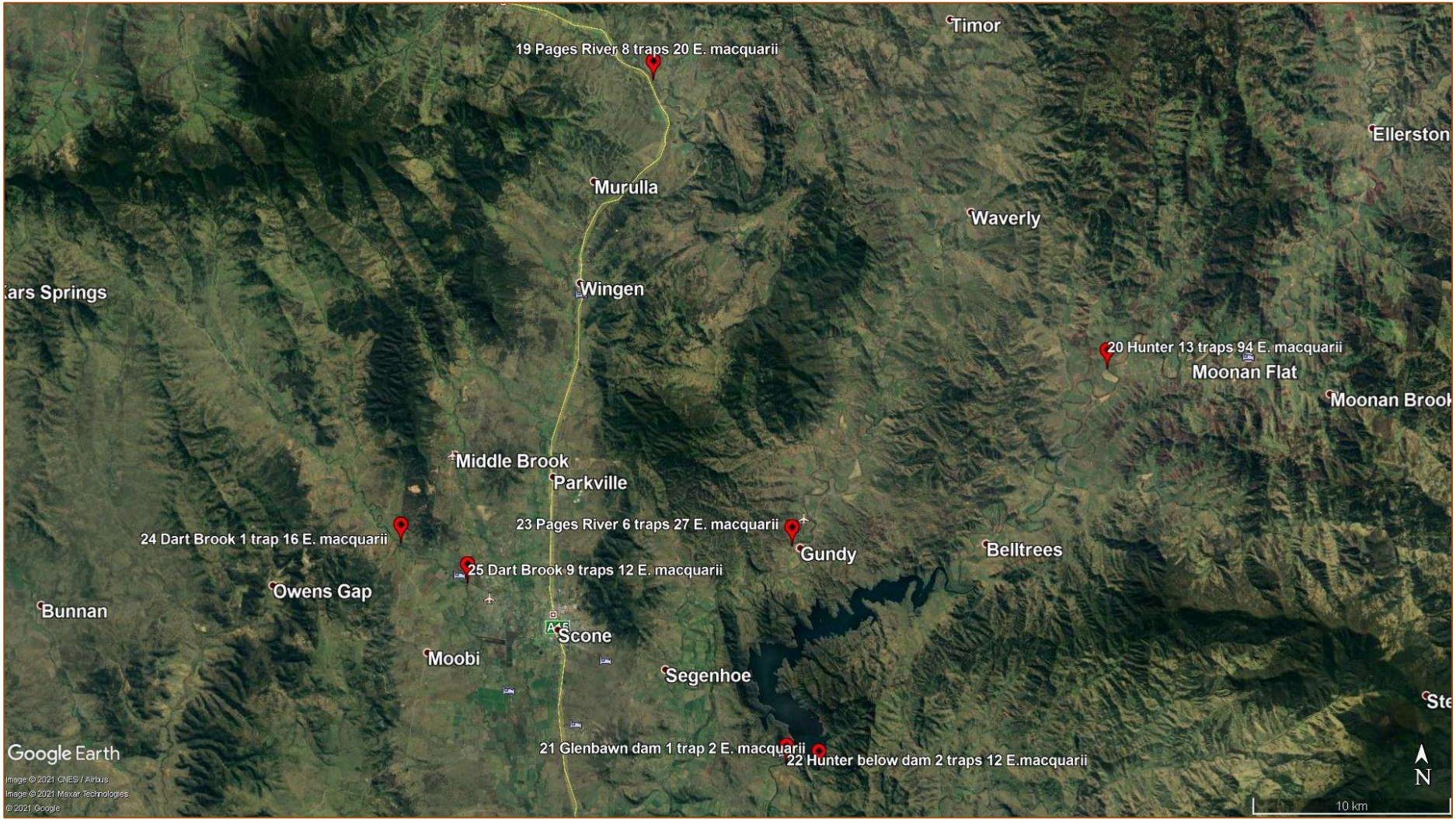


Figure 5. The turtle survey sites across the southern part of the Hunter River Catchment

Figure 6. The turtle survey sites across the western half of the Hunter River Catchment

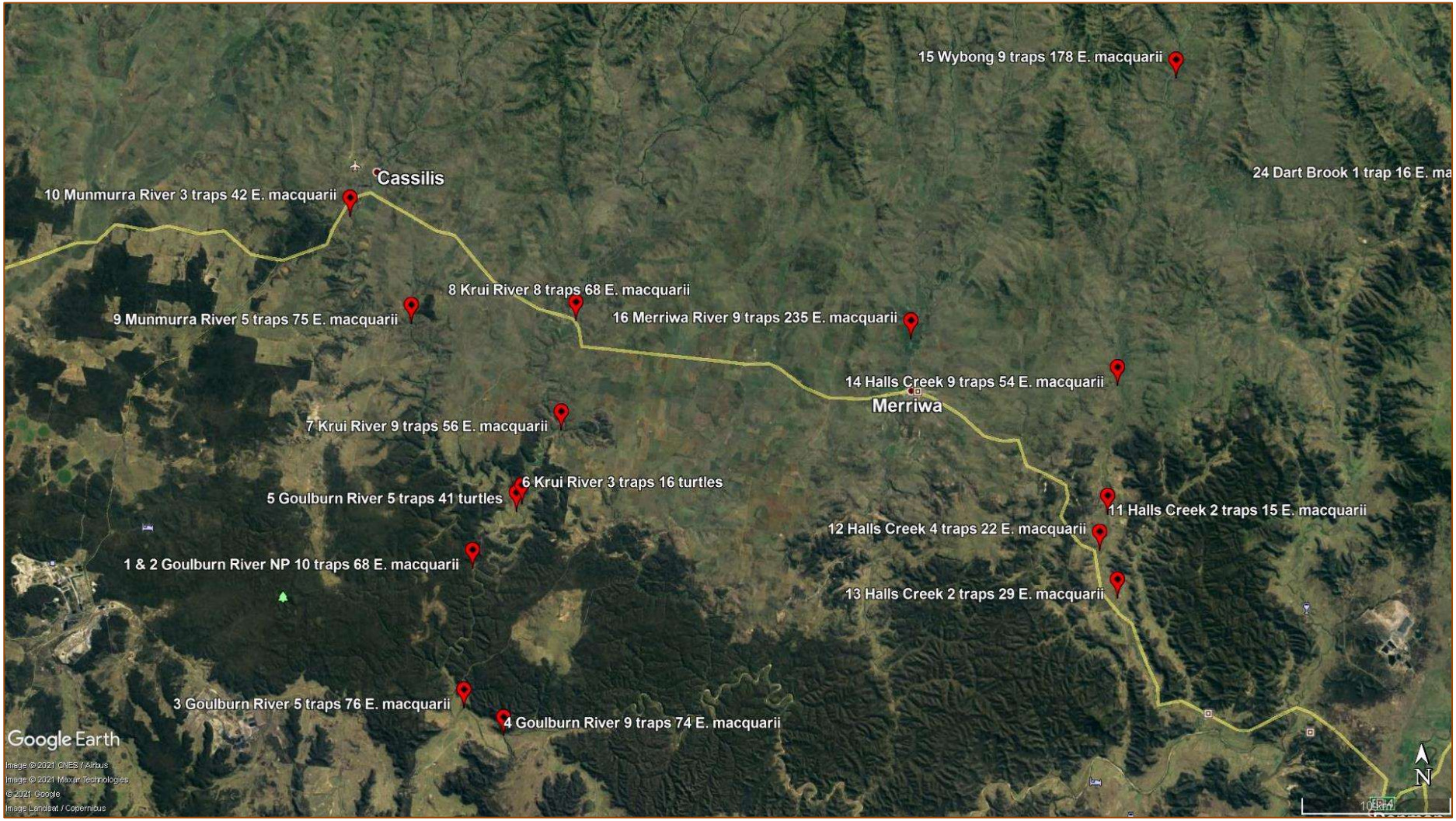


Figure 7. Shows the streams in the Hunter River catchment that would provide turtle habitat; those marked with a star were not surveyed and are likely to contain significant numbers of *E. macquarii gunabarra*

2.0 METHOD

2.1 Site selection

The objective was to cover a cross section of the Hunter River catchment to determine the abundance and distribution of the Hunter River Turtle - *Emydura macquarii gunabarra.*

Large holes 1.5m deep were selected that had water in the drought that were identified by using 2019 Google images.

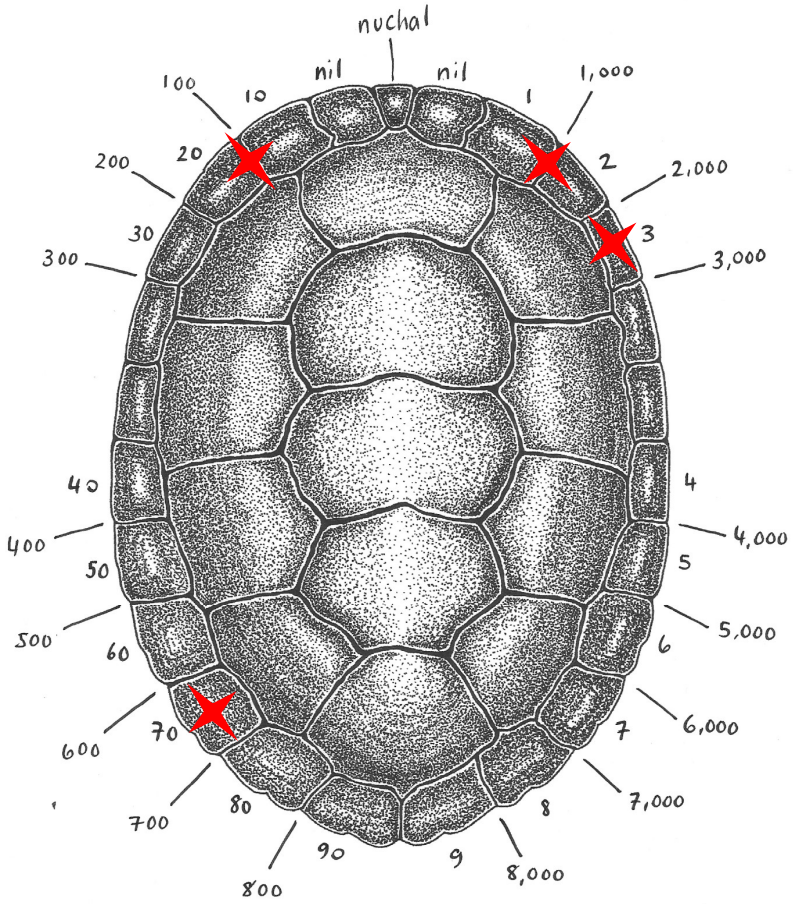
The map Figure 2 shows 165 potential survey locations where water holes were identified on satellite images that had persisted through the 2019 drought. In the upper catchment the Bow River was the only priority stream that was not surveyed.

Stream	Number of potential survey sites identified	Sites surveyed
Goulburn River	25	5
Krui River	5	3
Merriwa River	8	1
Wybong Creek	27	1
Dart Brook River	11	2
Munmurra River	15	2
Halls Creek	4	4
Muswellbrook Creek	2	0
Muscle Creek	1	0
Wollombi Brook	11	1
Hunter River	24	4
Pages River	25	2
Isis River	11	0
Total potential sites to survey turtles	**169**	**25**

2.2 Survey Method

The standard survey effort per site/night was 8 big crab traps and 1 fyke trap; some sites had more or less effort depending on the area of trappable habitat. Traps were mostly at the one large hole, but sometimes at many small holes. Approximately half the sites didn't have a suitable fyke trap location either being too deep or too shallow. Traps were baited with a mix of Ox heart, lamb heart, lamb liver, chicken hearts and tuna. Turtles were sexed, weighed, marked and health checked, females were palpated for eggs. Two to three turtles from each location were swabbed for virus analysis. The recording proforma is presented in Appendix 1. An excel spreadsheet of all the data collected has been forwarded to Hunter Local Land Services.

Figure 8. shows the marking system used to number each turtle;
for example to mark a turtle 1,173 holes would be drilled at the following locations.



Turtles were measured, numbered, and weighed

Big crab trap set in Dart Brook, a clear gravel bed stream

Cathedral trap also set in Dart Brook

Fyke net set in Dart Brook

2.3 Access to streams - Landholder permission

The first draft of potential turtle survey sites was produced by searching google satellite images taken during the worst of the drought when the rivers were dry except for the deepest holes. The lot and DP numbers of the land on which those holes occurred were sent to Scone and Singleton councils requesting the addresses of the owners to whom letters were sent seeking permission to survey turtles on their property. There was a good response and there were multiple sites to choose from for most streams except for the lower Hunter and Wollombi Brook which only had two replies and the Dart Brook and Bow Rivers that had no replies.

2.4 Opportunistic Frog and Bird recordings

Throughout the survey any significant fauna heard or observed were recorded. Each night the team camped alongside the stream being trapped and on most nights frog surveys were conducted to opportunistically look for the Booroolong Frog.

2.5 Limitations

The weather and seasonal timing was good, the trap-ability of the turtles was very good, the stream flows were good, and landholders were very helpful; the only limitation was the human factor of not having time to do more sites in the unknown area of the lower Hunter River.

3.0 RESULTS

3.1 Turtle Species Recorded

Table 1. Sites surveyed and results for each location trapped

Site	River	Date	Traps – (holes)	*Emydura macquarii gunabarra*	*Chelodina longicollis*
1	Goulburn	18/09/2020	3 (3)	24	0
2	Goulburn	27/09/2020	7 (6)	44	1
3	Goulburn	28/09/2020	5 (2)	76	1
4	Goulburn	28/09/2020	9 (1)	74	0
5	Goulburn	29/09/2020	5 (1)	41	0
6	Krui	29/09/2020	3 2)	16	0
7	Krui	30/09/2020	9 (1)	56	0
8	Krui	1/10/2020	8 (1)	68	0
9	Munmurra	2/10/2020	5 (3)	75	0
10	Munmurra	2/10/2020	3 (2)	42	2
11	Halls Creek	3/10/2020	2 (1)	15	0
12	Halls Creek	3/10/2020	4 (4)	22	0
13	Halls Creek	3/10/2020	2 (1)	29	1
14	Halls Creek	4/10/2020	9 (7)	54	12
15	Wybong Creek	5/10/2020	9 (9)	178	3
16	Merriwa	6/10/2020	9 (2)	235	5
17	Hunter	7/10/2020	9 (1)	8	0
18	Wollombi Brook	8/10/2020	8 (1)	21	1
19	Pages River	22/01/2021	8 (1)	20	1
20	Hunter River	22/01/2021	13 (1)	94	0
21	Lake Glenbawn	22/01/2021	1	2	1
22	Hunter River	22/01/2021	2 (1)	12	0
23	Pages River	22/01/2021	6 (1)	27	2
24	Dart Brook	22/01/2021	1 (1)	16	0
25	Dart Brook	22/01/2021	9 (3)	12	5
		TOTALS	**146**	**1261**	**35**

Figure 9. Graph shows the abundance of each turtle species recorded at each site.

Graph of the total of 35 Eastern Long-neck & 1261 Hunter River Short-neck turtles recorded. The higher abundance of Long-necks at site 14 was associated with a lower abundance of Hunter River Short-neck turtles and poorer habitat quality, indicating that Long-necks prefer muddy creeks and dams.

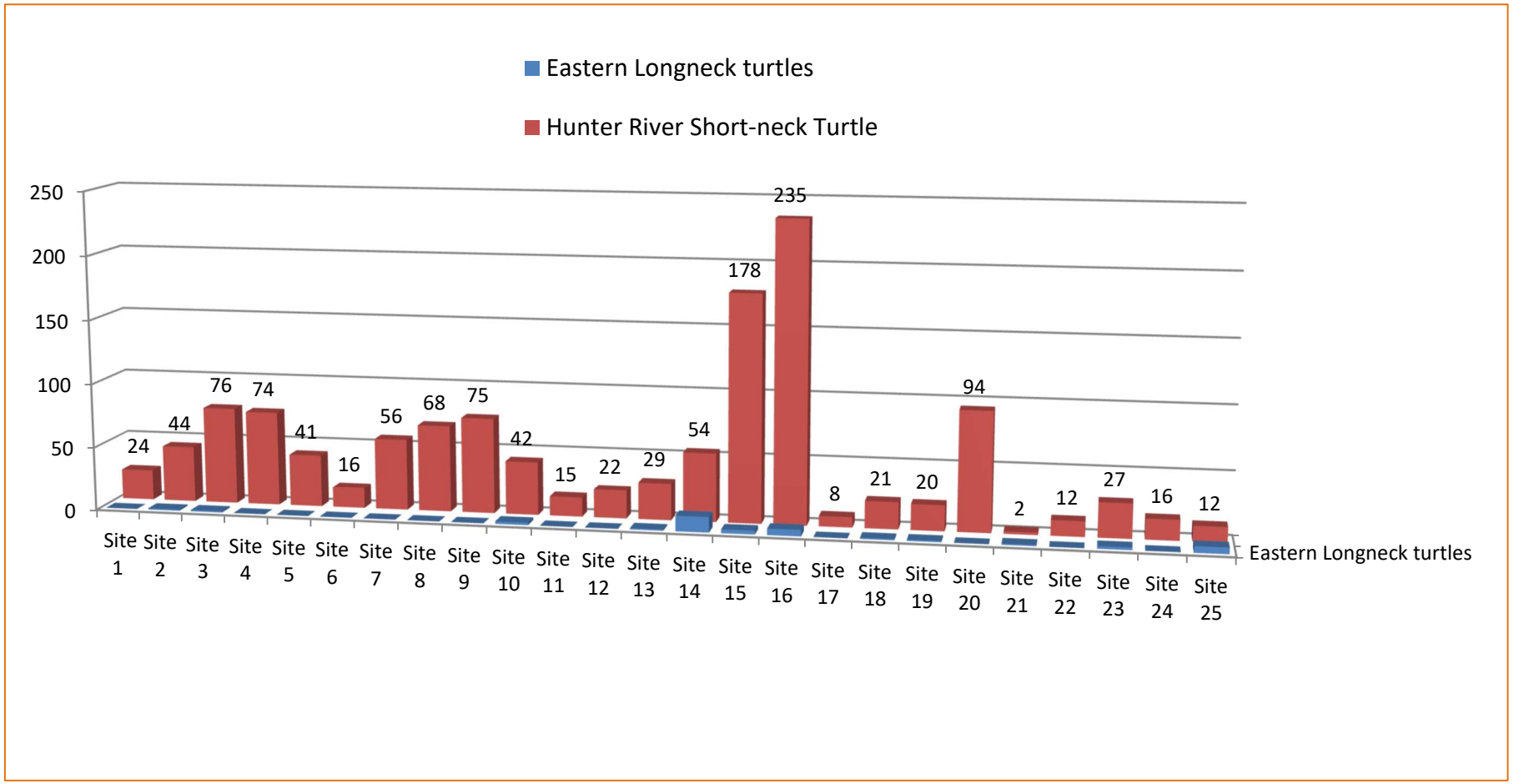
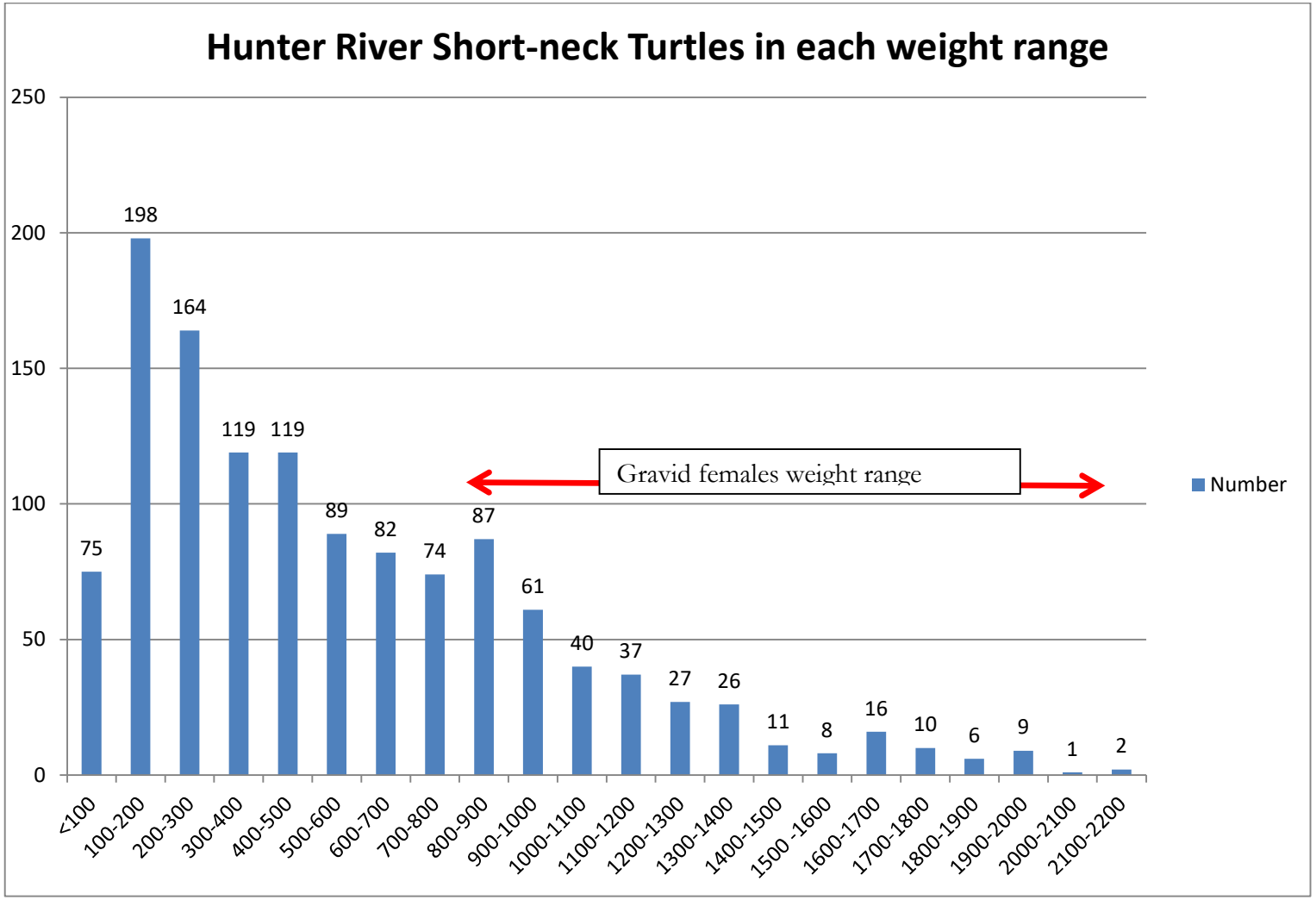
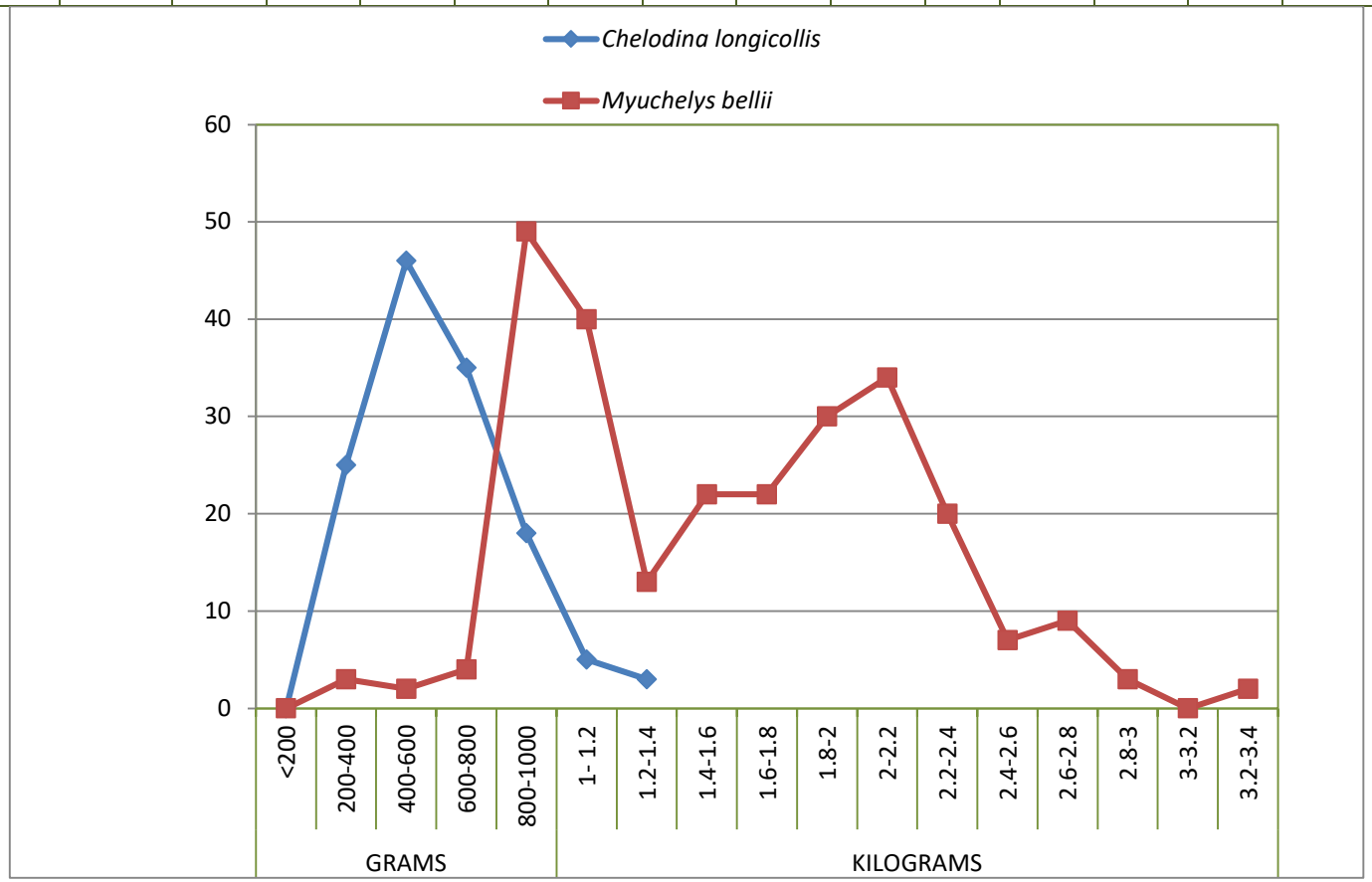


Figure 10. The abundance of Hunter River Short-neck turtles for each weight range.
Appears to be a population about to increase as the juveniles mature to breed and take advantage of improved seasonal conditions



This table and graph are unrelated to this survey but an example of what an aging turtle population looks like lacking recruitment due to fox predation of eggs; shows the captures of *C. longicollis* and *M. bellii* from the Macdonald River in 2020 sorted into weight ranges

	GRAMS					KILOGRAMS											
Weight ranges	**<200**	**200-400**	**400-600**	**600-800**	**800-1000**	**1-1.2**	**1.2-1.4**	**1.4-1.6**	**1.6-1.8**	**1.8-2**	**2-2.2**	**2.2-2.4**	**2.4-2.6**	**2.6-2.8**	**2.8-3**	**3-3.2**	**3.2-3.4**
Chelodina longicollis	0	25	46	35	18	5	3										
Myuchelys bellii	0	3	2	4	49	40	13	22	22	30	34	20	7	9	3	0	2



3.2 Mix of sexes

The table below is the breakdown of the 1261 Hunter River Short-neck turtles into sexes; a high proportion (340) of the juveniles could not be confidently sexed.

Male	Male ? juvenile	Female	Female ? juvenile	Juvenile unknown ?
269	91	652	93	156

3.3 Detection of gravid females

The seasonal timing of the turtle survey in late September and early October was too early for most females to have developed eggs large enough to be detectable by palpitation of the organ cavity. Only 4.59% or 30 females were confidently recorded as being gravid. Another 13 may have been gravid. The first eggs confidently detected were on the 3rd of October 2020; after that date the percentage recorded as gravid increased. The smallest female confidently recorded as gravid weighed 806 grams.

3.4 Weight classes

Female (608) was the largest turtle captured - weighed 2.153kg (full of eggs). She also had the largest carapace length 266mm and largest plastron length of 223mm.

The largest male recorded was 984 which weighed 1.138kg and was at Site 16, Merriwa River.

The male (1079) below was the third largest - weighed 1.062kg, carapace length was 216.5mm and plastron length was 178.9 mm

The four smallest turtles weighed less than 40grams; indicating that breeding & hatching occurred in February 2020 despite the drought of 2019

Table 2. Proportion of *E. m. gunabarra* population that are juvenile <200g

There appears to be a higher proportion of juveniles associated with the sandy streams, and fewer juveniles in the degraded Halls Creek, upper Hunter and Wybong Creek gravel bed streams at Sites 20 and 15. Site 16 was the exception; a degraded gravel bed stream with high abundance of all sizes. Dart Brook had fewer turtles, maybe because it had fewer drought refuge holes.

Site	River	Total *E. m. gunabarra*	Traps – (holes)	0 – 100g	100 - 200g	<200g
1& 2	Goulburn	68	10 (9)	nil	10	10
3	Goulburn	76	5 (2)	12	21	33
4	Goulburn	74	9 (1)	8	32	40
5	Goulburn	41	5 (1)	2	10	12
6	Krui	16	3 2)	nil	2	2
7	Krui	56	9 (1)	10	14	24
8	Krui	68	8 (1)	9	23	32
9	Munmurra	75	5 (3)	2	9	11
10	Munmurra	42	3 (2)	nil	12	12
11	Halls Creek	15	2 (1)	nil	nil	nil
12	Halls Creek	22	4 (4)	nil	2	2
13	Halls Creek	29	2 (1)	nil	nil	nil
14	Halls Creek	54	9 (7)	nil	nil	nil
15	Wybong	178	9 (9)	nil	7	7
16	Merriwa	235	9 (2)	26	43	69
17	Hunter	8	9 (1)	2	nil	2
18	Wollombi Brook	21	8 (1)	1	2	3
19	Pages River	20	8 (1)	1	4	5
20	Hunter River	94	13 (1)	nil	1	1
21	Lake Glenbawn	2	1	nil	nil	nil
22	Hunter River	12	2 (1)	nil	nil	nil
23	Pages River	27	6 (1)	2	2	4
24	Dart Brook	16	1 (1)	nil	3	3
25	Dart Brook	12	9 (3)	nil	1	1
		1261	**146**			

3.5 Additional data recorded from the turtles caught

Table 3. Summary of additional data recorded from the turtles caught

Recorded	Number of Hunter River Short-neck turtles affected
Fractures of carapace and/or plastron	8 -variety of fractures from heavy impacts - see photos, could be from stock trampling, boats, flood impacts??
Missing marginal scutes or damaged shell	23 -majority were impacted by an object or predators chewing on marginal scutes, possibly flood impacts??
Notches, grooves, holes	15 -mostly impacted by sharp objects, flood impacts??
Missing limbs or tails	4 -tails & 4 limbs, most likely predator attack
Warped carapace old turtles	5 -a sign of an old turtle when the carapace warps
Deformed shells	10 -raised carapace edges, gutters, 3 with no nuchal
Open wound /abscess?	1 -cause unknown, but healed well and released
Eyes	2 -cataract, 2 -smoky, 1 –damaged; very low incidence as compared to Bells Turtle population
Gravid with Eggs	30 confident, 13 questionable, 305 nil eggs, smallest female gravid was 806g
Swabbed turtles	38 -all clear for Bellingen River virus
Photos of turtles	80 -presented in drop box album.
Dimensions & weights	Presented in excel spreadsheet provided

3.6 Population estimate

Table 4 gives a very rough estimate of the total number of Hunter River Short-necked turtles in the streams surveyed. It came up with three estimates;

1. by adding together the number calculated for each stream = 126,588 turtles

2. using an average number of turtles per km for just the upper catchment streams (excluding Wollombi Brook, lower Hunter at Branxton and Glenbawn Dam) = 121,770 turtles

3. by using an average number of turtles per km for all streams surveyed = 132,81 turtles.

The estimates are considered minimal as only half of the turtles present would have been caught in one night of trapping, and the length of stream has been halved considering that the other half of the length of the stream would be too shallow to provide turtle habitat. That may be an under estimate because turtles forage widely at night in shallow areas, and the turtle abundance in Oct 2020 would have been at an all-time low after the worst drought on record killed a lot of turtles when the holes dried up.

The satellite image during the drought showed that some of the sites trapped were dry 12 months prior; the captures at those sites are likely to be below the average over the length of that stream. The Branxton lower Hunter site was a good example of a marginal hole because it was shallow and had flowing water, and had been completely dry in the drought.

The average abundance of turtles in the lower Hunter catchment is likely to be considerably higher than that reported in the results. Conversely, some sites trapped were better than the average habitat of that stream - hence the capture would be higher than the average per km. Site 19 on the Pages River at Blandford is a good example of a hole much better than holes elsewhere in the locality.

There were other major tributaries of the Hunter River that were not trapped that would contain substantial numbers of turtles - if included would increase the total population of Hunter River Short-neck turtles. Those streams include the Isis River, Williams River, Paterson River, Glennies Creek, Allyn River, Widden Creek, Martindale Creek, Brush Hill Creek, Stewarts Brook, Moonan Brook, Donalds Creek, Branch Creek and the Bow River. There are also the major dams that would provide suitable habitat; Lake St Clair, Chichester Dam, Lostock dam, Lake Lidell. The coal mine storages may also be potential habitat.

Table 4. Rough population estimate per stream

Sites	River	Length taken from Bonzle River lengths	Approx ½ length of Turtle Habitat	Trapped *Emydura macquarii gunabarra* to estimate rough number per 1000m	Rough population estimate
1, 2, 3, 4, 5	Goulburn	221km	100km	259 turtles over 1530m = 169	100 x 169 = 16,900
6, 7, 8	Krui	71km	30km	140 turtles over 530m = 264	30 x 264 = 7,920
9, 10	Munmurra	74km	30km	117 turtles over 220m = 531	30 x 531 = 15,930
11, 12, 13, 14,	Halls Creek	68km	30km	120 turtles over 810m = 148	30 x 148 = 4,440
15	Wybong Creek	86km	40km	178 turtles over 1000m = 178	40 x 178 = 7,120
16	Merriwa	78km	40km	235 turtles over 370m = 635	40 x 635 = 25,400
17	Lower Hunter River	150km	80km	8 turtles over 450m = 17	80 x 17 = 1,360
18	Wollombi Brook	118km	60km	21 turtles over 400m = 52	60 x 52 = 3,120
19,23	Pages River	97km	40km	47 turtles over 200m = 235	40 x 235 = 9,400
20, 22	Upper Hunter River	150km	70km	106 turtles over 250m = 424	70 x 424 = 29,680
21	Lake Glenbawn	20km	20km	2 turtles over 40m = 50	20 x 50 = 2,500
24, 25	Dart Brook	64km	30km	28 turtles over 300m = 93	30 x 93 = 2,790
Combined rough turtle estimate for those streams					126,588
All streams combined		1,197km	570km	Average 233per km	132,810
Upper streams only without sites 17,18, & 21		909km	410km	Average 297 per km	121,770

Table 4 shows how the number of *E. m. gunabarra* per km was estimated for each stream. If the estimated number per km is added up for the nine Upper Hunter streams, excluding Wollombi Brook and lower Hunter at Branxton and Glenbawn Dam, it comes to 2677 turtles. That number divided by the nine streams comes to an average number per km across those nine streams of 297turtles per km. If that 297 is multiplied by the 410 kms of the combined length of turtle habitat in those streams it comes to a total of 121,770 turtles.

If all the streams are included (Wollombi Brook, lower Hunter at Branxton and Glenbawn Dam) the stream length of potential turtle habitat comes to 570km, and an average of 233 turtles per km which multiplied comes to 132,810 total turtles in those streams.

Either way it is calculated it is a significant population that has just suffered the worst drought on record, and will likely increase in abundance until the next extreme event.

The loss of habitat in the western catchment could be an increasing threat as siltation works down through the river systems slowly filling the holes. Nest predation was observed by John Cann, however the numbers of juveniles recorded doesn't indicate a high predation threat, however it could also be an increasing threat if predators evolve to be more successful at finding nests. In the future disease and hybridisation with *E. m. macquarii* may be a threat.

3.7. Turtle Health assessment

By comparison to the Bells turtle population surveyed by NWES, the Hunter River Short-neck Turtle population appears to be very healthy. Turtles that had perished during the peak of the drought in 2019 were found at most sites. Four of the dead turtles from Halls Creek Site 14 were sent to the museum along with two smaller ones from the Wybong Creek. Mass turtle deaths have happened before; John Cann reported mass deaths in the Wybong Creek back in 2000.

Six dead turtles were sent to the Australian Museum from Halls Creek and Wybong Creek

Despite the mass mortality during the drought, the turtle is obviously resilient enough to have come through in good numbers. It is likely that the extreme drought event would have culled the weak, diseased, or disabled turtles, and after a good season the average health would be good.

During the peak of the drought on the 11th December 2019 one sick and one recently dead turtle *E. m. gunabarra* were collected from the Isis River where there was mass mortality and sent to Jane Hall at Taronga laboratory for post-mortem, histopathology, and screening for Bellinger River Virus (BRV). At the time, dead turtles were scattered along the dry river bed.

Turtle 1 that was found alive was euthanised at a private veterinarian in Tamworth. A post-mortem and histopathology (looking at the cells of the organs under a microscope) was performed on this animal, however there was no clear finding indicating a potential cause of the illness observed in the field.

Turtle 2 was found dead and unfortunately was not processed for histopathology due to advanced decomposition. No internal organs or structures could be identified. Bellinger River Virus (BRV) was excluded on fresh tissues and a conjunctival swab from Turtle 1 and an internal body cavity swab from Turtle 2.

Swabbing for viral analysis

38 Hunter River Short-neck Turtles from across the catchment had conjunctival swabs taken that were sent to Kate Parrish at Elizabeth Macarthur Agricultural Institute (EMAI) to screen for Bellingen River virus (BRV). The swab report from Kate Parish advised that all those tested came back negative in a BRV qRT-PCR .

Turtle 637 from Wybong Creek was the only trapped animal with an open abscess on both sides of its tail. Initially it was thought to be cancerous, so it was sent to Taronga to be assessed, however it was treatable and the turtle recovered well to be released again.

Jane Hall reported that the wound was chronic, so while it may not have been that extensive when it first appeared, the infection had gone on to cause necrosis of the margins of the wound (the tissue died) which gets worse until the body can fight it back.

The animal's shell appeared normal, but it had deep ulcerations on the caudal aspect of each thigh penetrating down to the muscle layer, which were coated with grey, fibrinoid material. Biopsies collected from the margin of each ulcer showed that the wounds were consistent with chronic bacterial infection. What caused the wounds is uncertain, and while squamous cell carcinoma cannot be excluded based on histopathology, it is likely the animal suffered trauma to the area, possibly from predation.

Turtles are slow to heal, a lot longer than it would take in most mammals – which is why the animal was in care for months to get the wounds to heal and close. It may not have survived if it was not brought it in for treatment.

Eye health

The 1261 turtles had very few eye problems - only 2 had cataracts, 2 had smoky coloured eyes, and 2 had a damaged eye - shown below.

Below -Turtle 268 -Krui River had a smoky left eye

Turtle 567 Halls Creek damaged right eye

Shell Damage and Deformity-

The turtle shown below appeared to have been chewed by a predator

This turtle (1110) at Site 20 Hunter River at Moonan appeared to have a fractured plastron – perhaps from a heavy impact

The turtle below had a deformed carapace

Turtle 1068 at Wollombi Brook also had a deformed carapace

Turtle 859 Site 16 Merriwa River had a deformed carapace with curled edges

Turtle 142 from Site 3 Goulburn River O'Brien's crossing was missing its left foot and its carapace had been chewed around that leg

3.9 Stream Habitat Assessment

The captures of both Hunter River Short-neck turtles and Eastern Long-neck turtles gave some insight into their preferred habitats in the Hunter catchment; however there were exceptions to the broad trends.

The Merriwa River at Site 16 was the exception that caught the most turtles (235) yet it was a degraded stream; it also recorded the highest abundance of Goldfish, Carp, and Eels.

The broad trends were that Hunter River Short-neck turtles occur in all the streams, but degraded streams like Site 14 Halls Creek had fewer and those present were dominantly old mature turtles, whereas elsewhere they were abundant and immature/juvenile turtles dominated.

Table 2 shows there was a trend for higher immature turtle abundance in the sandy bed streams as compared to the gravel bed streams. The loamy soil banks for nesting may result in higher recruitment as compared to the hard setting basalt clays.

Halls creek was also the only stream where Eastern Long-neck turtles were considered common.

The other stream where the Eastern Long-neck turtle was more common was the clear gravel bed Dart Brook where five were caught; it also caught fewer (12) Hunter River Short-neck turtles which may be an indication that Hunter River Short-neck turtles exclude or out-compete the Eastern Long-neck turtles when they are abundant. The Dart Brook had fewer turtles in total, that was likely due to fewer refuge holes in the drought.

The author has observed the movement of Eastern Long-neck turtles in the New England tableland streams during drought and after drought, where they are common in rivers during drought, but they leave the rivers as soon as it rains.

The low abundance of Eastern long-neck turtles was consistent and most noticeable at the low elevation streams of Wollombi Brook and the Hunter River at Branxton where seventeen traps caught 1 Eastern Long-neck turtle.

The Hunter River at Branxton recorded the least turtles per trap, but the 8 Hunter Short-neck turtles caught were a good mix of age classes; two were tiny turtles that weighed just 31grams that had hardly grown in their first year. There were tracks in the sand 7th Oct that looked like a female test dig. The females trapped were ready to lay; palpating could feel big hard eggs. The section of river trapped was a dirty coloured, flowing, long shallow section. European carp and eels were common.

The turtles caught in the first two weeks were very dirty, which indicates being buried in mud over winter, and for some they may have been buried longer if the streams did not flow before winter.

3.10 Threats to Turtles

The local people who have spent their lifetime in the western catchment, all told of how the streams have changed dramatically over their lifetime. They recalled deep holes where they swam and caught Bass as kids – those deep holes are now just a metre deep.

Seems the problem is getting worse not better, as the volume of silt from erosion moves down the system. The Goulburn River appears to be the worst affected. The loss of deep refuge holes increases the impact of droughts on all aquatic life, as the holes are fewer and dry out more quickly. Within the few holes that do persist, there is likely be increased predation from exotic and native predators such as eels, catfish, and sea eagles.

The genetics of the population is also under threat from hybridisation with *Emydura macquarii macquarii* from people releasing unwanted pets. One turtle trapped was a suspected hybrid.

The abundant immature age class suggests good recruitment with insignificant egg predation from nests, which is a major problem for the Bell's turtle on the New England Tablelands. John Cann reported seeing nests dug up, so it may be that foxes are evolving to get better at finding nests and it may become a major threat in the future.

Weed invasion of riparian areas that results in increased shading and loss of nesting beds can be a significant impact to turtles. Likewise the clearing of native vegetation and over-grazing that increases erosion can have significant impact on aquatic ecosystems.

All the side effects of climate change are a major threat to turtles through rising temperatures, prolonged and more extreme heatwaves and droughts, higher evaporation, increased erosion, and the defoliation and death of vegetation.

The Hunter River turtle population currently appears healthy, however disease is a major threat in the Bellingen River: biosecurity regulations and awareness are required to prevent disease introduction.

Water extraction for irrigation and even stock and domestic supplies during droughts can be a major threat to refuge holes when flows stop.

Pollution sources from surrounding land uses are likely to be significant threats to turtles and the aquatic ecosystems, particularly during low flows. Land management is responsible for controlling most of those threats, and those related to climate change require global action to reduce emissions.

3.11 Non-target species trapped

Table 5 shows the most common fish trapped were the exotic European Carp, Goldfish, and the native Longfin Eels. The other exotic, Mosquito Fish, were only recorded in Wollombi Brook but are likely to also be common in the small creeks and backwaters. Another four native fish species were found associated with the clearer streams: Freshwater Mullet, Cox's Gudgeon, Australian Smelt, and the Eel-tailed Catfish which is an endangered population.

Frog surveys were conducted opportunistically most nights when camped by the streams.

The western headwater streams looked to be good habitat for Booroolong Frogs, however none were found. The eastern headwater streams are known habitat for Booroolong Frogs, but during this survey they were only recorded in the Hunter at Moonan. The common frog species found were *Limnodynastes dumerilii, Litoria peronii, Litoria wilcoxii,* and *Crinia signifera.*

Table 5. Additional species captured in the traps

Common Name	Scientific Name	No.	Site numbers	Rivers
Freshwater Mullet	*Trachystoma petardi*	1	4	Goulburn
Longfin Eels	*Anguilla reinhardtii*	18	3, 7, 8, 9, 12, 16, 17, 18, 22, 25	Hunter, Goulburn, Krui, Munmurra, Halls Creek, Merriwa, Wollombi, Dart Brook
Cox's Gudgeon	*Gobiomorphus coxii*	7	15, 19, 25	Pages, Wybong Creek, Dart Brook
Australian Smelt	*Retropinna semoni*	20	19	Pages
Eel-tailed Catfish	*Tandanus tandanus*	4	6, 19	Pages, Krui
Goldfish	*Carassius auratus*	8	15, 16,19, 20, 23, 25	Pages, Merriwa, Dart Brook
European Carp	*Cyprinus carpio*	36	15, 16, 17, 19, 20, 23, 25	Pages, Hunter, Merriwa, Dart Brook, Wybong Creek
Mosquito fish	*Gambusia holbrooki*	20	18	Wollombi Brook

3.12 Opportunistic records

Significant species recorded were; Glossy Black-cockatoos at Site 7 Krui River, Grey-crown babblers at Site 11 Halls Creek, Painted Honeyeater at Site 18 Wollombi Brook, and Eastern brown snake and Little Red Flying fox at Site 14 Halls Creek.

Booroolong Frog – *Litoria booroolongensis* and its habitat in the Hunter River at Site 20

Eel-tailed Catfish – *Tandanus tandanus*, an endangered population found in the less degraded clear gravel bed streams like the Krui and Pages River.

Cox's Gudgeon – *Gobimorphus coxii* common in clear gravel streams like the Pages, Wybong Creek and Dart Brook.

Australian Smelt – *Retropinna semoni* also found in clear gravel streams like the Pages River.

Exotic fish species European Carp – *Cyprinus carpio* and Goldfish *Carassius auratus* recorded at seven sites common throughout the Hunter River catchment

Exotic Mosquito Fish – *Gambusia holbrooki* common in Wollombi Brook, likely to be throughout the catchment in creeks and dams

Longfin Eel – *Anguilla reinhardtii* recorded at nine sites throughout the Hunter River catchment; likely in all streams, potential predator of juvenile turtles

Common River Prawn - *Macrobrachium australiense* common in the clear gravel bed streams

Freshwater Mullet – *Trachystoma petardi* recorded in the Goulburn River

3.13 Photograph and description of each survey site

Site 1 Goulburn River National Park

Trapped three holes with three traps - caught 24 Hunter Short-neck turtles and nil Eastern Long-neck turtles.
Nil juveniles < 100g and 3 below 200g.
Nil gravid females 18th Sept 2020.
A clear gravel bed and sand stream, adjoining slopes sandstone National Park.

Site 2 Goulburn River National Park

Trapped six holes with seven traps - caught 44 Hunter Short-neck turtles and 1 Eastern Long-neck turtle.
Nil juveniles < 100g and 7 below 200g.
Nil gravid females 27th Sept 2020.
A clear gravel bed and sand stream, adjoining slopes sandstone National Park.

Site 3 Goulburn River Obrien's Crossing

Trapped two holes with five traps - caught 76 Hunter Short-neck turtles and 1 Eastern Long-neck turtle.
Twelve juveniles < 100g and 21 below 200g and an Eel.
Nil gravid females - too early at 28th Sept 2020.
A sandy bed stream that was dirty at the time.

Site 4 Goulburn River private property

Trapped one big hole with nine traps - caught 74 Hunter Short-neck turtles and nil Eastern Long-neck turtles.
Eight juveniles < 100g and 32 below 200g and a Freshwater Mullet.
One likely to be gravid female - too early at 28th Sept 2020.
A sandy bed stream that was dirty at the time.

Site 5 Goulburn River private property

Trapped one big hole with five traps - caught 41 Hunter Short-neck turtles and nil Eastern Long-neck turtles.
Two juveniles < 100g and 10 below 200g.
Nil gravid females - too early at 29th Sept 2020.
A sandy bed stream that was dirty at the time.

Site 6 Krui River private property

Trapped two small holes with three traps - caught 16 Hunter Short-neck turtles and nil Eastern Long-neck turtles.
Nil juveniles < 100g and 2 below 200g.
Nil gravid females - too early at 29th Sept 2020.
A sandy bed stream that was dirty at the time.

Site 7 Krui River private property

Trapped one big hole with nine traps - caught 56 Hunter Short-neck turtles and nil Eastern Long-neck turtles.
Ten juveniles < 100g and 14 below 200g.
Five Eels.
Nil gravid females - too early at 30th Sept 2020.
A gravel bed stream that was dirty at the time.

Site 8 Krui River private property

Trapped one big hole with eight traps - caught 68 Hunter Short-neck turtles and nil Eastern Long-neck turtles.
Nine juveniles < 100g and 23 below 200g
Nil gravid females - too early at 1st Oct 2020.
Three Eels.
A gravel bed stream that was dirty at the time, banks dominated by Willows.

Site 9 Munmurra River private property

Trapped three holes with five traps - caught 75 Hunter Short-neck turtles and nil Eastern Long-neck turtles.
Two juveniles < 100g and 9 below 200g.
One gravid female and two likely - too early at 2ndst Oct 2020.
One Eel.
A gravel bed stream that was dirty at the time.

Site 10 Munmurra River private property

Trapped two small holes with three traps - caught 42 Hunter Short-neck turtles and 2 Eastern Long-neck turtles.
Nil juveniles < 100g and 12 below 200g.
Nil gravid females - too early at 2ndst Oct 2020.
A gravel bed stream that was dirty at the time.

Site 11 Halls Creek private property

Trapped one hole with two traps - caught 15 Hunter Short-neck turtles and nil Eastern Long-neck turtles.
Nil juveniles < 100g and nil below 200g.
Nil gravid females 3rd Oct 2021.

Site 12 Halls Creek private property

Trapped four holes with four traps - caught 22 Hunter Short-neck turtles and nil Eastern Long-neck turtles.
Nil juveniles < 100g and 2 below 200g.
Two likely to be gravid females - 3rd Oct 2021.

Site 13 Halls Creek private property

Trapped one hole with two traps - caught 29 Hunter Short-neck turtles and 1 Eastern Long-neck turtle.
Nil juveniles < 100g and nil below 200g.
Nil gravid females - 3rd Oct 2021.

Site 14 Upper Halls Creek private property

Trapped seven holes with nine traps - caught 54 Hunter Short-neck turtles and 12 Eastern Long-neck turtles.
Nil juveniles < 100g and nil below 200g.
Nine gravid females and four likely gravid females.

Halls Creek was one of the most degraded creeks surveyed. The upper section was worse than the lower section; its instream habitat resembled a dam more than a gravel bed stream. It was unique in that it had the least number of juvenile turtles, and yet it had a high proportion of large female turtles that were gravid. It also had a higher proportion of Eastern Long-neck turtles. Found four dead turtles along the creek that had died during the drought.

Eastern long-necks seem to prefer degraded creeks and dams. They may be actively excluded from the better streams by the Hunter River Short-neck turtles. Smallest gravid female was 806 grams.

Site 15 Wybong River private property

Had the second highest capture success - 178 Hunter River Short-neck turtles and three Eastern Long-neck turtles; trapped nine holes with nine traps.
No juvenile turtles < 100g and 7 juveniles < 200g, and 9 gravid females.
A clear gravel bed stream that was likely dry during the drought; high enough in the catchment to be less degraded.

Site 16 Merriwa River private property

Trapped one long hole and a short hole with nine traps - caught 235 Hunter Short-neck turtles and 5 Eastern Long-neck turtles; the highest capture success.
Twenty six juveniles < 100g and forty three below 200g.
Seven gravid females and three likely gravid females - 6th Oct 2020.
Lots of Goldfish, Carp, and eels.
A gravel bed stream but degraded by intensive agriculture, a short distance upstream it is clear and clean.

Site 17 Hunter River private property at Branxton

Trapped one long shallow hole with nine traps - caught 8 Hunter Short-neck turtles and nil Eastern Long-neck turtles; the lowest capture success.
Two juveniles < 100g and nil below 200g.
Three heavily gravid females - 7th Oct 2020.
Lots of carp and eels.

Site 18 Wollombi Brook private property

Trapped a long deep hole which should have been good turtle habitat but only caught 21 Hunter Short-neck turtles and 1 Eastern Long-neck turtle with eight traps.
Had the second lowest capture success, 1 juvenile < 100g and 2 below 200g.
No gravid females.

Site 19 Pages River private property

Trapped one large hole with eight traps - caught 20 Hunter River Short-neck turtles and 1 Eastern Long-neck turtle.
1 juvenile < 100g and 4 below 200g.
Trapped in January 2021 so no gravid females.
A clear gravel bed stream, lots of native fish.

Site 20 Hunter River Moonan private property

Trapped one large hole with thirteen traps - caught 94 Hunter River Short-neck turtles and nil Eastern Long-neck turtles.
Nil juvenile < 100g and 1 below 200g.
Trapped in January 2021, so no gravid females.
A dirty gravel bed stream, lots of European carp and Booroolong Frogs.

Site 21 Glenbawn Dam

Trapped with 1 trap - 2 Hunter Short-neck turtles and 1 Eastern Long-neck turtle.
Nil juveniles < 100g and nil below 200g.
Trapped in January 2021, so no gravid females.
Dams are known to support good populations of *Emydura macquarii* and are likely to be good for *Emydura macquarii gunabarra* as well.

Site 22 Hunter River below Glenbawn Dam

Trapped one large hole with two traps - caught 12 Hunter Short-neck turtles and nil Eastern Long-neck turtles.
Nil juveniles < 100g and nil below 200g,.
Trapped in January 2021, so no gravid females.
1 Eel
A dirty hole with no flow at the time.

Site 23 Pages River Gundy recreation reserve

Trapped one large hole with six traps - caught 27 Hunter Short-neck turtles and 2 Eastern Long-neck turtles.
Two juveniles < 100g and two below 200g.
Trapped in January 2021, so no gravid females.
8 European Carp and 3 Goldfish.
A dirty gravel bed stream at the time.

Drought photo above Dec 2019 and January 2021 below

Site 24 Dart Brook Bunnan Road Bridge

Trapped one hole with one trap - caught 16 Hunter River Short-neck turtles and nil Eastern Long-neck turtles.
Nil juveniles < 100g and 3 below 200g.
Trapped in January 2021, so no gravid females.
A clear gravel bed stream, likely to have been completely dry in drought.

Site 25 Dart Brook private property

Trapped three holes with nine traps - caught 12 Hunter River Short-neck turtles and 5 Eastern Long-neck turtles.
Nil juveniles < 100g and 1 below 200g.
Trapped in January 2021, so no gravid females.
Lots of native fish and European Carp and Goldfish.
A clear gravel bed stream likely to have been all dry in drought

Did not survey Bow River; it appeared to be more degraded than any of the streams surveyed.

4.0 CONCLUSION

The population of Hunter River Short-neck turtles - *Emydura macquarii gunabarra* is both very abundant and healthy across the Hunter catchment, 1261 were trapped in 146 traps; a very high average of 8.6 turtles per trap, especially considering 17 traps had a nil result.

The mass mortality recorded during the drought was a significant impact to the population; however it is likely to bounce back after a couple of average rainfall years. A similar mass mortality event was observed by John Cann in the early 2000's in the Wybong Creek. The results show the species is very resilient - much like the *Emydura macquarii* that occurs in the inland slopes streams.

The *Emydura macquarii gunabarra* population has a good mix of age classes but is dominantly immature as shown in the graph of the weights of the 1261 turtles processed (Figure 10). The average weight was 569grams, which is a sub-adult turtle. As the immature turtles mature to begin to breed, the population should increase significantly.

The mix of sexes was dominantly female as was expected; a high proportion (340) could not be confidently sexed as they were too small.

Male	Male ? juvenile	Female	Female ? juvenile	Juvenile unknown ?
269	91	652	93	156

The high abundance of juvenile turtles suggests recruitment is sustaining the population, and if nest predation is occurring it is not excessive, as is the case shown by the example graph of age classes for the Bell's turtle on page 31. This surveys timing did not coincide with laying to observed nest predation. It began late Sept and ended early October before egg laying began in Oct and the second survey was after egg laying in January.

During the first two weeks of the survey female turtles became noticeably gravid toward the end of the second week. The first female confidently recorded as gravid was on the 3rd Oct, before that date it was too early to detect eggs. On the 7th Oct 2020 tracks and digging were observed in the sand that indicated a test dig in the lower Hunter River at Branxton. The smallest gravid female weighed 806 grams.

Very few of the turtles had health issues; just a couple had cloudy eyes and one had deep ulcerations. Many more had damage of some sort but were otherwise very healthy. Swabs taken from 38 turtles were found to be clear of Bellingen River virus.

The population of Eastern Long-neck turtles - *Chelodina longicollis* is very sparse in the river system; 35 were trapped in 146 traps. After the drought they are likely to have moved out of the rivers to farm dams and small creeks. Also it is likely that there is some competition/exclusion going on between them and *E. m. gunabarra.*

Emydura macquarii gunabarra was most common in the mid elevation streams between 174m & 350 m ASL. The population was found to be significantly less at low elevations between 17m and 90m ASL, but there was still a healthy mix of age classes.

In the western half of the Hunter catchment *Emydura macquarii gunabarra* was trapped at an average of 9.8 turtles per trap; at low elevations trapping success dropped to 1.7 turtles per trap with 29 caught in 17 traps. The highest elevation trapped (320m) in the Wybong Creek trapped 178 turtles in 9 traps, an average of 19.7 turtles per trap. That record was broken at Merriwa with 235 turtles caught in 9 traps - an average of 26 turtles per trap.

Trapping in January 2021 in the eastern half of the Hunter catchment recorded fewer *E. m. gunabarra;* 183 were caught in 37 traps which is an average of 4.9 turtles per trap. Those sites were on average at higher elevation with the highest at 450m in the Pages River, and the next highest was 350m in the Hunter River above Glenbawn Dam. A likely reason for lower captures would be the later trapping in January 2021.

The author has experienced declining captures after December in the streams of the New England tablelands.

A couple of trends were observed in the smaller degraded streams with lower water quality like at Halls Creek where the population appeared to be older *Emydura macquarii gunabarra;* in those locations *Chelodina longicollis* were more common. In the larger less degraded streams it appears that *Emydura macquarii gunabarra* either out-compete or exclude *C. longicollis*. Also at Halls Creek the egg development appeared earlier in the season as more turtles with large eggs were detectable.

There appears to be little difference in *Emydura macquarii gunabarra* abundance between sandy and gravel bed streams, apart from a higher abundance of juvenile turtles in the sandy steams. Sandy streams are likely to provide more suitable nesting habitat with loamy soft soil.

All of the long-term landholders spoke of the streams losing the deep holes over time due to sedimentation from upstream erosion. Vast stretches of the Goulburn River are now too shallow to put in a trap. The fish species are likely to be more affected by the loss of holes than the turtles. Fewer floods will allow the sediments to fill the refuge holes that would have normally provided the drought refuges.

Amazingly there were four small turtles trapped, each weighing less than 40grams. They are likely to be from the 2020 February hatching and there were more from the 2019 February hatching, indicating that the turtles continued to breed through the worst of the drought in 2019 and successfully hatched and survived despite the very low water levels.

Most of the small turtles had a thick coating of algae and mud likely indicating they had been buried in the river bed camouflaged from predators.

The long-term threats to the *Emydura macquarii gunabarra* population are stream sedimentation due to erosion and prolonged low flows, diseases such as the Bellingen River virus, increased predation of eggs and females laying eggs, pollution, river regulation, water extraction, weed invasion of nesting banks, and the extremes of hot and dry due to climate change.

Land management is responsible for controlling most threats and those related to climate change require global action to reduce emissions. State regulations are required to prevent pollution, land clearing and water extraction. Biosecurity regulations and awareness are required to prevent disease introduction.

Other actions that can be of benefit to aquatic ecosystems include weed and feral predator control, protection and maintenance of refuge holes, and the use of bores to provide off-stream water points for stock and domestic supplies.

More survey trapping is required at low elevations to assess turtle populations and aquatic ecosystem condition relevant to potential surrounding land use pressures.

Further surveys would refine the rough estimate of the turtle population. Even if there is only half the population of this survey estimate, the population would still be at healthy levels.

The protection of natural spring fed permanent holes is very important, such as the one below on the Isis River. The protection of such refuge holes is critical for the ongoing survival of all the aquatic species, including vulnerable fish and the Booroolong Frog.

The major refuge holes and spring fed holes need to be mapped and targeted for incentive funding to protect and enhance them.

Spring fed hole in the Isis River during the worst of the 2019 drought

REFERENCES

Cann, J. & Sadlier, R. 2017 - Freshwater Turtles of Australia by CSIRO publishing

APPENDIX 1. North West Ecological Services Turtle Recording Proforma

Turtle trapping location **Date** **Sheet Number**

Operation No.	Species	Sex	Mark	Recapture? Yes, No	Carapace length midline (cm)	Plastron length midline (cm)	Carapace Width	Weight (g)	Eyes; Smokey, Cataract, Blind	Shell damage Scute notches,	Eggs	Age; Juv, Sub, Adult, Warped	Swabbed	Photo	Notes – Marks? Damage? Lesions? etc