

# **Brisbane Catchment Mary River Cod Monitoring**

## **Targeted Baseline Mary River Cod Surveys in the Brisbane and Bremer Catchments**



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## **Background**

The Somerset and Wivenhoe Fish Stocking Association (SWFSA) has been instrumental in delivering the Brisbane River Cod Recovery Program. This program was borne following a rigorous workshop in 2018 attended by relevant stakeholders, whereby a need for the program to be formally initiated and delivered was identified. Between November 2020 and June 2023, SWFSA have released a total of 47,900 Mary River cod across 78 sites.

Unfortunately, flood events of February and May 2022 significantly impacted water quality and habitat across the majority of sites stocked. It was suspected that issues relating to lost riparian vegetation, physical displacement of individuals and sediment smothering structurally complex habitats, that many of the cod released through the group's recovery efforts may have been lost.

In early 2023, SWFSA successfully applied for a grant through the Disaster Recovery Funding Arrangements (DRFA) 'Sub-Package C – Biodiversity Conservation Program', to undertake targeted aquatic surveys throughout the Bremer and Brisbane catchments. These surveys were to assess the current state of the recovery program which will be indicated by the presence of juvenile cod within the reaches stocked through the recovery program. Alternatively, the absence of fish will likely indicate impacts to survivorship brought about by the floods.

The results of these surveys will provide baseline data for this program and information where cod have managed to persist through the flood events, and areas where losses may have occurred. This information will inform future stocking strategies and assist in identifying key features of resilient habitats and reaches. The results will also provide information on survivorship and growth rates on individuals which have managed to persist despite the widespread flooding of 2022.

## **Objectives**

- 1) Assess the current state of cod populations through the recovery reaches within the Bremer and Brisbane River catchments and their associated tributaries.
- 2) Detect reaches that juvenile cod (<300mm) released through the Brisbane River Cod Recovery Program since 2019 have persisted through the floods.
- 3) Assess abundances and distributions of the vulnerable Queensland Lungfish throughout these catchments.
- 4) Measure species richness and estimated abundances (native and pest species) of other species occupying these reaches.

## **Methods**

This monitoring was conducted in mid-October through the Bremer and Brisbane River catchments. Sampling was primarily undertaken using a boat mounted 7.5 Kva electrofishing unit (Smith Root) and pulsed dc power. Backpack electrofishing was to be used at sites too small or shallow to use the boat. Where possible, a minimum of 1000 seconds of "power on time" was conducted at each site. Electrofishing targeted habitat preferred by cod to maximise the catch of this species. All fish and crayfish species were counted and recorded, and any cod or small lungfish (<700mm) encountered were netted and placed in a holding tank for later processing.

All cod and lungfish captured were measured, weighed, genetically sampled and tagged. Tags used were Passive Integrated Transponders (PIT) inserted into the body cavity.

Water quality parameters were also recorded at each site. Water quality characteristics including pH, water temperature, dissolved oxygen and conductivity were measured at the water surface. Basic physical characteristics of each site was described in terms of average width and maximum depth.

A minimum of 20 sites were to be sampled, selected from a list provided by members of SWFSA of sites that have been stocked through the recovery program and were flood-affected. Sites selected will offer a representative cross section of stocking effort over the Brisbane, Stanley, Bremer and Warrill catchments. Access to these sites where required was also facilitated by members of SWFSA.

**Figure 1. Images of boat electrofishing activities with one operator and two netters.**



## Sites

A total of 29 sites were visited during the monitoring (Table1). Three sites were visited on Warrill Creek, Six sites on the Bremer River, 14 on the Brisbane River, two on Emu Creek and one each on Neurum and Stoney Creeks and the Stanley River. Three sites visited were not sampled. Two of these sites (Keanes Rd and Ivor Marsden Park) were designated as backpack electrofishing sites but unfortunately poor water quality, namely high conductivity at Keanes Rd (Table 2) would have made backpack electrofishing ineffective. At Ivor Marsden Park, dissolved oxygen levels were extremely low because of algae covering the entire water surface. Any fish captured would be unlikely to survive. The remaining site on Stoney creek was a boat electrofishing site but the launch was deemed too precarious.

Sites sampled on Warrill Creek, whilst located in high value agricultural land still retained a reasonable amount of riparian vegetation, large woody debris, little evidence of sedimentation with good water depths and undercut banks (Figure 2). Similarly, the Bremer River sites retained surprisingly good instream habitat with substantial amounts of large woody debris and undercut banks and largely unimpacted riparian zone, they did show signs of increased sedimentation at some sites and increased salinity levels (Figure 3).



**Figure 2. Site image at Warrill Creek (Site No. 2)**



**Figure 3. Site image at Bremer River (Berry Weir)**



All Brisbane River sites showed the highest levels of flood impact on the riparian zone. The mid Brisbane River is the most highly regulated of all sites sampled, this area also had great riparian vegetation prior to the recent flooding during which much was damaged or lost. This area still retains good amounts of large woody debris and some rocky areas. The upper Brisbane River sites retained only a narrow riparian zone dominated largely by callistemons, much less large woody debris than most other sites, but rockier habitat and still some good undercut banks. These sites also showed some indications of a recent increase in sedimentation and resulting decrease in depth.

Emu Creek was the surprise of the survey with small waterholes retaining good depths and instream habitat and riparian zones. Similarly, the sites in the Stanley reach of the catchment retain a largely intact riparian zone and incredible amounts of large woody debris, however recent flooding has resulted in increased sedimentation and some shallowing of the waterholes.



Figure 4. Habitat images. Note good in-stream habitat, however limited riparian in some reaches.

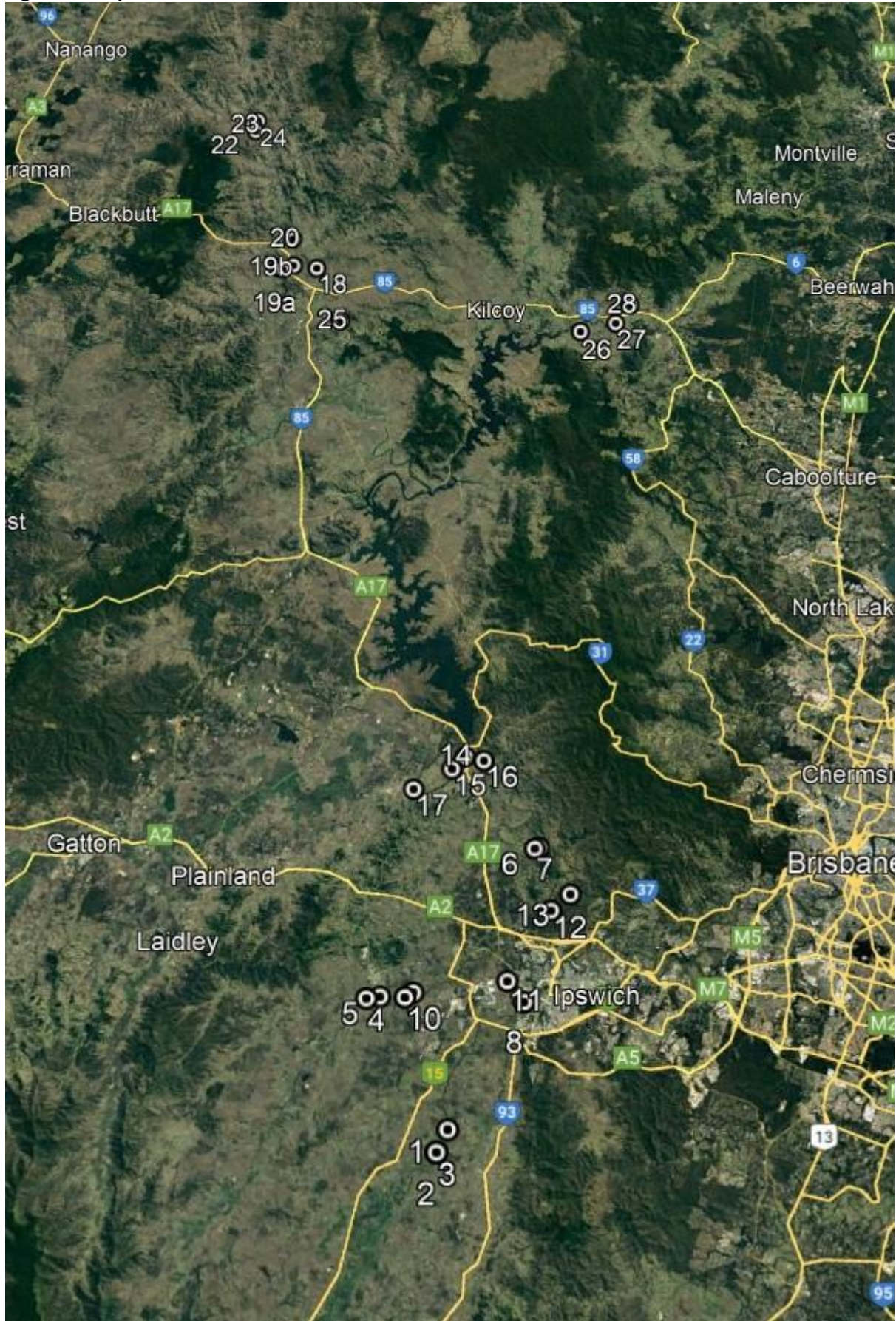


**Table 1 Sites sampled/visited**

Site No.	Site Name	River	Date	Upstream Latitude	Upstream Longitude	Downstream Latitude	Downstream Longitude
1	[REDACTED]	Warrill Creek	14/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
2	[REDACTED]	Warrill Creek	14/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
3	[REDACTED]	Warrill Creek	14/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
4	[REDACTED]	Bremer R	15/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
5	[REDACTED]	Bremer R	15/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
6	[REDACTED]	Brisbane R	15/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
7	[REDACTED]	Brisbane R	15/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
8	[REDACTED]	Bremer R	16/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
9	[REDACTED]	Bremer R	16/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
10	[REDACTED]	Bremer R	16/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
11	[REDACTED]	Bremer R	16/10/23	** Not sampled **			
12	[REDACTED]	Brisbane R	17/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
13	[REDACTED]	Brisbane R	17/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
14	[REDACTED]	Brisbane R	17/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
15	[REDACTED]	Brisbane R	17/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
16	[REDACTED]	Brisbane R	18/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
17	[REDACTED]	Brisbane R	18/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
18	[REDACTED]	Brisbane R	19/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
19a	[REDACTED]	Emu Ck	19/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
19b	[REDACTED]	Emu Ck	19/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
20	[REDACTED]	Brisbane R	19/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
21	[REDACTED]	Emu Ck	19/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
22	[REDACTED]	Brisbane R	20/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
23	[REDACTED]	Brisbane R	20/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
24	[REDACTED]	Brisbane R	20/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
25	[REDACTED]	Brisbane R	20/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
26	[REDACTED]	Neurum Ck	21/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
27	[REDACTED]	Stanley R	21/10/23	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
28	[REDACTED]	Stoney Ck	20/10/23	** Not sampled **			



Figure 5. Map of Sites



## Results

### Mary River Cod Results

Ten Mary River cod *M.mariensis* were captured with a further two observed. The smallest was only 145mm in length and the largest 697mm (Table 4). All fish captured were tagged and had genetic samples collected. Genetic samples will be used for further research into ageing and diversity within the population. No cod were collected or observed within the Bremer catchment during this survey, all cod were collected in the mid Brisbane River, Emu Creek and the upper Brisbane and Stanley Rivers.

**Table 4 Mary River Cod Information.**

Site No.	Length (mm)	Weight (g)	Pit	Genetic Sample	
				DR Genetic	tsu
15	594	2934	141000009705	GF001	AU7394332
15	697	4518	141000010432	GF002	AU7394333
17	145	46	15300039887	GF003	AU7394335
18	446	1358	982000210206206	GF004	AU7394322
19a	525	2942	982000210206892	GF005	AU7394356
19a	406	1254	982000210208028	GF006	AU7394355
19b	335	624	982000210206811	GF007	AU7394351
23	432	1586	091061590529	GF009	AU7394344
27	426	1354	091061590615	GF010	AU7394347
27	325	510	091061590546	GF011	AU7394348

**Figure 6. A range of field images of captured Mary River cod.**







### Overall Catch Results

Sampling yielded a total of 7075 fish and 5 crustaceans, comprising 31 species of fish and 1 crustacean. Details of the catch are presented in Table 2. For all species of Carp gudgeon *Hypseleotris* sp the counts were grouped as *Hypseleotris* spp as identifying females and juveniles to species level is near impossible in the field. However four species were identified during this survey, Empire gudgeons *H.compressa*, Western Carp gudgeons *H.klunzingeri*, fire tailed gudgeons *H. galii* and Midgley's carp gudgeon *H.sp1*. Eight exotic species were encountered during the monitoring, these include two native species (banded grunter *A.percoides* and sleepy cod *O.lineolatus* not endemic to the catchment). Another two species recorded were not endemic but translocated, the Queensland lungfish *N.forsteri* for conservation purposes in the 1800's and golden perch *M.ambigua*

as part of the Queensland Government Recreational Fishing Enhancement Program that commenced in the 1990's and is ongoing.

**Table 2 Summary of Total Catch by Species**

Scientific Name	Common Name	Translocated/Exotic	Total Catch
<i>Ambassis agassizii</i>	Agassiz's Glassfish		6
<i>Amniataba percoides</i>	Banded Grunter	Exotic	137
<i>Anguilla reinhardtii</i>	Long Finned Eel		135
<i>Arrhamphus sclerolepis</i>	Snubnose Garfish		124
<i>Carrasius auratus</i>	Goldfish	Exotic	7
<i>Cherax quadricarinatus</i>	Redclaw Crayfish	Exotic	5
<i>Craterocephalus stercusmuscarum</i>	Fly Specked Hardyhead		78
<i>Cyprinus carpio</i>	European Carp	Exotic	302
<i>Gambusia holbrooki</i>	Mosquito fish	Exotic	110
<i>Geophagus brasiliensis</i>	Pearl Cichlid	Exotic	162
<i>Glossamia aprion</i>	Mouth Almighty		18
<i>Gobiomorphis australis</i>	Striped Gudgeons		7
<i>Hypseleotris spp</i>	Gudgeons (Hypseleotris complex)		107
<i>Leiopotherapon unicolor</i>	Spangled Perch		152
<i>Macquaria ambigua</i>	Golden Perch	Translocated	28
<i>Maccullochella mariensis</i>	Mary River Cod		12
<i>Melanotaenia duboulayi</i>	Duboulay's Rainbow Fish		168
<i>Mugil cephalus</i>	Striped Mullet		875
<i>Nematalosa erebi</i>	Bony Bream		3990
<i>Neoceratodus forsteri</i>	Queensland Lungfish	Translocated	311
<i>Neoarius graeffei</i>	Forktail Catfish		27
<i>Notesthes robusta</i>	Bullrout		3
<i>Oreochromis mossambicus</i>	Tilapia	Exotic	75
<i>Oxyeleotris lineolatus</i>	Sleepy Cod	Exotic	1
<i>Percalates novemaculeata</i>	Australian Bass		119
<i>Philypnodon grandiceps</i>	Flathead Gudgeon		2
<i>Tandanus tandanus</i>	Eel Tailed Catfish		107
<i>Trachystoma petardi</i>	Freshwater Mullet		12

The numerically dominant species were bony bream *N.erebi* (56.3%), striped mullet *M.cephalus* (12.3%), Queensland lungfish *N.forsteri* (4.4%), European carp *C.carpio* (4.3%), Duboulay's rainbow fish *M.duboulayi* (2.4%), pearl cichlid *G. brasiliensis* (2.3%) and spangled perch *L. unicolor* (2.1%). The remaining species each contributed less than 2% to the total numerical catch (Table 2). Twelve Mary River cod *M.mariensis* were captured contributing 0.17% of the catch. Three species including sleepy cod *O.lineolatus*, flathead gudgeon *P.grandiceps* and bullrout *N.robusta* were represented by less than five individuals.



None of the 28 species of fish occurred at all 26 sites sampled (Table 3). The most widespread species was Australian bass *P.novemaculata* recorded at 24 sites, bony bream *N.erebi* and eel tailed catfish *T.tandanus* both at 23 sites, Queensland lungfish *N.forsteri* at 19 sites, Duboulay's rainbowfish *M.duboulayi* at 18 sites and long finned eels *A.reinhardtii* and carp *C.carpio* both at 15 sites. The introduced sleepy cod *O.lineolatus* was recorded at only a single site.

The highest species diversity was found within the Brisbane River. Three sites below Wivenhoe Dam on the mid Brisbane River (Sites 12,14 and 17), had the highest species diversity with 17 species at each site, Site 23 in the upper Brisbane River with 16 species and 15 species each at sites 24 and 15. The lowest diversity was seven species at a site each on Emu Creek and the Bremer River.

Mary River cod were captured at seven sites with confirmed observations at a further two sites. This species was only recorded in the Brisbane River catchment, none were confirmed from the Bremer River or its tributaries during this sampling.

Figure 7. Images of fish captured during the surveys including lungfish (*N. forsteri*), barred grunter (*A. Percoides*), eel-tailed catfish (*T. tandanus*), Australian bass (*P. novemaculeata*), striped mullet (*M. cephalus*) and mouth almighty (*G. aprion*).







**Table 3 Summary of Catch by Sampling Site**

Scientific Name	Sites																										
	1	2	3	4	6	7	8	9	10	12	13	14	15	16	17	18	19a	19b	20	21	22	23	24	25	26	27	
Ambassis agassizii																				3		1				2	
Amniataba percoides							1			5	1	2			30	7	10	15	16	10	4	18	17			1	
Anguilla reinhardtii	6	12	9	11	5	1	3	22	20	7	5	7	1	5	21												
Arrhamphus sclerolepis					4					1	14	4	4		13	18			7		4	14	12	8		21	
Carrasius auratus				1			2															2	1	1			
Cherax quadricarinatus																							5				
Craterocephalus stercusmuscarum						1				2	2			1							40	2		3	14	13	
Cyprinus carpio	45	14	52	28	15	2	32	14	23	7	14	21	19	7	9												
Gambusia holbrooki					10																100						
Geophagus brasiliensis											1			1		4	41	8		49	17	17	4	5	15		
Glossamia aprion										5	2									3	3	5					
Gobiomorphis australis				3						3				1													
Hypseleotris species		50								50																7	
Leiopotherapon unicolor										1		2	2		2	13	1	5			23	29	15	25	1	33	
Macquaria ambigua	4										1	1	2	2	2	1	3		2		6	4					
Maccullochella mariensis												2			1	1	2	1	1			1		1		2	
Melanotaenia duboulayi		1		2	19	3	1	1		25		2		9	4	8		6	6		46	2		5	10	18	
Mugil cephalus		34	25	5	44	12	174	14	40	60	140	67	103	99	58												
Nematolosa erebi				1	197	107	64	2	54	189	166	357	145	259	213	251	38	2	628	37	74	330	364	168	227	117	
Neoceratodus forsteri	2		2		6	8				2	5	41	36	45	28	15	10	2	21	6	11	36	17	18			

Nearius graeffei					2	1	1				1	6	2		2	3	1		3			1	4			
Notesthes robusta			1				1	1																		
Oreochromis mossambicus				3	3		1	1		4	1	15	12	7	1	3								7	17	
Oxyeleotris lineolatus																							1			
Percalates novemaculeata	8	9	2		2	1	16	2	6	6	6	6	8	5	10	11	5	3	1	1		3	1	2	1	4
Philypnodon grandiceps												1													1	
Tandanus tandanus	1	10	2	1	7		3	1	2	4	1	7	1	2	12	2			1	3	6	12	19	1	4	5
Trachystoma petardi	10						1						1													
Total No Individuals	76	130	93	55	314	136	300	58	145	371	358	540	337	442	407	334	72	78	692	59	363	476	482	237	276	249
Species Richness	8	8	8	10	13	10	14	10	7	17	14	17	15	13	17	13	9	9	11	7	13	16	15	13	10	14



## Discussion

The survey design of this study specifically targeted habitat preferred by Mary River cod to maximise the catch of this species. Nevertheless, in terms of total species richness this study compares favourably with previous fish community surveys in the Brisbane River catchment. Wetland info (<https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/wildlife/?ArealD=sub-basin-brisbane-river&Kingdom=animals&Class=ray-finned%20fishes&SpeciesFilter=Native>) listed 48 species of fish recorded in the freshwater reaches of the Brisbane River, however this also included 12 species that are predominantly marine. This list did not include the two native species driving this survey, namely Queensland lungfish and Mary River cod. This list also omitted the exotic species found within the catchment.

During the present monitoring 26 native fish species were collected using the boat based electrofisher. This represents approximately two thirds of all the predominantly freshwater fish species expected to be found in the freshwater reaches of the Brisbane River catchment. Two of these species were released illegally and are considered nonindigenous under the Qld Fisheries act and if captured must not be released back into the water.

Diadromous species contributed notably during this study to fish abundances with striped mullet being the second most abundant species. Unfortunately, the distribution of these species within the study area are limited by barriers to movement. The recent construction of a fishway on Berry's Weir has greatly improved the movement of diadromous species within the Bremer catchment. This included juvenile Australian bass which were common within catches in this reach (Figure 8).

In comparison Mt Crosby Weir, which does not have a functional fish passage device on the mid Brisbane River restricts the movement of these species only to times of substantial flooding. Further up the system Wivenhoe Dam halts the movement of all diadromous species except for eels. The reinstatement of fish passage on Mt Crosby Weir should be a priority action within the catchment as it is likely that any Mary River Cod and or Queensland lungfish that are "washed" into the lower Brisbane River during floods will be lost to the population. It is highly unlikely that these fish will ever make it back over the weir and more likely they will perish.

**Figure 8 Juvenile Bass**



Five exotic fish species were also recorded. Interestingly, numbers of tilapia observed were lower than expected, particularly at sites where Mary River cod were recorded. Native predatory species

have been noted previously to reduce or control numbers of invasive species. In this instance it is unlikely that the presently low cod populations are having a major impact on this exotic species, nevertheless as the population increases this is likely to occur.

Despite having suitable habitat and water quality, no Mary River cod were observed or captured within the Bremer catchment during this monitoring despite being stocked over the last three years. Eel abundances were higher in this catchment and although they can be a major predator of fingerlings, we have little evidence that this is the case. It is possible that we were simply unlucky during the sampling and fish were simply not where we sampled, which is likely as many of the release sites in the Bremer catchment are very difficult to access with a boat. It is also possible that fish were too deep to be sighted when stunned.

Adult Mary River cod have been captured regularly by teams undertaking Queensland lungfish monitoring and anglers within the mid Brisbane River over recent times. However, few juveniles have been recorded, despite the presence of mature fish and suitable habitat for breeding. As expected, adult fish were captured upstream of Twin Bridges, but none at the other mid Brisbane sites where they have been previously recorded. It is possible that the recent floods have displaced these fish, anglers have removed them, floods have impacted on suitable habitat or that these fish were simply holding too deep during the survey to be captured using the electrofisher.

Despite this, a single juvenile was captured at Lowood Rocks within habitat where juvenile Mary River cod were released in the previous year. It is likely that this fish is one of those stocked and at 145mm in length it is comparable to the growth of typical Murray Cod in its first year of growth (Figure 9). This fish was captured within part of the rock bar that offered fissures and other suitable refuge habitat for small cod to hide.

**Figure 9 Juvenile Mary R cod captured at Lowood Rocks**



The highest Mary River cod abundances were recorded in the upper Brisbane River and Emu Creek with five fish captured and a further two observed. Aside from a single fish observed at Gregors



Creek it is most likely all the remaining fish recorded in this reach were a result of the recent recovery stockings that commenced in 2019.

These fish have achieved very high levels of growth not normally observed in established cod populations. This phenomenal growth has previously been observed within stocked impoundment fisheries where little direct competition to the initial stockings allow the fish to grow exceptionally fast. Initial stockings of Mary River cod within Cressbrook Dam in the 1990's exceeded one metre after only five years. It appears that individuals from all three stocking cohorts were captured in the Upper Brisbane River with one-year old fish around 330mm (approximately double normal growth rates), second year olds at 400 to 450mm and the three-year olds now exceeding 500mm.

The Stanley River is now known to hold adult Mary River cod and the habitat is largely intact through this catchment with dense riparian vegetation and significant availability of large woody debris within the channel. It was always considered that this area would be the ideal place and was stocked by the Queensland Government for many years with fish produced by the Gerry Cook Hatchery at Lake Macdonald resulting in the present population. It is likely that Mary River cod are successfully spawning and recruiting in this catchment because of the largely intact habitat, and the two fish captured during this survey may be natural recruits. One of the major challenges is the difficulties in accessing sites to sample, the dense riparian vegetation and steep riverbanks make launching an electrofishing vessel impossible at most sites. The sites that we can access are mainly through the upper reaches of Somerset Dam and are the periphery of the good habitat.

Queensland lungfish were amongst the most widespread of all the fish during this survey, being found at 19 of the 26 sites. This species was also the third most abundant, however this may be an artefact of the sampling design. Targeting habitat known to be preferred by Mary River cod will also have resulted in a higher proportion of Queensland lungfish captured. A major concern of the scientific community in the late 1800's has been the lack of juveniles within the populations of Queensland lungfish in the Burnett and Mary Rivers. This concern resulted in the translocation of lungfish into several other catchments in Southern Queensland to try and establish conservation populations. The most notable of these was this population established within the Brisbane River, and yet juveniles are still rarely and only sporadically captured within any of the populations. This is not only a result of the cryptic nature of the juveniles and their propensity for dense complex habitats, but also that lungfish only recruit a couple of times or less every decade when conditions are suitable.

Queensland lungfish weren't targeted nor captured and weighed and measured during this survey except for fish <700mm, due to their known high numbers especially in the Brisbane River. These fish were retained at the request of researchers undertaking monitoring of this population. Only a single fish of this size was captured and a further two observed and not captured. Conditions within the Brisbane River have not been conducive to the recruitment of Queensland lungfish since most of the macrophytes (suitable spawning habitat) were washed away during the major floods of 2011 floods. Reoccurring floods such as in 2022 have continued to impact on this habitat and the macrophytes have been slow to recover.

Of note was the observation of four Queensland lungfish in Warrill Creek, at sites 1 (Morrows Road, downstream of Churchbank Weir) and 3 (upstream of Churchbank weir). This is largely considered new information, as until these surveys were carried out, reports of lungfish in Warrill Creek have only been anecdotal in nature. Whilst lungfish are known to occur in the lower, connected reaches of the Bremer River, no recognised accounts of lungfish have been recorded upstream of Berry's

Weir in the lower Bremer. This new information can contribute to improved environmental management of the mid and upper Warrill, which is heavily influenced by agricultural irrigation.

This study has demonstrated that the stocking of Mary River cod within the Brisbane River is viable and that these fish can survive the flooding that occurred during early 2022. Fish stocked in the upper Brisbane River where there are fewer other predatory fish and little competition exhibited exceptional growth rates double that of fish stocked in the mid Brisbane River. The results presented here constitute a comprehensive baseline data set of fish communities of the Brisbane Catchment upon which to compare any future monitoring.

The results of this monitoring suggest that stocking should continue in the upper Brisbane and tributaries whilst there may be some merit in stocking larger fingerlings or juvenile Mary River cod in the Bremer and mid Brisbane areas. Further investigations should be carried out on identifying suitable locations and launch sites to undertake further monitoring on the Stanley River system to determine if cod are in fact successfully reproducing in this area. Consideration should be given to developing an app to gain data on Mary River cod captured by anglers within the Brisbane catchment.

Other studies have identified that the extent of temporal variability in fish communities highlights the severe limitations of “snapshot” sampling designs. This survey should be repeated in the future to build on the baseline data set, reduce the variability in data and knowledge of stocking Mary River cod within this catchment. The incorporation of select anglers to fish areas that cannot be accessed with normal sampling equipment also has merit.

### **Recommendations**

- Continue investment in conservation stocking of Mary River cod under the recovery program throughout the Bremer, Brisbane and Stanley catchments. Evidence and observation suggest these areas support suitable habitat and water quality for the species to be sustainable, despite impacts from flood events in 2022. Supplementing the stocking with larger fish (>150mm) where available may yield greater results in establishing a self-sustaining population more rapidly. Larger fish will withstand pressure from other species for food and habitat, as well as reduce the threat of direct predation.
- Further investigation should be made into identifying new areas with suitable habitat to bring into the recovery program for future stocking. This will likely include continued stakeholder engagement with local landholders managing waterways on private property, as well as organisations such as RAAF in the Bremer-Warrill catchment.
- Continue monitoring at regular intervals to compare to the current baseline dataset. New information gained by on-going monitoring can continually feed back into the recovery program to inform the necessary actions required.
- Continue to support and encourage rehabilitation activities and improved catchment management practices by local landholders, Councils, and industry.
- Investigate options for further development of genetic studies to better understand the current parentage and possible issues in the future.
- Identify further access sites within the Stanley River so this area can be better sampled.
- Encourage anglers within the catchment to utilise the fish monitoring app to report any cod captures.
- Investigate the feasibility of a citizen science monitoring program similar to the successful program that investigated Murray cod in the Dumaresq River.





**Appendix 1 Water Quality and Site Characteristics**

Site No.	Site Name	Water Temp (°C)	pH	Cond (µs)	Oxy (mg/l)	Max Depth (m)	Av. Width (m)
1	[REDACTED]	23.9	7.95	530.1	4.99	5.2	15
2	[REDACTED]	26.8	8.07	485	5.5	4.8	12
3	[REDACTED]	26.8	8.07	485	5.5	6	20
4	[REDACTED]	23.6	8	1411	6.37	2	15
5	[REDACTED]	22.2	8.12	4950	6.66		
6	[REDACTED]	26.9	7.96	373.5	8.01	4.5	50
7	[REDACTED]	26.9	7.96	373.5	8.01	4	40
8	[REDACTED]	23.1	8.47	804.1	11.57	4.6	30
9	[REDACTED]	27.8	8.34	1741	5.65	3.9	40
10	[REDACTED]	29.4	8.07	1951	6.35	4.6	25
11	[REDACTED]	27.3	8.15	496.1	2.63		
12	[REDACTED]	23.5	8.36	384.4	7.88	4	40
13	[REDACTED]	23.5	8.36	384.4	7.88	3.4	40
14	[REDACTED]	26.4	8.3	353.8	9.08	3.8	60
15	[REDACTED]	26.4	8.3	353.8	9.08	3.5	60
16	[REDACTED]	21.2	8.25	398.1	8.91	5	40
17	[REDACTED]	22	8.15	329.6	8.45	3	50
18	[REDACTED]	21.3	8.49	919.4	8.1	4.6	30
19a	[REDACTED]	26.6	7.99	1066	6.5	4	30
19b	[REDACTED]	26.6	7.99	1066	6.5	3	25
20	[REDACTED]	25.1	7.96	761.4	8.1	3	50
21	[REDACTED]	26.2	8.09	1094	11.27	3.5	30
22	[REDACTED]	22.7	7.97	1011	7.49	3.1	20
23	[REDACTED]	25.9	7.9	1035	7.6	2.8	60
24	[REDACTED]	26.1	7.82	1005	9.3	2.4	30
25	[REDACTED]	27.5	8.05	1038	7.86	3	70
26	[REDACTED]	22.3	8.06	544.4	6.46	3	25
27	[REDACTED]	25.7	7.98	336.2	7.47	2.5	40
28	[REDACTED]	24.7	7.68	392.5	5.1		



**Appendix 2 Electrofishing Effort (power on time (s))and Setting**

Site No.	Site Name	Gear type	Volts	Amps	Duty Cycle	Frequency (pulses/s)	E/fishng Time (s)
1	[REDACTED]	boat	1000	6	10	120	968
2	[REDACTED]	boat	1000	6.5	10	120	1016
3	[REDACTED]	boat	1000	6.5	10	120	970
4	[REDACTED]	boat	500	18	10	120	798
5	[REDACTED]	backpack				120	
6	[REDACTED]	boat	1000	6	10	120	1720
7	[REDACTED]	boat	1000	6	10	120	350
8	[REDACTED]	boat	500	14	10	120	1133
9	[REDACTED]	boat	500	14	10	120	708
10	[REDACTED]	boat	500	14	10	120	1032
11	[REDACTED]	backpack				120	
12	[REDACTED]	boat	500	12	20	120	1039
13	[REDACTED]	boat	500	12	20	120	1015
14	[REDACTED]	boat	500	12	20	120	1309
15	[REDACTED]	boat	500	12	20	120	892
16	[REDACTED]	boat	500	12	20	120	1059
17	[REDACTED]	boat	500	12	20	120	1006
18	[REDACTED]	boat	500	14	15	120	968
19a	[REDACTED]	boat	500	14	20	120	320
19b	[REDACTED]	boat	500	14	20	120	230
20	[REDACTED]	boat	500	14	15	120	1020
21	[REDACTED]	boat	500	12	18	120	386
22	[REDACTED]	boat	500	14	10	120	537
23	[REDACTED]	boat	500	14	10	120	1011
24	[REDACTED]	boat	500	14	10	120	476
25	[REDACTED]	boat	500	14	10	120	980
26	[REDACTED]	boat	500	14	10	120	1044
27	[REDACTED]	boat	1000	7	10	120	1044
28	[REDACTED]	boat				120	

**Appendix 3 Catch per unit (fish/minute of electrofishing time)**

Species	Site												
	1	2	3	4	6	7	8	9	10	12	13	14	15
ambagg													
amnper							0.052957			0.288739	0.059113	0.091673	
angrei	0.371901	0.708661	0.556701	0.827068	0.174419	0.171429	0.15887	1.864407	1.162791	0.404235	0.295567	0.320856	0.067265
arrscl					0.139535					0.057748	0.827586	0.183346	0.269058
caraur				0.075188			0.105914						
chequa													
craste						0.171429				0.115496	0.118227		
cypcar	2.789256	0.826772	3.216495	2.105263	0.523256	0.342857	1.694616	1.186441	1.337209	0.404235	0.827586	0.962567	1.278027
gamhol					0.348837								
geobra												0.045837	
gloapr										0.288739	0.118227		
gobaus				0.225564						0.173244			
hypsp		2.952756								2.887392			
leiuni										0.057748		0.091673	0.134529
macamb	0.247934											0.045837	0.067265
macmar													0.134529
meldub		0.059055		0.150376	0.662791	0.514286	0.052957	0.084746		1.443696		0.091673	
mugcep		2.007874	1.546392	0.37594	1.534884	2.057143	9.214475	1.186441	2.325581	3.46487	8.275862	3.071047	6.928251
nemere				0.075188	6.872093	18.34286	3.389232	0.169492	3.139535	10.91434	9.812808	16.36364	9.753363
neofor	0.123967		0.123711		0.209302	1.371429				0.115496	0.295567	1.879297	2.421525
neogra					0.069767	0.171429	0.052957				0.059113	0.275019	0.134529
notrob			0.061856				0.052957	0.084746					
oremos				0.225564	0.104651		0.052957	0.084746		0.230991	0.059113	0.687548	0.807175
oxylin													
pernov	0.495868	0.531496	0.123711		0.069767	0.171429	0.847308	0.169492	0.348837	0.346487	0.35468	0.275019	0.538117
phigra												0.045837	

tantan	0.061983	0.590551	0.123711	0.075188	0.244186		0.15887	0.084746	0.116279	0.230991	0.059113	0.320856	0.067265
trapet	0.619835						0.052957						0.067265

	Site												
Species	16	17	18	19a	19b	20	21	22	23	24	25	26	27
ambagg								0.335196		0.12605			0.114943
amnper		1.789264	0.433884	1.875	3.913043	0.941176	1.554404	0.446927	1.068249	2.142857			0.057471
angrei	0.283286	1.252485											
arrscl		0.775348	1.115702			0.411765		0.446927	0.830861	1.512605	0.489796		1.206897
caraur									0.118694	0.12605	0.061224		
chequa										0.630252			
craste	0.056657							4.469274	0.118694		0.183673	0.804598	0.747126
cypcar	0.396601	0.536779											
gamhol								11.17318					
geobra		0.059642		0.75	10.69565	0.470588		5.47486	1.008902	2.142857	0.244898	0.287356	0.862069
gloapr								0.335196	0.178042	0.630252			
gobaus	0.056657												
hypssp												0.402299	
leiuni		0.119284	0.805785	0.1875	1.304348			2.569832	1.721068	1.890756	1.530612	0.057471	1.896552
macamb	0.113314	0.119284	0.123967	0.1875	0.782609		0.310881		0.356083	0.504202			
macmar		0.059642	0.061983	0.375	0.26087	0.058824			0.059347		0.061224		0.114943
meldub	0.509915	0.238569	0.495868		1.565217	0.352941		5.139665	0.118694		0.306122	0.574713	1.034483
mugcep	5.609065	3.459245											
nemere	14.67422	12.70378	15.55785	7.125	0.521739	36.94118	5.751295	8.268156	19.58457	45.88235	10.28571	13.04598	6.724138
neofor	2.549575	1.66998	0.929752	1.875	0.521739	1.235294	0.932642	1.22905	2.136499	2.142857	1.102041		
neogra		0.119284	0.18595	0.1875		0.176471			0.059347	0.504202			
notrob													
oremos	0.396601	0.059642	0.18595									0.402299	0.977011
oxylin											0.061224		



