HEALTHY RIVERS TO REEF PARTNERSHIP
MACKAY-WHITSUNDAY-ISAAC

Carmila Creek Estuary Pilot Study

Fish Assemblage Report

September 2022

Carmila Estuary – Fish Assemblages

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Introduction

CQUniversity, the Mackay-Whitsunday-Isaac Healthy Rivers to Reef Partnership (HR2RP), and Catchment Solutions collaborated to investigate water quality and estuarine fish populations in the estuary of a cane growing catchment of the Great Barrier Reef (GBR), south of Mackay (see also Flint et al. 2022). Estuarine fish are not currently monitored in this region, so this component of the study provides a useful and topical addition to the regional waterway health data that is already collected by HR2RP and partners. Coastal fisheries resources are valued by commercial and recreational fishers in the Mackay region and are of high interest to a range of partners.

As video and battery technology improves, the use of baited remote underwater video stations (BRUVS) to observe and record aquatic species is becoming increasingly popular in a wide range of marine and freshwater environments. One of the key benefits of using BRUVS is that they are non-destructive and non-extractive, so interference with wild fish populations is reduced in comparison to the capture methods traditionally used for fish surveys (Whitmarsh et al. 2017). Their use makes for easy sampling replication, and in some situations, BRUVS can also be relatively cheap in terms of personnel costs (Whitmarsh et al. 2017). BRUVS can be used to record species presence, relative abundance, body size; and to observe behaviour, including in relation to other animals.

Pitfalls often experienced when using BRUVS include difficulties with fish identification in low-visibility waterways, and time required to process video footage. These issues are particularly relevant for estuaries, where turbidity can be high leading to low visibility and longer video processing time. Other considerations include standardising protocols and the potential for bait-related biases (Hardinge et al. 2013). The aim of this preliminary study is to trial the use of BRUVS to monitor fish and large crabs in Carmila Creek estuary. The study will provide initial fish assemblage data for the estuary, determine whether BRUVS are potentially suitable for use in the estuary, and help to inform future monitoring options and management decisions for Carmila Creek and similar estuaries in the GBR.

Sampling methodology

The BRUVS consisted of a GoPro Hero 5 camera mounted on a weighted aluminium frame, with a mesh bait bag attached via an extendable bait arm. The view from the GoPro was horizontal to the substrate, towards the bait bag. Four BRUVS were deployed for ~1 hr on two consecutive days each month, for four months in early 2022. Sea mullet were purchased each month for use as bait, and around 500g was added to each bait bag immediately before deployment.

Deployment sites were between ~0.9km and 3.4km from the mouth of Carmila Creek estuary and were in shallow water (usually 0.5–1m depth) to increase visibility on the videos. The BRUVS were deployed for one hour on each sampling day, to provide 8 replicate videos per sampling month, and 32 one-hour long videos across the study period (Table 1). On the first day of sampling (24 January), the BRUVS bait arms were extended to 1m from the bait bag, but the videos were found to be too unclear for analysis. The bait arms were then shortened to ~0.5m, and turbidity profiles from the YSI EXO2 sonde that was deployed in the same project were used to identify the best time of the tide to deploy BRUVS for clearer videos.

As the boat ramp access at Carmila Creek is tide-dependent, the deployment of the buoy on one day and retrieval the next day was timed to allow for boat access. Catchment Solutions provided the vessel and skipper for sampling, and CQUniversity researchers collected data.

Data was downloaded daily after each deployment and analysed by CQU research staff. Three fish assemblage indices were then calculated: 1) presence/absence to calculate the number of species observed (a measure of diversity), 2) the maximum number of each species recorded in one frame (MaxN; a measure of relative abundance), and 3) time to first record of each species (T1st). In cases where species-level identification wasn't possible, a higher taxonomic level was used. Teleost and chondrichthyan fishes, as well as decapod crustaceans, were recorded.

Table 1: Sampling dates at Carmila Creek

Dates	Water monitoring buoy deployed	BRUVS deployed (fish assemblages)
23–24 November 2021	Yes – 24 hrs	No
9–10 December 2021	Yes – 24 hrs	No
24–25 January 2022	Yes – 24 hrs	Yes – 1 hr on each day
8–9 February 2022	Yes – 24 hrs	Yes – 1 hr on each day
22–23 March 2022	Yes – 24 hrs	Yes – 1 hr on each day
5–6 April 2022	Yes – 24 hrs	Yes – 1 hr on each day

Figure 1: A baited remote underwater video station (BRUVS) deployed at Carmila Creek estuary in January 2022.

Results and Discussion

Four BRUVS were deployed on two consecutive days each month from January to April 2022, but the footage collected on 24 January was not sufficiently clear for analysis. A total of 16 taxa were recorded by the BRUVS, including 13 teleosts, 1 chondrichthyan (stingray), and 2 crustaceans (mud crabs and prawns). Footage was only moderately clear in the estuary in comparison to less turbid marine environments (e.g., see Figure 2), however one of the crustaceans (mud crabs, *Scylla serrata*) and 10 of the teleosts were able to be identified to species level (Table 2). Maximum visible range was usually less than 1m.

Three metrics were used to analyse the combined BRUVS data from each of the four sampling months:

- Number of taxa recorded across all BRUVS for each month,
- Maximum number of individuals of each taxon seen in any one video frame across the duration of the video record for each month (MaxN), and
- Time of first arrival of each taxon across the duration of the video record for each month (T1st).

Five taxa were recorded during every sampling month (prawns, glassfish, banded toadfish, yellowfin bream, and moses perch), two were recorded in three of the four months (diamond fish, crescent grunter), four were recorded in two of the four months (mud crab, fork-tailed catfish, common toadfish, and sand whiting), and five taxa were recorded in only one month (barred javelin, garfish, pikey bream, stingray, and goldspotted estuary cod) (Table 2). The month with the highest diversity (number of taxa) recorded was March 2022, with 12 taxa (Figure 3), though this included garfish which were visible on the surface because one BRUV emerged from underwater as the tide dropped during deployment. Unidentified fish were not included in the results table.

The taxa recorded in the highest numbers (MaxN) were prawns, glassfish, crescent grunter, and yellowfin bream (Figure 4). MaxN provides an assessment of relative abundance and can be used in combination with other metrics such as T1st (Whitmarsh et al. 2017). Time until the first animal was observed (T1st) was less than one minute in all months (January, T1st = 0:36; February T1st = 0:10; March T1st = 0:01; April T1st = 0:01), and the taxa with highest MaxN generally arrived quickly, particularly prawns, glassfish, and yellowfin bream. T1st is a measure of how fast each taxon is observed in the field of view after the BRUVS are deployed and may indicate that the species arriving quickly are abundant in the sampling area (Stobart et al. 2015). Taxa that were only seen in one of four months had high T1st values (i.e., arrived later), possibly indicating lower abundance in comparison to the taxa that arrived quickly. However, T1st is influenced both by the distance the animal has to travel to get to the bait and their level of attraction to the bait type used (Whitmarsh et al. 2017).

Figure 2: Selected images from BRUVS deployments at Carmila Creek estuary

Table 2: Fish and crustaceans recorded, maximum number at one time (MaxN), and time first seen during each sampling event (T1st, minutes:seconds). MaxN > 10 are rounded to the nearest 5.

Scientific name	Common name	25 January 2022*	8-9 February 2022	22-23 March 2022	5-6 April 2022
Penaeoidea	Prawn (unidentified)	Present MaxN = 30 T1st = 00:36	Present MaxN = 30 T1st = 00:10	Present MaxN = 60 T1st = 12:50	Present MaxN = 10 T1st = 34:08
Ambassis sp.	Glassfish	Present MaxN = 15 T1st = 02:59	Present MaxN = 9 T1st = 01:01	Present MaxN = 20 T1st = 03:39	Present MaxN = 30 T1st = 00:11
Marilyna pleurosticta	Banded toadfish	Present MaxN = 1 T1st = 36:44	Present MaxN = 1 T1st = 25:08	Present MaxN = 1 T1st = 02:13	Present MaxN = 1 T1st = 29:36
Acanthopagrus australis	Yellowfin bream	Present MaxN = 1 T1st = 07:06	Present MaxN = 2 T1st = 00:31	Present MaxN = 5 T1st = 00:01	Present MaxN = 8 T1st = 00:01
Lutjanus russellii	Moses perch	Present MaxN = 1 T1st = 53:29	Present MaxN = 1 T1st = 21:35	Present MaxN = 1 T1st = 21:47	Present MaxN = 1 T1st = 11:12
Monodactylus argenteus	Diamond fish	Absent	Present MaxN = 1 T1st = 34:11	Present MaxN = 1 T1st = 63:39	Present MaxN = 2 T1st = 05:30
Terapon jarbua	Crescent grunter	Present MaxN = 1 T1st = 47:36	Present MaxN = 15 T1st = 07:44	Present MaxN = 7 T1st = 01:59	Absent
Scylla serrata	Mud crab	Absent	Absent	Present MaxN = 1 T1st = 58:21	Present MaxN = 1 T1st = 23:21
Ariidae	Fork-tailed catfish	Absent	Absent	Present MaxN = 1 T1st = 49:16	Present MaxN = 2 T1st = 14:31
Tetractenos hamiltoni	Common toadfish	Absent	Present MaxN = 4 T1st = 05:07	Present MaxN = 1 T1st = 44:53	Absent
Sillago ciliata	Sand whiting	Absent	Present MaxN = 1 T1st = 24:16	Present MaxN = 1 T1st = 01:09	Absent
Pomadasys kaakan	Barred javelin	Present MaxN = 1 T1st = 42:44	Absent	Absent	Absent
Hemiramphidae	Garfish	Absent	Absent	Present MaxN = 7 T1st = 46:03	Absent
Acanthopagrus pacificus	Pikey bream	Absent	Absent	Absent	Present MaxN = 1 T1st = 36:13
Dasyatidae	Stingray	Absent	Present MaxN = 1 T1st = 33:12	Absent	Absent
Epinephelus coioides	Goldspotted estuary cod	Absent	Absent	Absent	Present MaxN = 1 T1st = 15:39

* Note first day of footage in January was not visible.

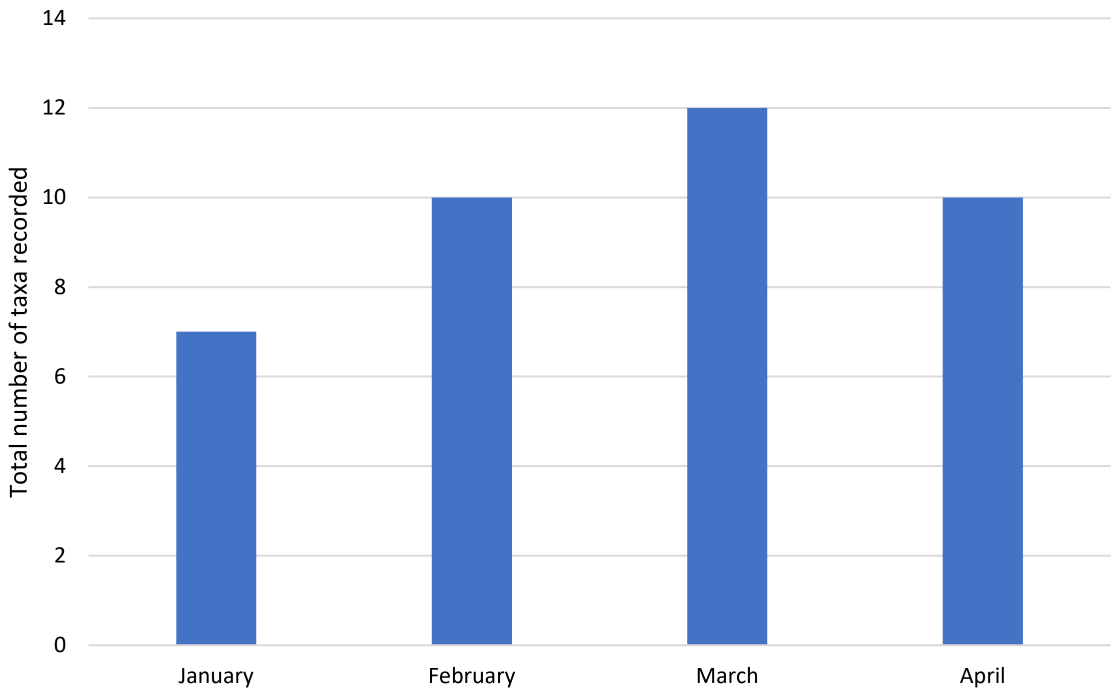

Figure 3: Total number of fish and crustacean taxa recorded each month. Note: the first day of footage in January was not visible so half the length of footage is available for that month; and March included one fish taxon that became visible on the water's surface as the BRUV emerged on the outgoing tide (garfish).

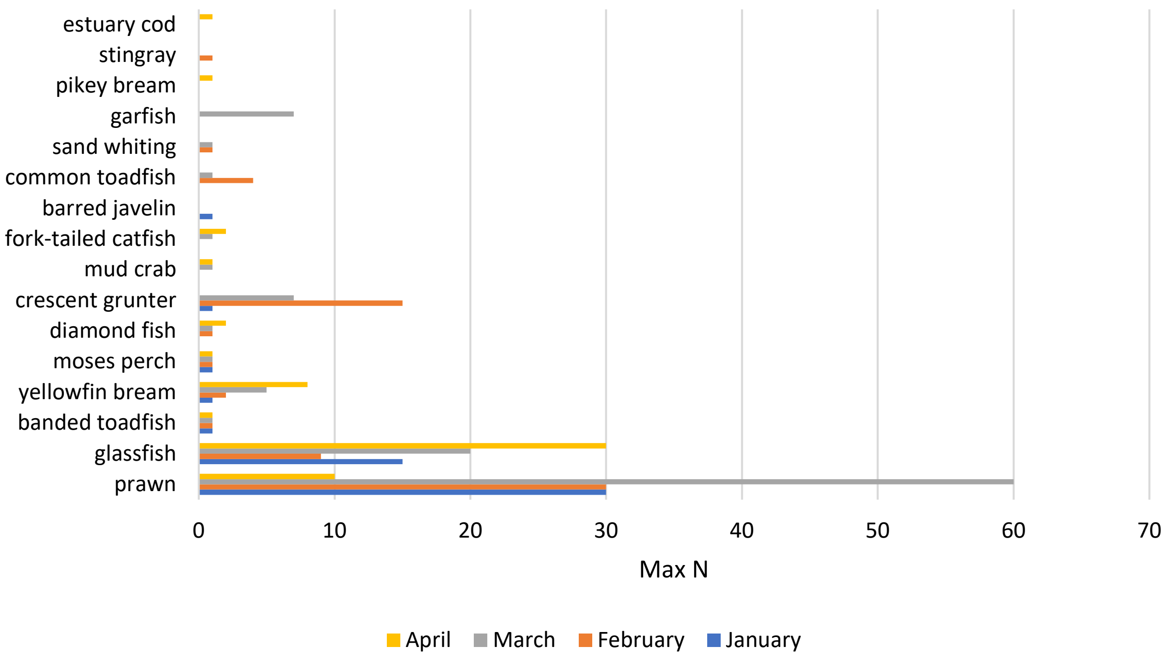

Figure 3: Maximum number of each taxa of fish and crustaceans recorded (MaxN) across all BRUVS deployed each month. Note: the first day of footage in January was not visible so half the length of footage is available for that month.

Conclusions

The preliminary results collected in this pilot study show some promise of using BRUVS to collect fish assemblage data in estuaries in the Mackay-Whitsunday-Isaac region, with 14 fish taxa and two decapod crustaceans detected. Challenges relating to visibility and video clarity were able to be managed by having a shorter bait-to-video range and by deploying BRUVS in shallow water (~1-2 m depth) during the least turbid times of the tide. However, turbid water did still obscure identification at times, and some taxa could not be confidently identified to species level.

In this study, GoPro Hero 5 cameras were used on the BRUVS, in video mode. The more recent GoPro models have better definition and battery time, so may provide better results. Further, BRUVS can be customised by the addition of a clear liquid optical change (CLOC) to improve visibility in turbid waters (Jones et al., 2019). Image restoration algorithms have also been successfully applied during processing to improve species identification (Donaldson et al. 2019). Another pitfall of using BRUVS is the time required to analyse video footage, which may be ameliorated in the future through computer vision and deep learning technology (Sheaves et al. 2020).

The main benefits of BRUVS are that they are non-destructive, pose a lower risk than other visual survey methods such as diving (a particular issue in crocodile and bull shark habitats), and allow for relatively straightforward and inexpensive data collection across targeted spatial and temporal variables in comparison to some other fish survey methods.

A previous study in Carmila Creek using standard fish survey methods identified 19 fish species in pre-wet season sampling and 25 species in post wet-season sampling (Moore et al. 2007). The study involved intensive netting across 11 estuaries in the Mackay-Whitsunday-Isaac Region, employing a combination of gill nets, cast nets, and seine nets. Several of the species caught in the previous study that were not caught in this study were smaller herbivorous species, including sea mullet (*Mugil cephalus*), common ponyfish (*Leiognathus equulus*), silver biddies (*Gerres subfasciatus*), and Ditchelee herring (*Pellona ditchela*). The absence of these species from the BRUVS likely reflects their trophic niche and lack of attraction to the bait. Some large, predatory fish species were also identified in the netting survey but were not detected by BRUVS, such as flathead (*Platycephalus* spp.), blue threadfin (*Eleutheronema tetradactylum*), king threadfin (*Polydactylus macrochir*), and giant queenfish (*Scomberoides commersonnianus*). The BRUVS were deployed in shallow water to improve visibility, which would have reduced the likelihood of detecting large fish.

Unlike netting surveys, BRUVS have potential for citizen science applications, though a scientifically robust experimental design would be needed to ensure that data are robust and interpretable, particularly for comparisons between sites/estuaries and through time. One option might be to combine the use of BRUVS with another non-capture fish survey technique such as eDNA, as using the two methods together can improve the overall fish composition detected (Cole et al. 2022). In particular, eDNA may assist with detecting species that are not attracted to bait or that inhabit deeper water.

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Appendix

The following data file is provided as an Appendix:

BRUVS data Carmila 2022_FINAL_CQU.xlsx

Thank you to our partners

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ABOUT US

The Mackay-Whitsunday-Isaac Healthy Rivers to Reef Partnership is a collaboration between community, Traditional Owners, farmers and fishers, industry, science, tourism, and government who recognise that more can be achieved by working together.

Contact us to learn more about how we help build and shape our community's understanding of waterway health and inform management actions.

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