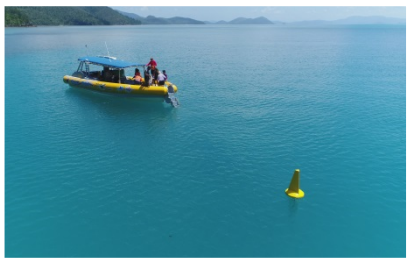
Whitsunday Water Quality Monitoring Blueprint for Tourism Operators:

Quarterly update - July 2020

Jordan Iles and Nathan Waltham

Report No. 20/30

July 2020



Whitsunday Water Quality Monitoring Blueprint for Tourism Operators: Quarterly update - July 2020

A Report for Reef Catchments (Mackay Whitsunday Isaac) Limited

Report No. 20/30

July 2020

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1 INTRODUCTION

This report gives a quarterly update on data collected by the Whitsunday Water Quality Monitoring Blueprint for Tourism Operators in the second quarter of 2020. The water sampling and logger maintenance schedule for this period is outlined in Table 1. Event 'd' was a water sampling only event as the loggers had only been deployed two week prior. Water samples were collected and the logger mooring checked for fouling but loggers were not replaced.

For project background and methodology please refer to the annual report: Iles, JA & Waltham, NJ 2020, 'Whitsunday Water Quality Monitoring Blueprint for Tourism Operators: Annual report 2019-2020', Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER) Publication, James Cook University, Townsville, 29 pp.

Table 1. Monitoring events for the second quarter of 2020. Events covered in previous reports are shown in grey.

Event	Date scheduled	Cairn Beach (WH1)	Tongue Bay (WH2)
a	04/02/2020	Ocean Rafting / TropWATER	Ocean Rafting / TropWATER
b	04/03/2020	True Blue	Red Cat
c	11/05/2020	Ocean Rafting	Ocean Rafting
d[#]	26/05/2020	Thunder Cat	Red Cat
e	23/06/2020	Ocean Rafting	Ocean Rafting

[#] water sampling only

2 RESULTS

The results within this report cover the period 11/05/2020 to 23/06/2020. Results reported in previous reports are shown in grey on figures and tables throughout.

2.1 Logger data

2.1.1 Water temperature

Water temperature during the most recent deployment period ranged from 22.4 to 26.3 °C at Cairn Beach and 21.7 to 25.7 °C at Tongue Bay (Figure 1). Warmer water temperatures were consistently measured at Cairn Beach compared to Tongue bay (approx. 0.5 °C difference).

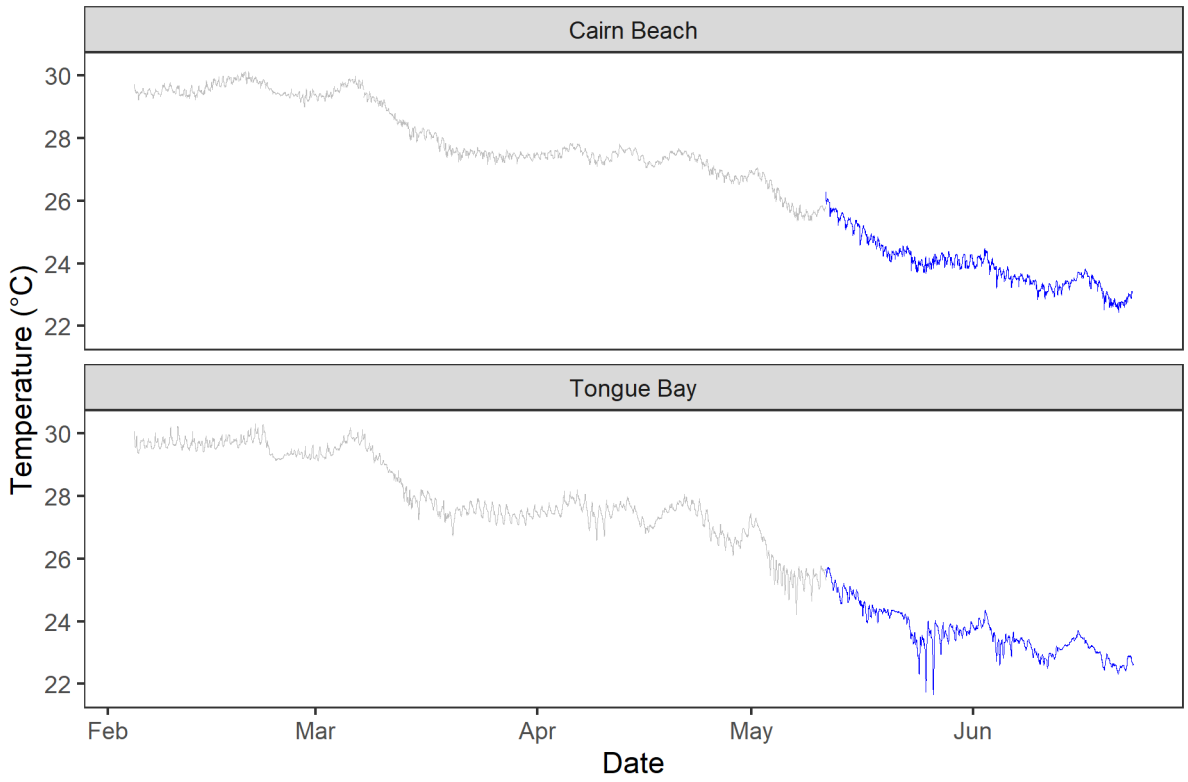

Figure 1. Water temperature measured at Cairn Beach and Tongue Bay

2.1.2 Water depth and wave height

The average water depth of the deployed loggers during the most recent deployment period was 11.2 m at Cairn Beach and 8.9 m at Tongue Bay (Figure 2). There was a slight change in the location and depth that the loggers were sitting between the deployments, with both the Cairn beach and Tongue Bay loggers sitting in slightly deeper water during the third deployment. Water depth at the two sites fluctuated by up to 3.8 m due to tides. The root means square (RMS) depth is shown in Figure 3. There was very little wave activity at the Cairn Beach site with RMS depth generally less than 0.005 m throughout the deployment period (average = 0.003 m). Tongue Bay was more exposed to wave energy with a mean RMS wave height of 0.023 m.

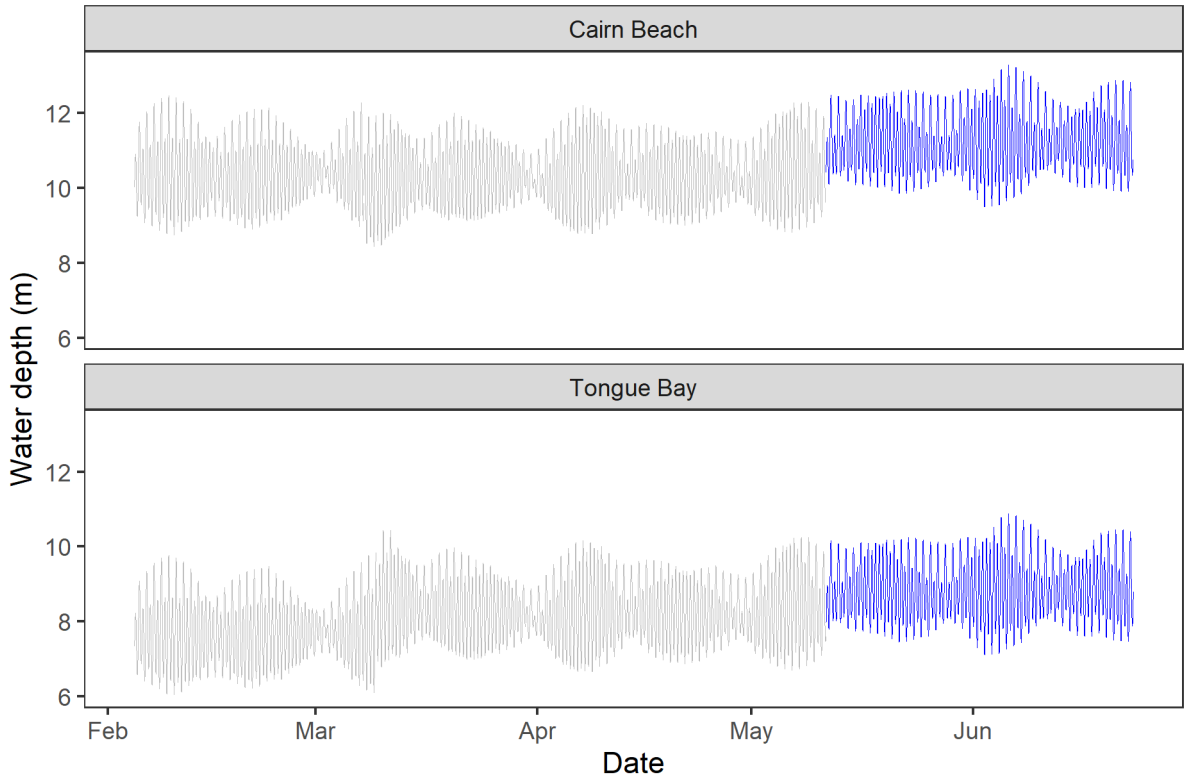

Figure 2. Water depth measured at Cairn Beach and Tongue Bay

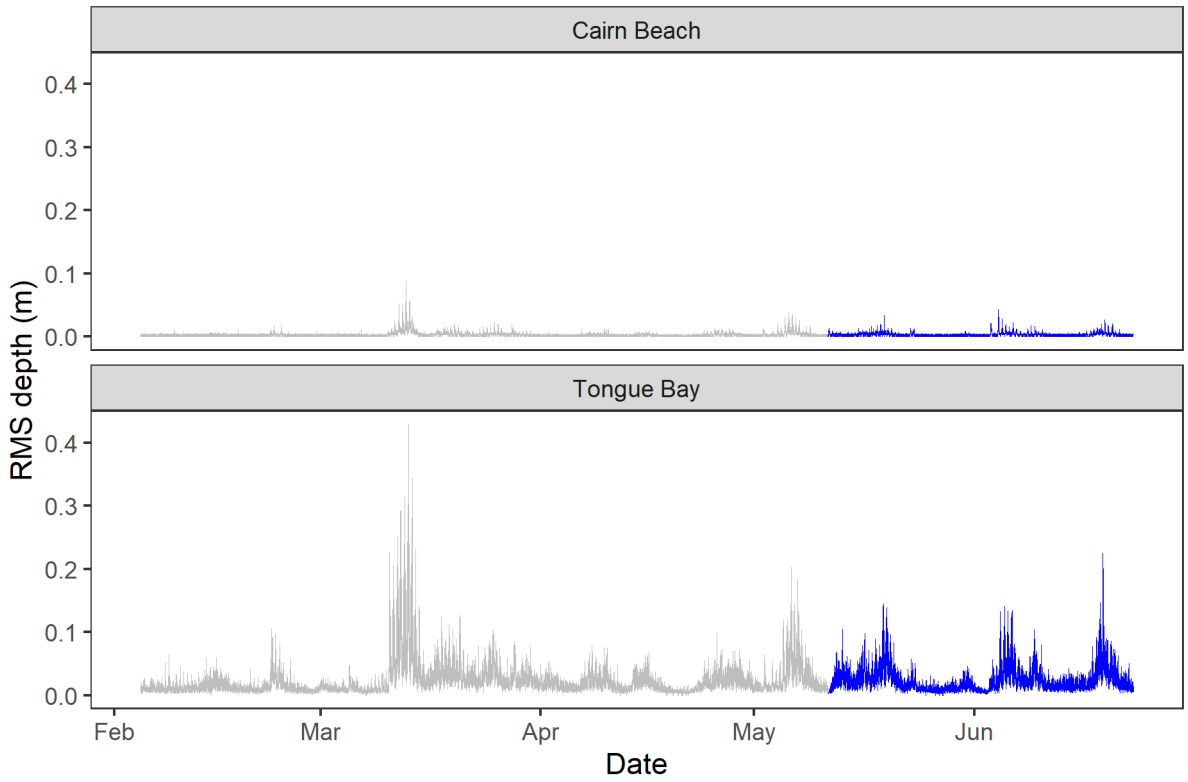

Figure 3. Root mean squared (RMS) water depth measured at Cairn Beach and Tongue Bay

2.1.3 Photosynthetically active radiation (PAR)

Photosynthetically active radiation (PAR) measured at depth followed a typical diel cycle with higher values during the day, decreasing to zero overnight (Figure 4). PAR levels were generally higher at Cairn Beach (measured at 11.2 m depth) than at the Tongue bay site (measured at 8.9 m depth). Daily photosynthetically active radiation is shown in Figure 5. Mean daily PAR was 0.6 mol m^{-2} d^{-1} at Cairn Beach, and 0.4 mol m^{-2} d^{-1} at Tongue Bay.

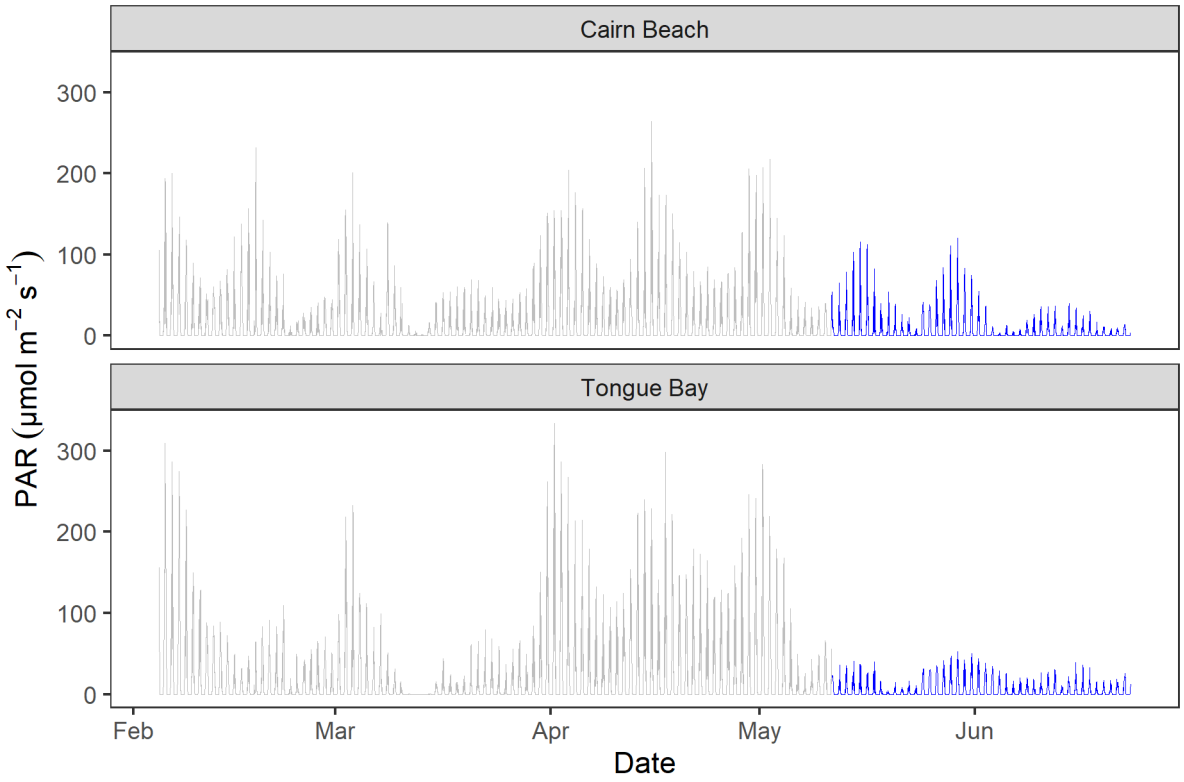

Figure 4. Photosynthetically active radiation (PAR) measured at 10 min intervals at Cairn Beach and Tongue Bay

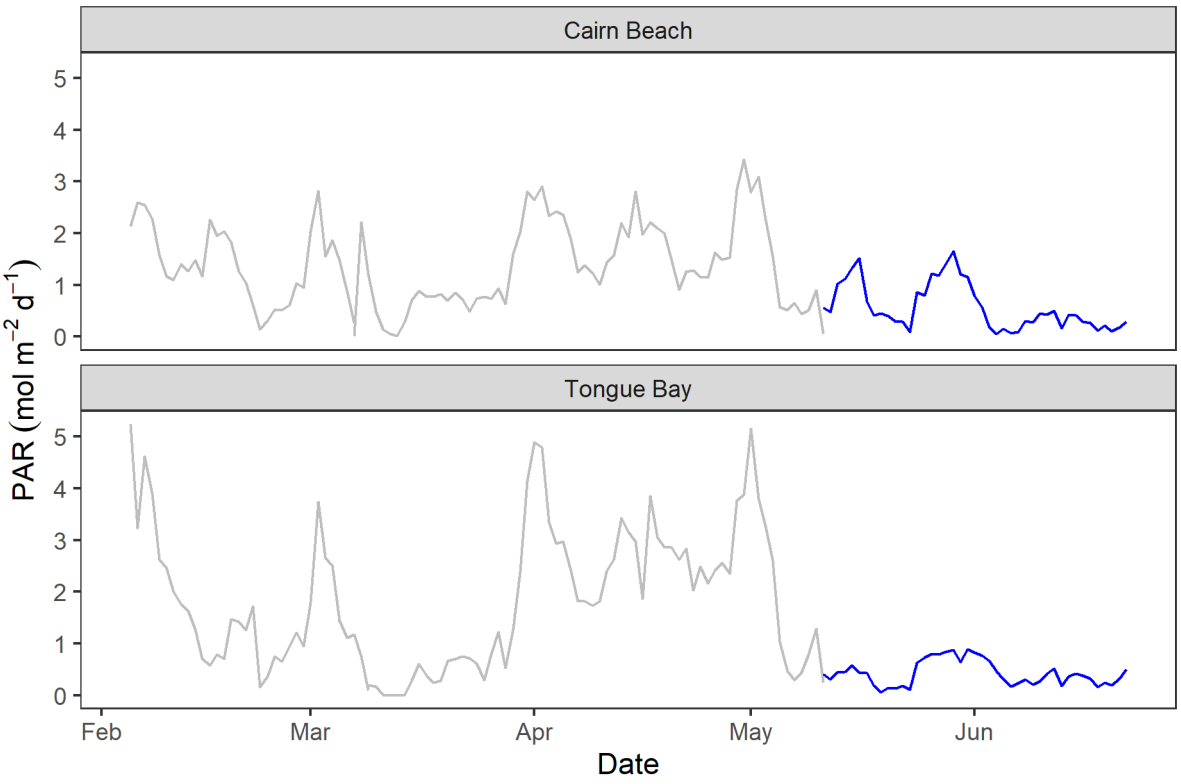

Figure 5. Daily photosynthetically active radiation at Cairn Beach and Tongue Bay

2.1.4 Turbidity

Turbidity ranged from 0.05 to 26.5 NTUe at the Cairn Beach monitoring site, with an average value of 1.04 NTUe over the deployment period (Figure 6). Turbidity ranged from 0 to 33.8 NTUe at the Tongue Bay monitoring site, with an average value of 6.38 NTUe over the deployment period. Both the Cairn Beach and Tongue Bay instruments had issues with sensor fouling during the deployment, with biofouling present on the sensor when inspected post-deployment. Turbidity data after 2nd June for Cairn Beach and 16th May for Tongue Bay was deemed unreliable and removed during the data QC process.

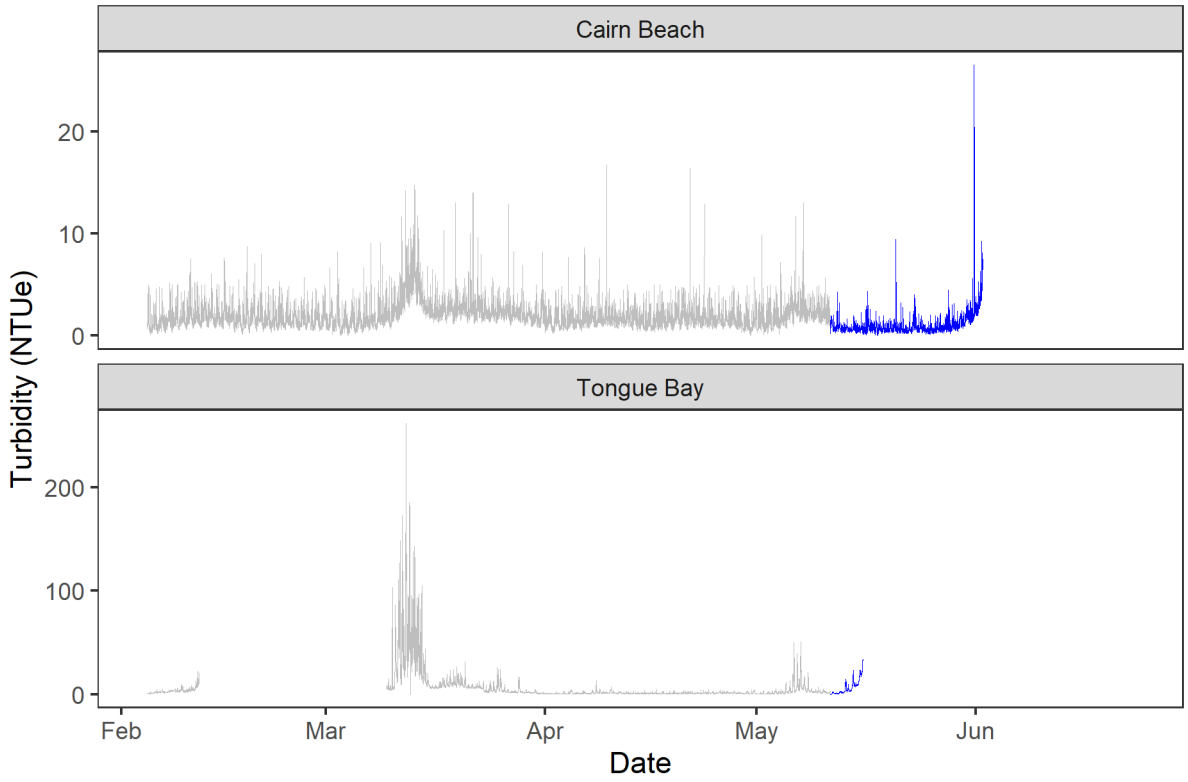

Figure 6. Turbidity measured at Cairn Beach and Tongue Bay. Note different y-axis scale to accommodate for high turbidity event at Tongue Bay in March 2020. Data has been removed during the QC process from 2nd June to the end of deployment period for Cairn Beach and from 16th May to the end of deployment period for Tongue Bay due to suspected sensor fouling.

2.2 Water samples

2.2.1 Field observations

The tourism operators recorded observations of conditions on the water at the time of each sampling and maintenance event (Table 2).

Table 2. Water quality measurements and observations recorded from Cairn Beach and Tongue Bay.

Site Name	Site Code	Date	Time	Secchi depth	Cloud cover	Wind	Sea surface	Surface scum/slick
				m	%	knots		
Cairn Beach	WH1	04/02/2020	13:45	4.5	15	5 - 10	Calm	Nil
		07/03/2020	17:15	4	80	0 - 5	Flat	Nil
		11/05/2020	08:05	3	75	21 - 25	Light surface chop	Nil
		26/05/2020	11:45	6	5 - 10	5 - 10	Calm	Nil
		23/06/2020	08:15	6	0	5 - 10	Calm	Nil
Tongue Bay	WH2	04/02/2020	15:00	6.5	10	5 - 10	Calm	Nil
		09/03/2020	10:30	0.3[#]	80	5	Glass	Nil
		11/05/2020	10:20	3*	5	25	Chop	Nil
		26/05/2020	12:30	5.5	60	5	Calm	Nil
		23/06/2020	09:30	4.2	0	10 - 15	0 - 0.3	Nil

[#] Note: Likely erroneous measurement, * Note: Secchi depth estimated

2.2.2 Physico-chemical parameters

Water samples collected from the monitoring sites during May 2020 were measured in the laboratory for electrical conductivity, total suspended solids (TSS), and pH (Table 3, Figure 7). Conductivity ranged from 53.01 to 53.64 µS cm^{-1} and was within expected range of seawater with limited freshwater inputs. TSS ranged from 1.8 to 2.6 mg L^{-1}. pH ranged from 8.24 to 8.35.

Table 3. Electrical conductivity (Cond, mS cm^{-1}), Total suspended solids (TSS, mg L^{-1}) and pH of surface water samples collected from Cairn Beach and Tongue Bay.

Site name	Site code	Sample Date	Cond mS cm^{-1}	TSS mg L^{-1}	pH
Cairn Beach	WH1	04/02/2020	54.02	1.9	8.29
		09/03/2020	52.95	9.3	8.33
		11/05/2020	53.03	2.2	8.35
		26/05/2020	53.08	1.9	8.24
		23/06/2020	53.62	2.4	8.25
Tongue Bay	WH2	04/02/2020	53.92	2.8	8.31
		08/03/2020	53.14	3.0	8.29
		11/05/2020	53.07	2	8.32
		26/05/2020	53.01	1.8	8.27
		23/06/2020	53.64	2.6	8.23

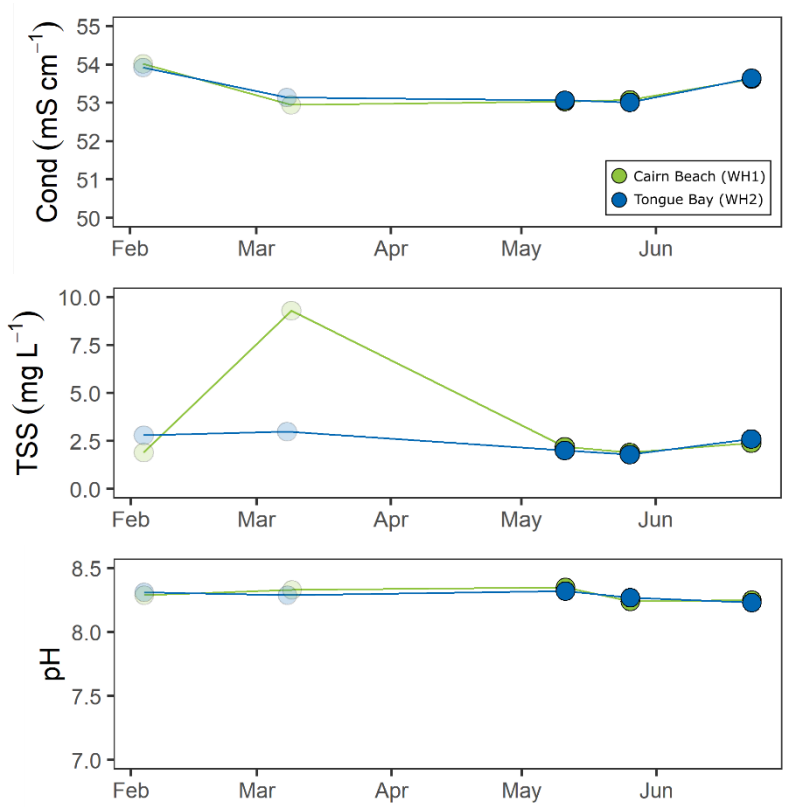

Figure 7. Electrical conductivity (Cond), total suspended solids (TSS), and pH of water samples collected from Cairn Beach WH1 (green) and Tongue Bay WH2 (blue).

2.2.3 Nutrients

Results for water samples collected during the three most recent scheduled trips are presented below. Nitrogen and phosphorus concentrations are presented in Table 4. Total nitrogen concentrations ranged from 93 to 169 µg N L^{-1} during the most recent sampling events (Figure 8). Total phosphorus concentrations ranged from 6 to 8 µg P L^{-1} (Figure 9). The bulk of nutrients were present in the dissolved fraction with 80 to 92% nitrogen dissolved, and 71 to 86 % phosphorus dissolved. Nitrate-nitrite concentrations ranged 2 to 5 µg N L^{-1}.

Table 4. Nutrient concentrations measured in surface water samples collected from Cairn Beach and Tongue Bay. Total nitrogen (TN, total dissolved nitrogen (TDN), nitrate-nitrite (NO_x), particulate nitrogen (PN), total phosphorus (TP), total dissolved phosphorus (TDP), and particulate phosphorus (PP). All concentrations reported in micrograms per litre (µg L^{-1}).

Site name	Site code	Sample Date	TN µg N L^{-1}	TDN µg N L^{-1}	NOx µg N L^{-1}	PN µg N L^{-1}	TP µg P L^{-1}	TDP µg P L^{-1}	PP µg P L^{-1}
Cairn Beach	WH1	4/02/2020	142	136	6	6	9	8	1
		9/03/2020	227	111	7	116	17	7	10
		11/05/2020	158	130	2	28	7	6	1
		26/05/2020	93	84	3	9	6	5	1
		23/06/2020	85	84	3	1	6	6	0
Tongue Bay	WH2	4/02/2020	126	118	3	8	9	8	1
		8/03/2020	130	109	3	21	8	7	1
		11/05/2020	169	155	2	14	8	6	2
		26/05/2020	102	82	2	20	7	5	2
		23/06/2020	109	88	5	21	6	5	1

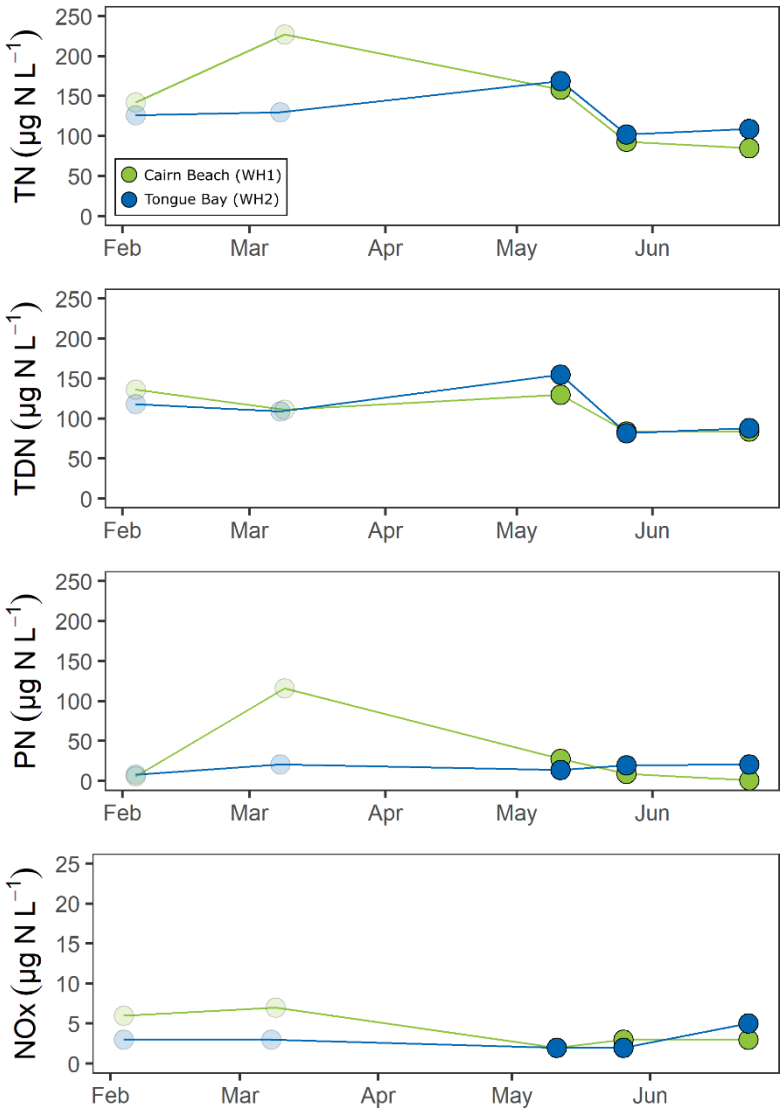

Figure 8. Total nitrogen (TN), total dissolved nitrogen (TDN), particulate nitrogen (PN), and nitrate-nitrite (NOx) concentrations measured in water samples collected from Cairn Beach WH1 (green) and Tongue Bay WH2 (blue).

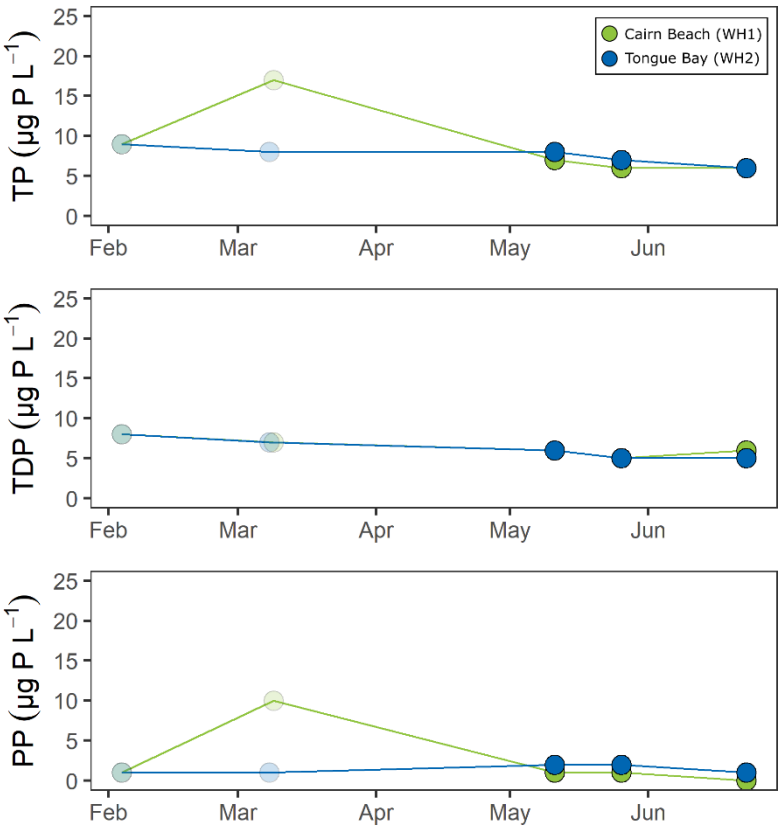

Figure 9. Total phosphorus (TP), total dissolved phosphorus (TDP), and particulate phosphorus (PP) concentrations measured in water samples collected from Cairn Beach WH1 (green) and Tongue Bay WH2 (blue).

2.2.4 Chlorophyll *a*

Chlorophyll *a* values ranged from 0.25 to 0.53 µg L^{-1} between sites during the most recent sampling events (Table 5, Figure 10). Phaeophytin *a* concentrations were generally near to or below detection limit.

Table 5. Chlorophyll-*a* and Phaeophytin-*a* concentrations measured in surface water samples collected from Cairn Beach and Tongue Bay. All concentrations reported in micrograms per litre (µg L^{-1}).

Site name	Site code	Sample Date	Chl-*a* µg L^{-1}	Phaeo-*a* µg L^{-1}
Cairn Beach	WH1	4/02/2020	0.41	<0.2
		9/03/2020	0.38	<0.2
		11/05/2020	0.39	<0.2
		26/05/2020	0.46	0.23
		23/06/2020	0.28	0.25
Tongue Bay	WH2	4/02/2020	0.40	0.22
		8/03/2020	0.40	0.21
		11/05/2020	0.44	<0.2
		26/05/2020	0.53	<0.2
		23/06/2020	0.25	<0.2

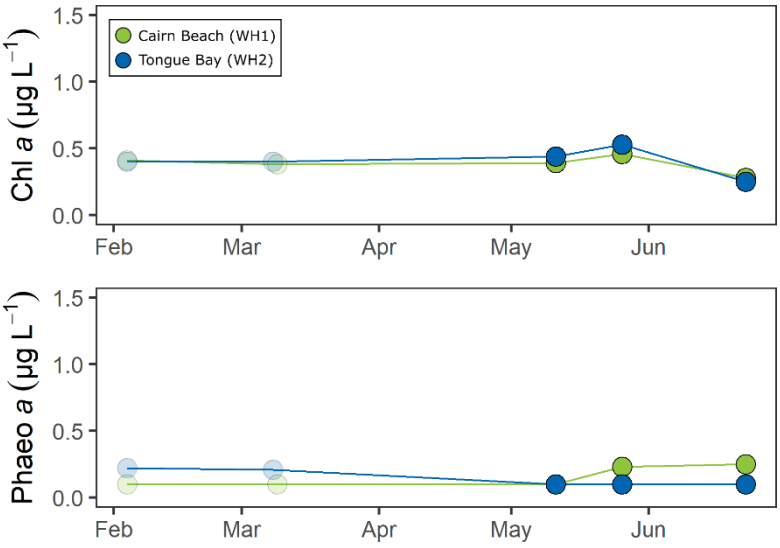

Figure 10. Chlorophyll *a* and phaeophytin *a* concentrations measured in water samples collected from Cairn Beach WH1 (green) and Tongue Bay WH2 (blue).

2.3 Quality assurance

2.3.1 Logger fouling

There has been some unfortunate data loss due to sensor fouling over the most recent deployment. Data loss has been limited to the turbidity sensor, with the temperature, pressure, and photosynthetically active radiation (PAR) sensors apparently not affected. There a number of contributing factors towards why fouling is occurring, the most likely is that the wiper on the turbidity sensor are not cleaning the sensor surface sufficiently. While the wipers are adjusted and tested in the laboratory before being sent down there is the possibility that sensor wipers may be bumped out of position during transport or when handling. This is especially likely for the turbidity wiper which protrudes out from the side of the instrument. It is important that project participants ensure that the sensor wipers are positioned correctly and observe that they are working when deploying the loggers. This should help reduce the likelihood of sensor fouling on future deployments.

The below diagram shows the correct configuration of the logger prior to deployment (Figure 11). In the diagram the wipers are set at their 'home' position. The following steps may help ensure that the logger wipers are working properly before deployment.

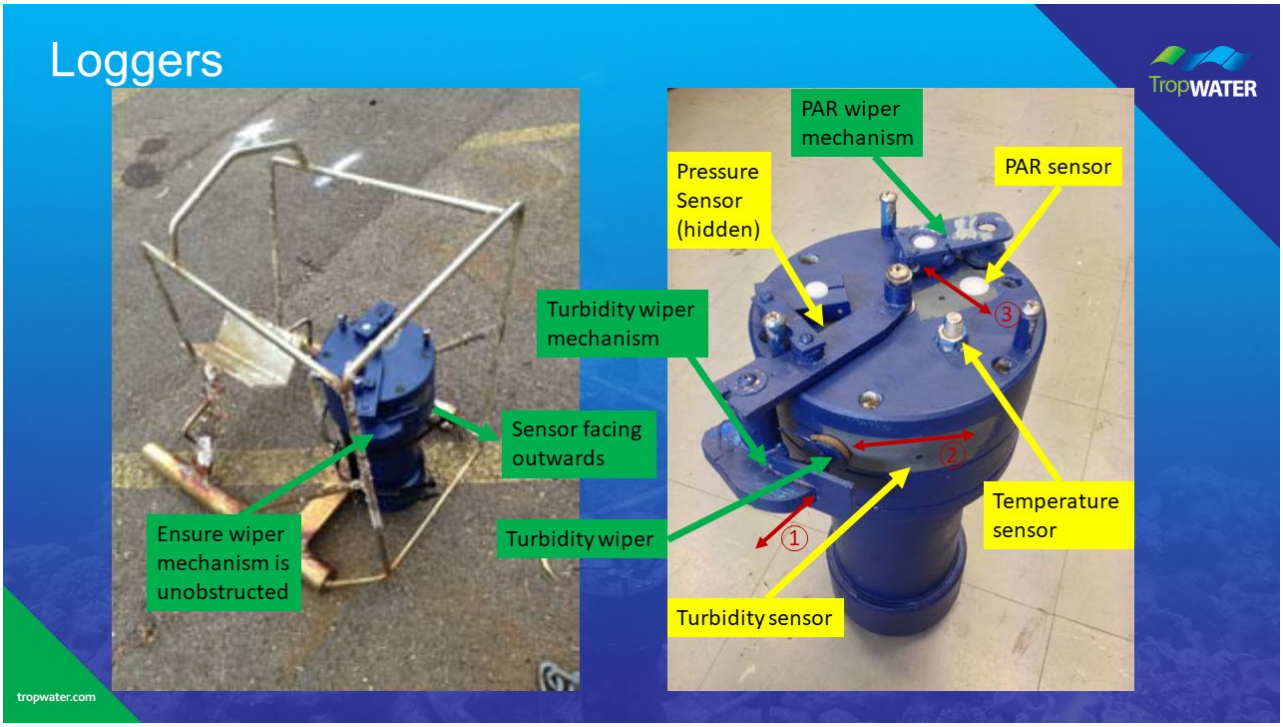

Figure 11. Diagram showing parts of the MGL loggers ready for deployment.

1) Check that the turbidity wiper mechanism is correctly positioned as per the figure above. The mechanism should be giving some resistance onto the spring and wiper. If the mechanism is pivoted away from the logger body (i.e. from being pushed out during transport or handling) it will be is unable to give sufficient resistance to the spring and wiper. If the mechanism is pivoted out of place simply push it back to the home position.

2) Sweep the turbidity wiper across the sensor face by pushing the mechanism from left to right and leave it on the right hand side. The wipers automatically activate every 10 minutes. Leave the wiper on the right side and come back after 10 minutes to confirm that the wiper has returned to its home position.

3) Sweep the PAR wiper across the sensor face by pushing the mechanism from left to right and leave it on the right hand side. The wipers automatically activate every 10 minutes. Leave the wiper on the right side and come back after 10 minutes to confirm that the wiper has returned to its home position.

4) Ensure that the turbidity sensor is orientated in a way that it is facing outwards and has a clear view of water from the frame and the wiper mechanism is not obstructed by the instrument frame or the cable ties.

5) Use a lowering rope slipped through the top of the instrument frame when redeploying the loggers to ensure a controlled drop to the seafloor.

2.3.2 Water sampling

There are some ongoing issues with transportation of water samples, as the samples have been arriving at the Townsville laboratory at ambient temperature. The issues is with the courier service rather than any action of the program participants. Nonetheless keep the water samples refrigerated (TSS, Cond, pH) and frozen (nutrients and chlorophyll filter) up until the day that courier has been arranged. Line the medium sized esky with frozen icebricks (lots) and place the samples inside. Seal the esky lid with a strip of packing tape and keep in a cool place for courier pickup. The two small eskies and the sample racks can remain at Airlie Beach and do not need to accompany the samples up to the Townsville laboratory.

2.3.3 Keep up the good work!

Overall, in lieu of the above hiccups the program has been running quite smoothly considering the disruptions we have all been facing in 2020. Improvements have been made in collection of environmental data and completeness of datasheets.