



Whitsunday Water Quality Monitoring Blueprint for Tourism Operators: Quarterly update – January 2021

Jordan Iles and Nathan Waltham

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Great Barrier
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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 fourth quarter of 2020. The water sampling and logger maintenance schedule for this period is outlined in Table 1.1.

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 1.1. Monitoring events for the fourth 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
f	08/08/2020	Ocean Rafting	Ocean Rafting
g	17/09/2020	Ocean Rafting / TropWATER	Ocean Rafting / TropWATER
h	21/10/2020	Southern Cross Sailing / Red Cat	True Blue Sailing
i [#]	18/11/2020	Red Cat	True Blue Sailing
j	13/12/2020	Red Cat	Ocean Rafting / True Blue Sailing

[#] water sampling only

2 RESULTS

The results within this report cover the period 18/09/2020 to 19/12/2020. There were two logger instrument deployments during this period. Deployment 6 covered 17/09/2020 to 28/10/2020 (41 days) for Cairn Beach and 17/09/2020 to 21/10/2020 (34 days) for Tongue Bay. Deployment 7 covered the period 28/10/2020 to 13/12/2020 (46 days) for Cairn Beach and 21/10/2020 to 16/12/2020 (56 days) for Tongue Bay. 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 last two deployment periods ranged from 22.5 to 28.0 °C at Cairn Beach and 23.4 to 28.2 °C at Tongue Bay (Figure 1). Water temperatures have continued to warm as we come into summer.

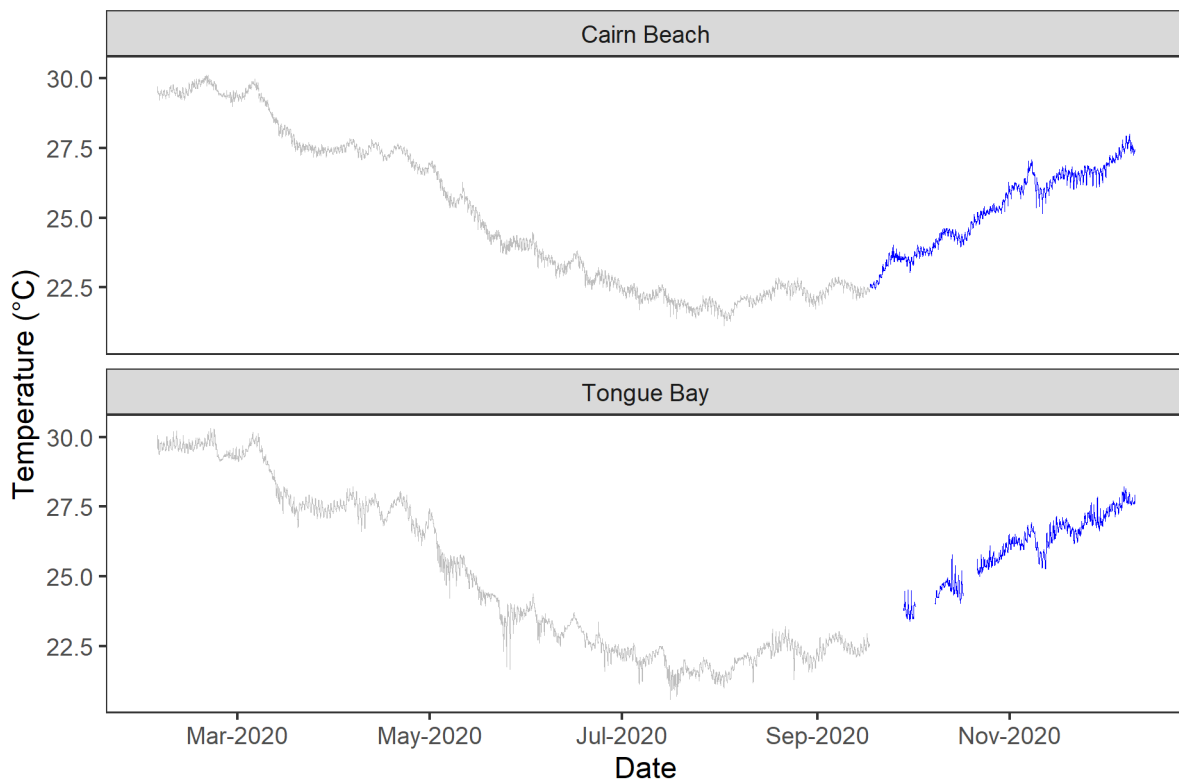


Figure 1. Water temperature measured at Cairn Beach and Tongue Bay 2020

2.1.2 Water depth and wave height

The average water depths of the logger at Cairn Beach were 10.3 and 10.0 m for Deployments 6 and 7 respectively. Average water depths of the logger at Tongue Bay was 8.4 m for both Deployments 6 and 7 (Figure 2). 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 periods (average = 0.003 m). Tongue Bay was more exposed to wave energy with mean RMS depths of 0.021 and 0.015 m for Deployments 6 and 7 respectively.

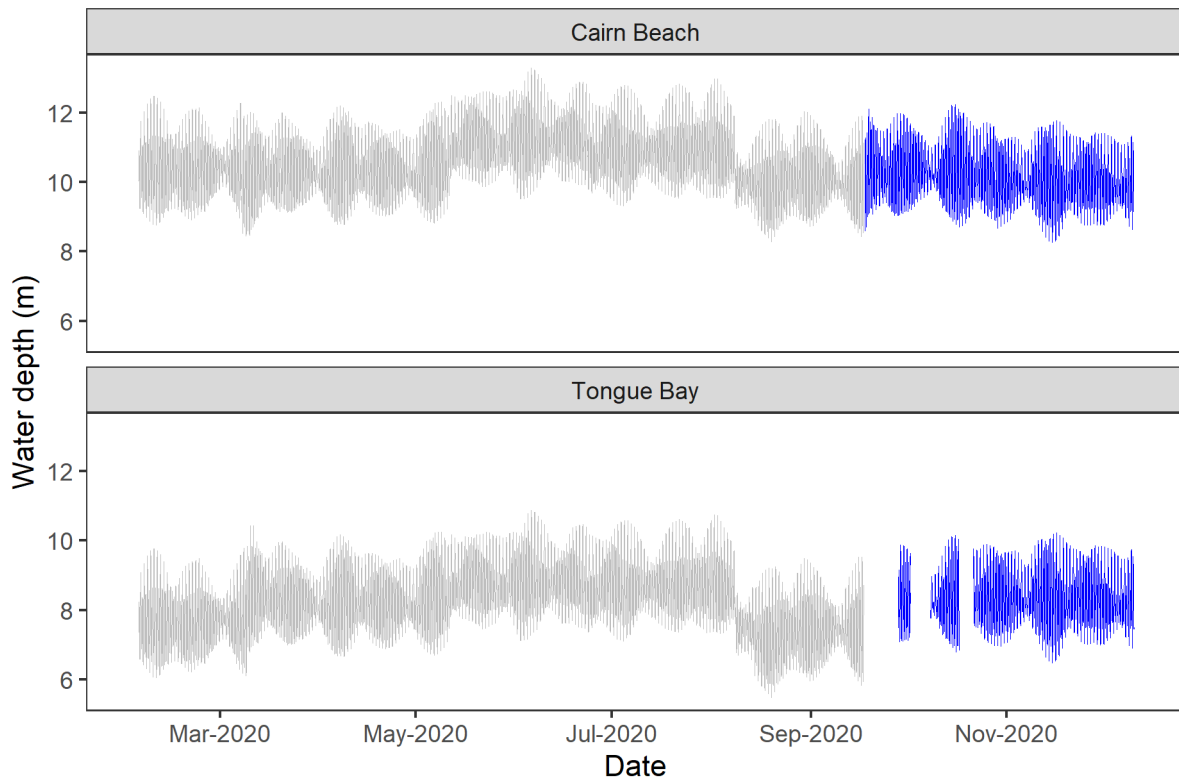


Figure 2. Water depth measured at Cairn Beach and Tongue Bay 2020

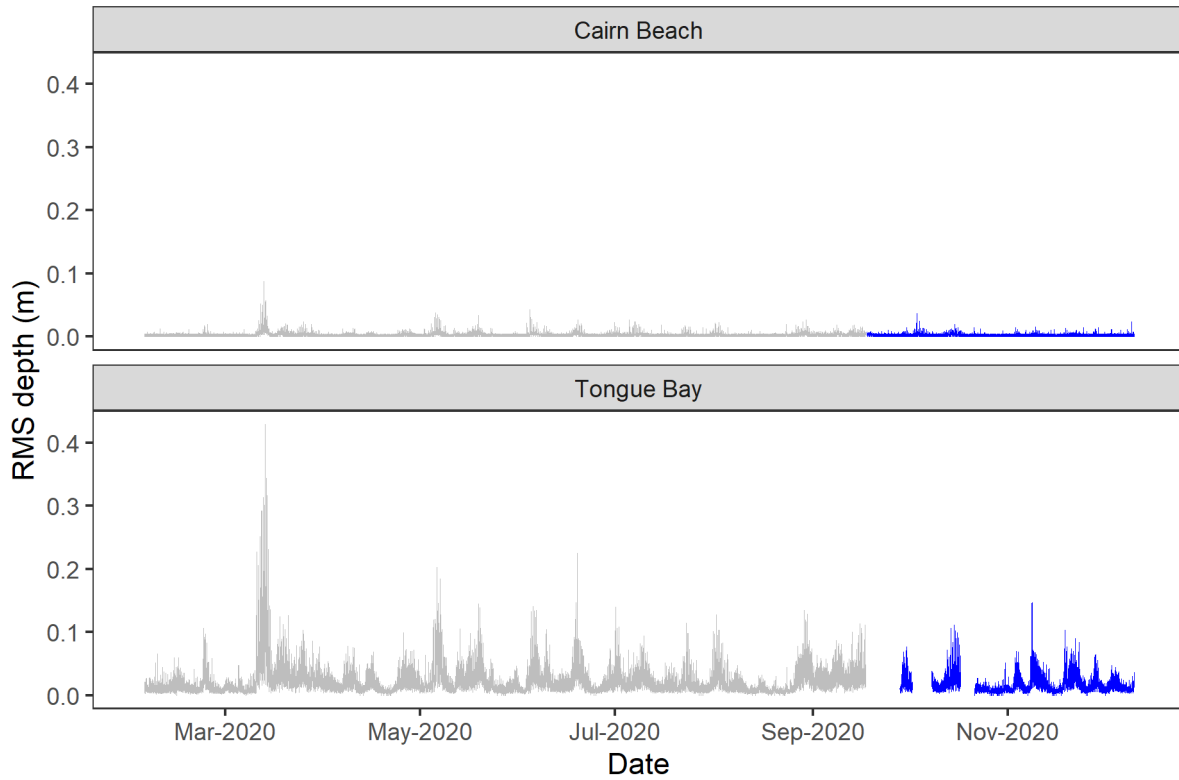


Figure 3. Root mean squared (RMS) water depth measured at Cairn Beach and Tongue Bay 2020

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). Daily photosynthetically active radiation is shown in Figure 5. Mean daily PAR values were 1.81 and 3.33 mol m⁻² d⁻¹ at Cairn Beach for Deployment 7 and Deployment 7 respectively. Mean daily PAR was 3.69 mol m⁻² d⁻¹ at Tongue Bay for Deployment 7.

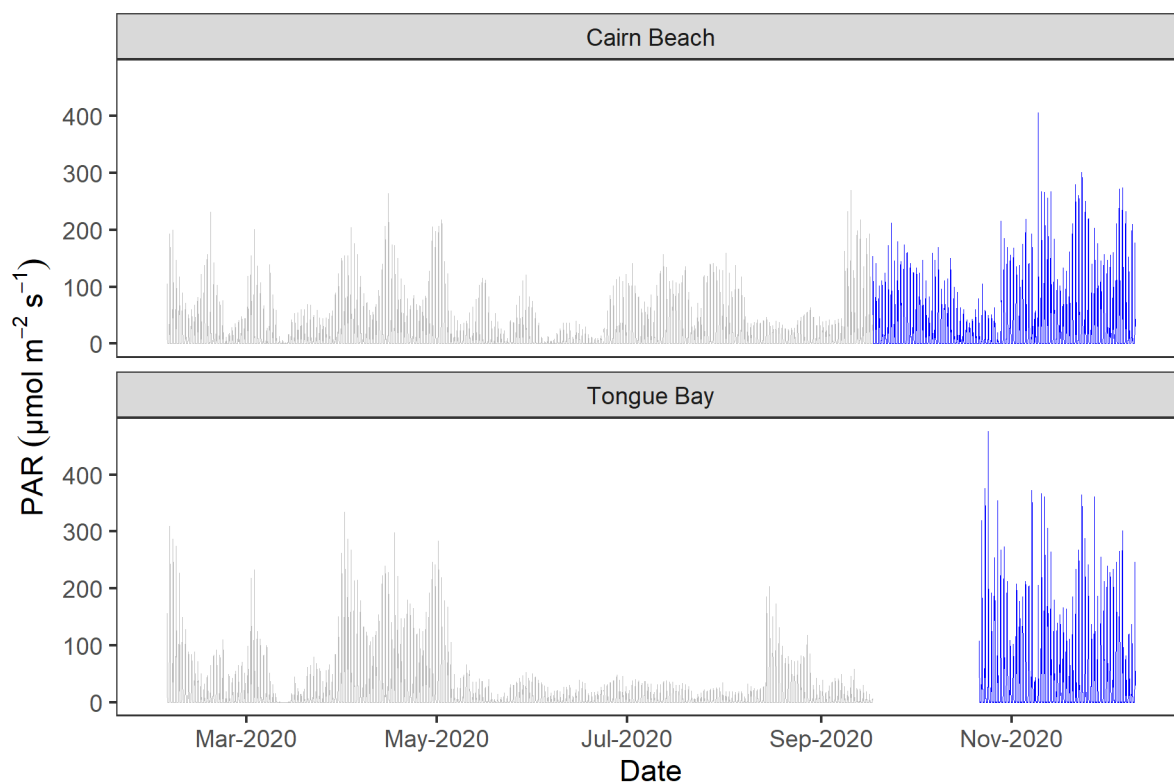


Figure 4. Photosynthetically active radiation (PAR) measured at 10 min intervals at Cairn Beach and Tongue Bay 2020

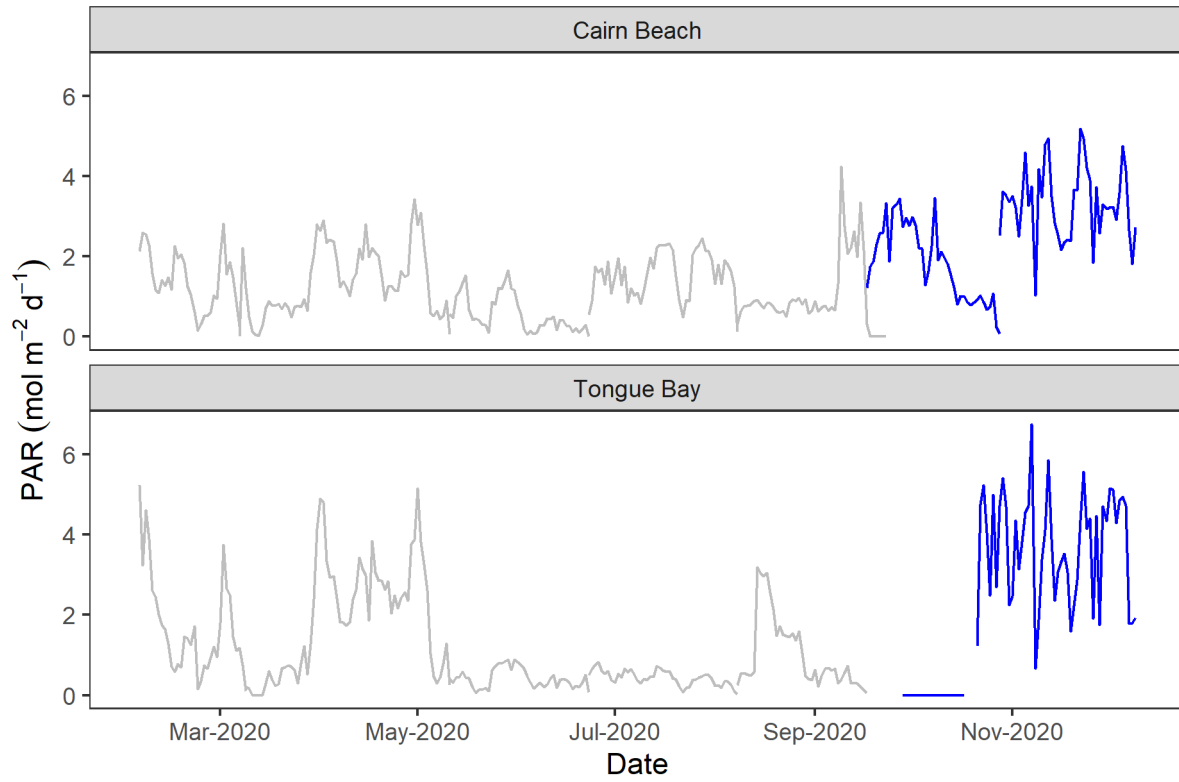


Figure 5. Daily photosynthetically active radiation at Cairn Beach and Tongue Bay 2020

2.1.4 Turbidity

Turbidity ranged from 0.05 to 21.2 NTUe at the Cairn Beach monitoring site, with an average value of 0.75 NTUe over the deployment period (Figure 6). Turbidity ranged from 0.05 to 30.0 NTUe at the Tongue Bay monitoring site, with an average value of 7.25 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 for Tongue Bay was deemed unreliable due to instrument failure for deployment 6, and after 6th November (day 16) for deployment 7 due to sensor fouling and removed during the data QC process.

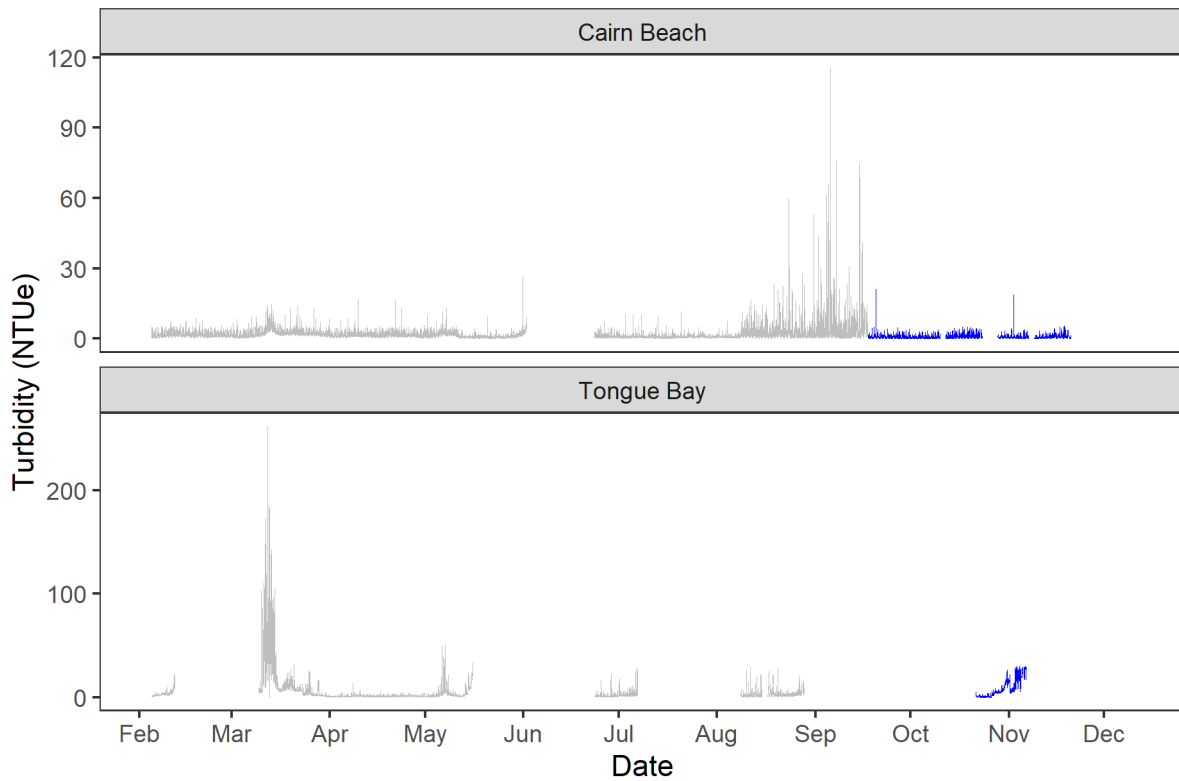


Figure 6. Turbidity measured at Cairn Beach and Tongue Bay 2020. Note different y-axis scale. Data has been removed from the timeseries for periods where the sensor fouled.

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 2.1). Secchi depths measured by tourism operators at Cairn Beach and Tongue Bay are shown in Figure 7.

Table 2.1. Water quality measurements and observations recorded from Cairn Beach and Tongue Bay.

Site Name	Site Code	Date	Time	Secchi depth m	Cloud cover %	Wind knots	Sea surface	Surface scum/slick
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
		08/08/2020	09:15	5.1	100	0	0	Nil
		17/09/2020	09:40	3	70	10 - 15	Choppy	Nil
		24/10/2020	06:15	12	100	5	Calm	NR
		19/11/2020	10:10	4	30	20	Choppy	Nil
19/12/2020	16:10	NR	50	15	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
		08/08/2020	10:15	5	80	5	Slight, Ripple	Nil
		17/09/2020	11:20	2.9	90	10 - 15	Choppy	Nil
		21/10/2020	09:55	4	Mild	5 - 10	Slight chop	NR
		18/11/2020	09:22	4	10	5 - 10	1m swell ESE	Nil
13/12/2020	11:15	3	25	25	Small wavelets	Nil		

[#] Note: Likely erroneous measurement, ^{*} Note: Secchi depth estimated, NR = not recorded.

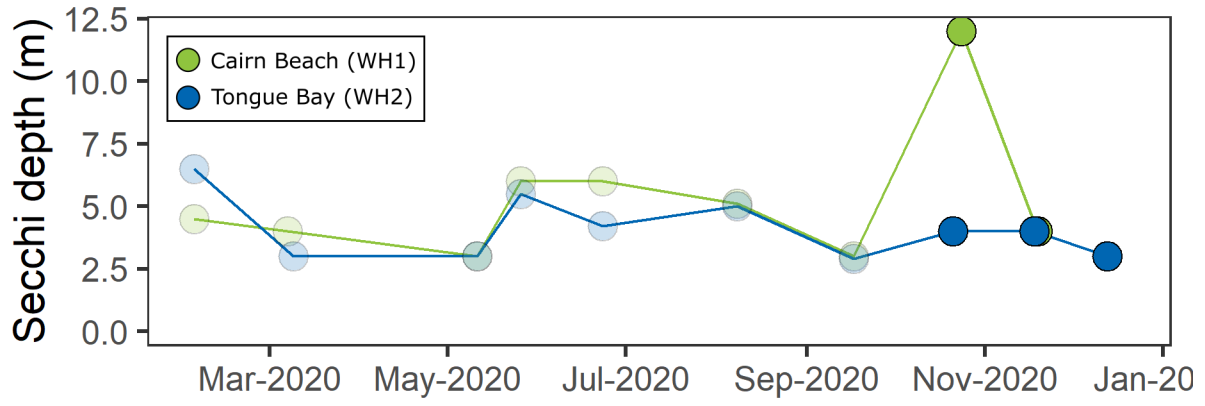


Figure 7. Secchi depth measured at Cairn Beach and Tongue Bay 2020

2.2.2 Physico-chemical parameters

Water samples collected from the monitoring sites during October, November, and December 2020 were measured in the laboratory for electrical conductivity, total suspended solids (TSS), and pH (Table 2.2, Figure 8). Conductivity ranged from 53.49 to 53.96 mS cm⁻¹ and was within expected range of seawater with limited freshwater inputs. TSS ranged from 1.9 to 3.3 mg L⁻¹. pH ranged from 8.15 to 8.27.

Table 2.2. 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	TSS	pH
			mS cm ⁻¹	mg L ⁻¹	
Cairn Beach	WH1	4/02/2020	54.02	1.9	8.29
		9/03/2020	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
		8/08/2020	52.96	1.0	8.19
		17/09/2020	53.63	2.0	8.14
		24/10/2020	53.49	1.9	8.23
		19/11/2020	53.70	2.7	8.15
		19/12/2020	53.86	2.3	8.27
Tongue Bay	WH2	4/02/2020	53.92	2.8	8.31
		8/03/2020	53.14	3.0	8.29
		11/05/2020	53.07	2.0	8.32
		26/05/2020	53.01	1.8	8.27
		23/06/2020	53.64	2.6	8.23
		8/08/2020	52.95	1.1	8.14
		17/09/2020	53.70	1.7	8.15
		21/10/2020	53.69	2.5	8.23
		18/11/2020	53.96	3.3	8.15
		13/12/2020	53.89	2.6	8.24

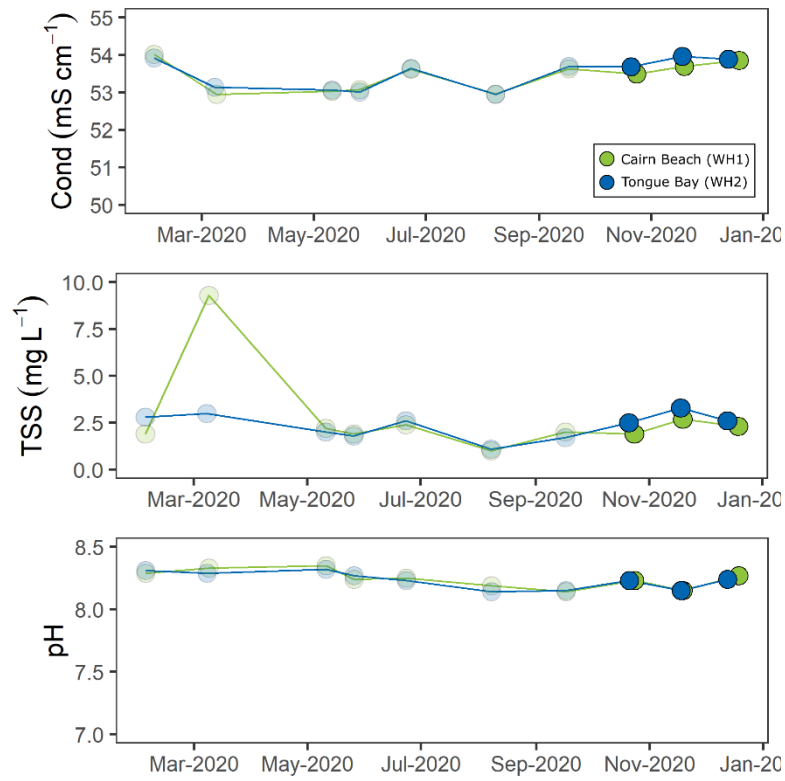


Figure 8. Electrical conductivity (Cond), total suspended solids (TSS), and pH of water samples collected from Cairn Beach WH1 (green) and Tongue Bay WH2 (blue) 2020.

2.2.3 Nutrients

Results for water samples collected during the three most recent scheduled trips are presented below, with previous sampling events shown in grey for comparison. Nitrogen and phosphorus concentrations are presented in Table 2.3. Total nitrogen concentrations ranged from 104 to 165 $\mu\text{g N L}^{-1}$ during the most recent sampling events (Figure 9). Total phosphorus concentrations ranged from 6 to 10 $\mu\text{g P L}^{-1}$ (Figure 10). The bulk of nutrients were present in the dissolved fraction with 68 to 96% nitrogen dissolved, and 78 to 90 % phosphorus dissolved. Nitrate-nitrite concentrations ranged 4 to 53 $\mu\text{g N L}^{-1}$.

Table 2.3. Nutrient concentrations measured in surface water samples collected from Cairn Beach and Tongue Bay. Total nitrogen (TN), total dissolved nitrogen (TDN), particulate nitrogen (PN), nitrate-nitrite (NO_x), total phosphorus (TP), total dissolved phosphorus (TDP), and particulate phosphorus (PP). All concentrations reported in micrograms per litre ($\mu\text{g L}^{-1}$).

Site name	Site code	Sample Date	TN $\mu\text{g L}^{-1}$	TDN $\mu\text{g L}^{-1}$	PN $\mu\text{g L}^{-1}$	NO_x $\mu\text{g L}^{-1}$	TP $\mu\text{g L}^{-1}$	TDP $\mu\text{g L}^{-1}$	PP $\mu\text{g L}^{-1}$
Cairn Beach	WH1	4/02/2020	142	136	6	6	9	8	1
		9/03/2020	227	111	116	7	17	7	10
		11/05/2020	158	130	28	2	7	6	1
		26/05/2020	93	84	9	3	6	5	1
		23/06/2020	85	84	1	3	6	6	0
		8/08/2020	160	114	46	5	7	6	1
		17/09/2020	113	82	31	5	6	3	3
		24/10/2020	119	112	9	7	10	9	1
		19/11/2020	165	112	5	53	9	8	1
		19/12/2020	104	94	<1	10	6	5	1
Tongue Bay	WH2	4/02/2020	126	118	8	3	9	8	1
		8/03/2020	130	109	21	3	8	7	1
		11/05/2020	169	155	14	2	8	6	2
		26/05/2020	102	82	20	2	7	5	2
		23/06/2020	109	88	21	5	6	5	1
		8/08/2020	254	126	128	3	7	5	2
		17/09/2020	94	87	7	2	6	5	1
		21/10/2020	129	88	3	41	7	6	1
		18/11/2020	119	97	3	22	9	7	2
		13/12/2020	105	101	2	4	7	6	1

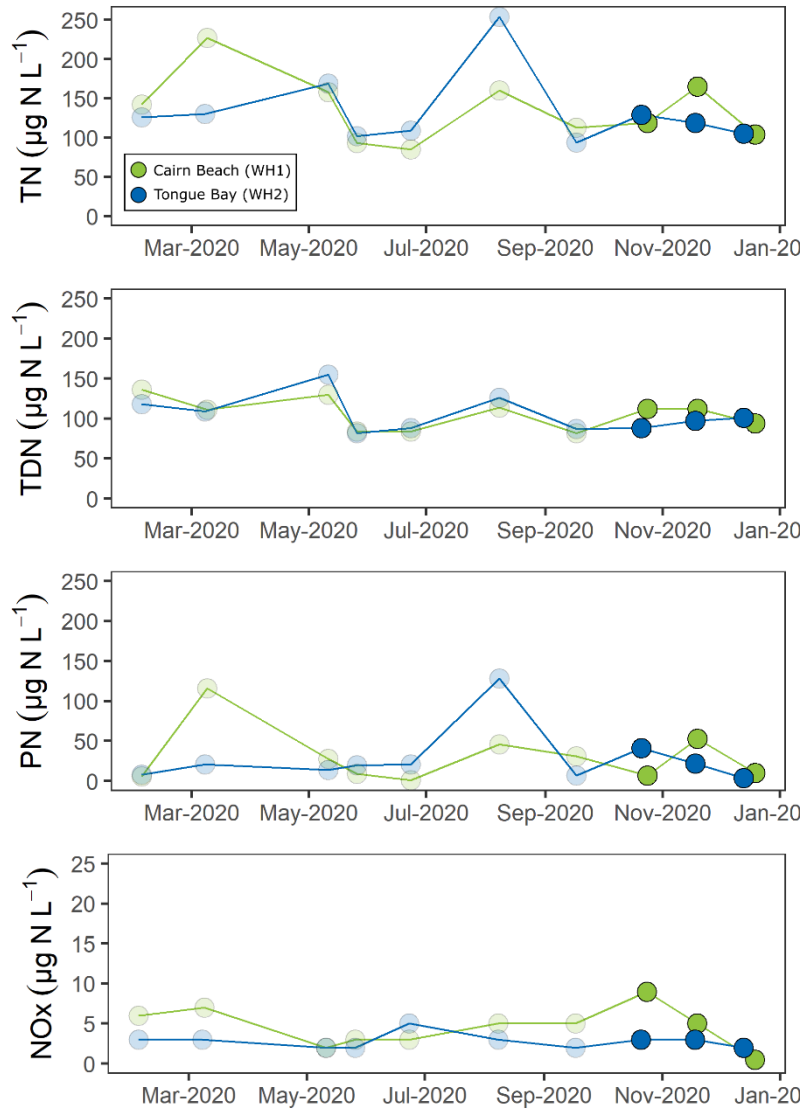


Figure 9. Total nitrogen (TN), total dissolved nitrogen (TDN), particulate nitrogen (PN), and nitrate-nitrite (NOx) concentrations measured in water samples collected from Cairn Beach WH1 (green) and Tongue Bay WH2 (blue) 2020.

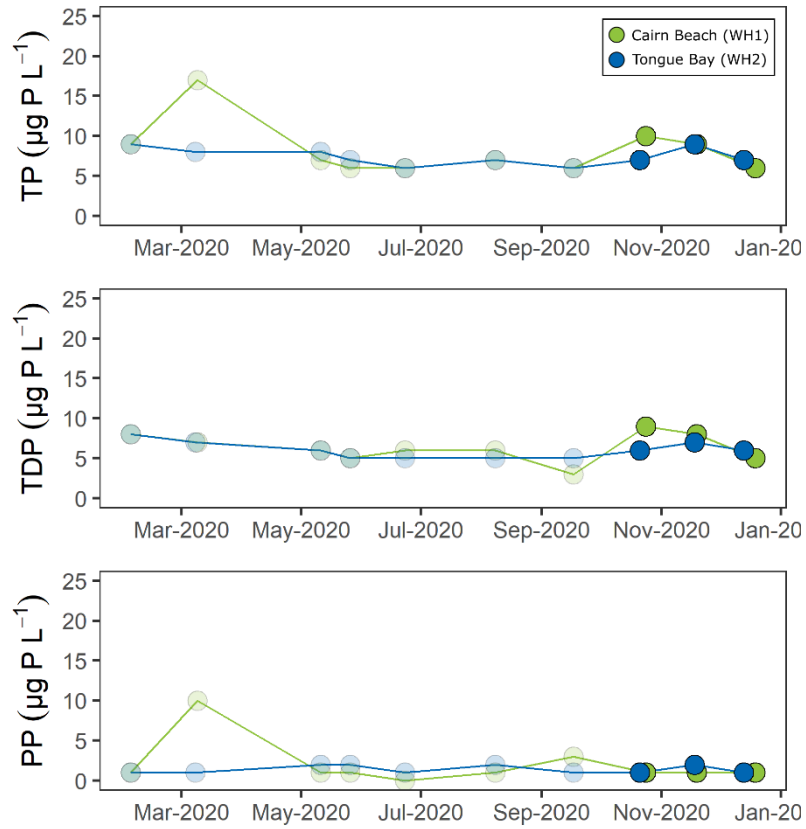


Figure 10. Total phosphorus (TP), total dissolved phosphorus (TDP), and particulate phosphorus (PP) concentrations measured in water samples collected from Cairn Beach WH1 (green) and Tongue Bay WH2 (blue) 2020.

2.2.4 Chlorophyll *a*

Chlorophyll *a* values ranged from below detection limit ($<0.2 \mu\text{g L}^{-1}$) to $0.5 \mu\text{g L}^{-1}$ between sites during the most recent sampling events (Table 2.4, Figure 11). Phaeophytin *a* concentrations were below detection limit ($< 0.2 \mu\text{g L}^{-1}$).

Table 2.4. 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 ($\mu\text{g L}^{-1}$).

Site name	Site code	Sample Date	Chl- <i>a</i> $\mu\text{g L}^{-1}$	Phaeo- <i>a</i> $\mu\text{g L}^{-1}$
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
		8/08/2020	<0.2	<0.2
		17/09/2020	0.45	<0.2
		24/10/2020	<0.2	<0.2
		19/11/2020	0.40	<0.2
		19/12/2020	0.49	<0.2
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
		8/08/2020	<0.2	<0.2
		17/09/2020	0.49	<0.2
		21/10/2020	0.22	<0.2
		18/11/2020	0.38	<0.2
		13/12/2020	0.50	<0.2

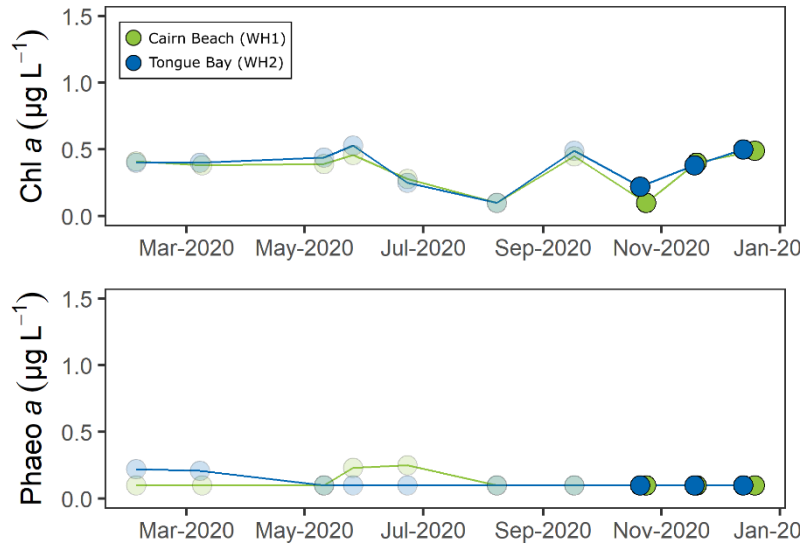


Figure 11. Chlorophyll *a* and phaeophytin *a* concentrations measured in water samples collected from Cairn Beach WH1 (green) and Tongue Bay WH2 (blue) 2020.

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