

**Supplementary material**

**Assessment of water quality from the Normanby River catchment to coastal flood plumes on the northern Great Barrier Reef, Australia**

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**Table S1. Mean flood event sediment and nutrient concentrations ( $\pm$ s.d.) for catchment regions and flood plume**

Upper catchment 2012 samples not analysed for statistical differences with 2013 or 2014 due to variations in river sampling methodologies that year.

Significant differences ( $P < 0.05$ ) between columns are represented by differences between the lowercase superscript letters. NA, not analysed

Analyte	Upper catchment			Mid-catchment			Lower Estuary			Plume		
	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014
SS (mg L <sup>-1</sup> )	613 (575)	269 (271) <sup>a</sup>	354 (268) <sup>a</sup>	62 (41) <sup>d</sup>	67 (37) <sup>d</sup>	71 (16) <sup>d</sup>	26 (20) <sup>g</sup>	74 (22) <sup>gh</sup>	102 (22) <sup>h</sup>	8 (7) <sup>x</sup>	8 (5) <sup>x</sup>	41 (55) <sup>x</sup>
PN ( $\mu$ M L <sup>-1</sup> )	NA	40.6 (44.4) <sup>a</sup>	73.7 (59.4) <sup>b</sup>	10.6 (6.9) <sup>d</sup>	10.7 (0.7) <sup>d</sup>	13.2 (6.6) <sup>d</sup>	5.5 (4.7) <sup>g</sup>	20.2 (4.8) <sup>h</sup>	15.6 (12.8) <sup>zq</sup>	4.2 (5.7) <sup>x</sup>	5.1 (5.3) <sup>x</sup>	3.9 (3.2) <sup>x</sup>
DON ( $\mu$ M L <sup>-1</sup> )	NA	23.7 (10.0) <sup>a</sup>	12.4 (4.1) <sup>b</sup>	21.8 (2.8) <sup>de</sup>	25.4 (0.4) <sup>d</sup>	17.8 (0.9) <sup>e</sup>	18.8 (7.0) <sup>g</sup>	21.2 (7.1) <sup>g</sup>	11.5 (6.8) <sup>g</sup>	12.8 (4.8) <sup>x</sup>	13.5 (6.6) <sup>x</sup>	14.0 (3.1) <sup>x</sup>
NH <sub>4</sub> /NH <sub>3</sub> ( $\mu$ M L <sup>-1</sup> )	0.71 (0.19)	1.05 (1.51) <sup>a</sup>	0.60 (0.26) <sup>a</sup>	0.39 (0.21) <sup>d</sup>	2.21 (0.62) <sup>e</sup>	0.54 (0.05) <sup>de</sup>	1.07 (0.45) <sup>g</sup>	3.34 (0.79) <sup>g</sup>	2.99 (3.96) <sup>g</sup>	0.99 (0.31) <sup>x</sup>	0.93 (0.82) <sup>x</sup>	0.73 (0.39) <sup>x</sup>
NO <sub>x</sub> ( $\mu$ M L <sup>-1</sup> )	8.97 (10.82)	12.38 (6.62) <sup>a</sup>	2.95 (1.98) <sup>b</sup>	1.53 (1.48) <sup>de</sup>	5.11 (3.17) <sup>d</sup>	0.53 (0.05) <sup>e</sup>	5.73 (1.05) <sup>g</sup>	2.58 (0.44) <sup>gh</sup>	0.83 (0.78) <sup>h</sup>	3.60 (0.86) <sup>x</sup>	1.57 (1.05) <sup>y</sup>	0.99 (0.24) <sup>y</sup>
PP ( $\mu$ M L <sup>-1</sup> )	NA	3.4 (3.0) <sup>a</sup>	8.4 (5.5) <sup>b</sup>	1.3 (1.1) <sup>d</sup>	1.3 (0.3) <sup>d</sup>	2.3 (0.9) <sup>d</sup>	0.4 (0.1) <sup>g</sup>	2.0 (0.9) <sup>h</sup>	2.4 (1.0) <sup>h</sup>	0.2 (0.1) <sup>x</sup>	0.2 (0.2) <sup>x</sup>	0.7 (0.5) <sup>x</sup>
DOP ( $\mu$ M L <sup>-1</sup> )	NA	0.4 (0.31) <sup>a</sup>	0.2 (0.2) <sup>b</sup>	0.5 (0.4) <sup>d</sup>	0.6 (0.1) <sup>d</sup>	0.1 (0.1) <sup>d</sup>	0.1 (0.1) <sup>g</sup>	0.2 (0.2) <sup>g</sup>	0.3 (0.3) <sup>g</sup>	0.4 (0.1) <sup>x</sup>	0.1 (0.1) <sup>y</sup>	0.2 (0.1) <sup>xy</sup>
FRP ( $\mu$ M L <sup>-1</sup> )	0.40 (0.19)	0.60 (0.42) <sup>a</sup>	0.44 (0.33) <sup>a</sup>	0.15 (0.12) <sup>d</sup>	0.60 (0.05) <sup>e</sup>	0.26 (0.04) <sup>de</sup>	0.26 (0.06) <sup>g</sup>	0.45 (0.08) <sup>h</sup>	0.19 (0.08) <sup>g</sup>	0.22 (0.09) <sup>x</sup>	0.15 (0.08) <sup>y</sup>	0.11 (0.06) <sup>y</sup>
Chl- <i>a</i> ( $\mu$ g L <sup>-1</sup> )	NA	NA	NA	NA	NA	NA	1.1 (1.2)	0.9 (0.3)	0.2 (0.0)	1.3 (0.6) <sup>x</sup>	2.2 (2.2) <sup>x</sup>	0.6 (0.3) <sup>x</sup>
Phyto (cells L <sup>-1</sup> , $\times$ 1000)	NA	NA	NA	NA	NA	NA	NA	NA	NA	20 (12) <sup>x</sup>	616 (1104) <sup>y</sup>	99 (66) <sup>xy</sup>
Salinity	NA	NA	NA	NA	NA	NA	NA	NA	NA	19.0 (7.9)	23.7 (7.8)	16.3 (11.1)
Temp ( $^{\circ}$ C)	NA	NA	NA	NA	NA	NA	NA	NA	NA	31.8 (0.6)	31.0 (1.9)	29.0 (0.7)

**Table S2. Select GBR catchment area, discharge and land use statistics and ‘end-of system’ sediment concentrations**

Select GBR catchment area, discharge and land use statistics data are from Joo *et al.* (2012) (Burdekin, Fitzroy, Herbert and Tully); State of Queensland (2015) (Normanby). ‘End-of system’ sediment concentrations data are from Brodie *et al.* (2004) and Bainbridge *et al.* (2012) (Burdekin); Douglas *et al.* (2008) (Fitzroy); Mitchell *et al.* (1997) (Herbert); Prange *et al.* (2007) and Hateley *et al.* (2007) (Tully)

Catchment statistics	Normanby	Burdekin	Fitzroy	Herbert	Tully
River basin area (km <sup>2</sup> )	24550	130050	142750	9800	1740
Mean annual discharge (GL)	1234	8930	4311	3429	2995
Grazing area (%)	53 <sup>A</sup>	96	82	68	14
Horticultural area (%)	<1	2	6	4	14
End of system SS max (mg L <sup>-1</sup> )	125	1600	1449	400	116
End of system SS mean (mg L <sup>-1</sup> )	52	290	848	156	42

<sup>A</sup>Previously 82% (Joo *et al.* 2012) before conversion of grazing lands to conservation

**Table S3. Comparison of mean flood plume salinity, nutrient and sediment concentrations ( $\pm$ s.d.) for select GBR catchments**

Mean plume concentrations not available for Annan or Daintree Rivers, although the results from Davies and Eyre (2005) are discussed in text. Burdekin, Fitzroy, Herbert and Tully data are from Devlin (2012): mean plume concentrations measured by JCU between 1994 and 2012. GBR mean data are from Devlin *et al.* (2012c), Mean GBR Concentrations 2007–2011 Flood Plume Monitoring. Combined  $\text{NH}_4$  and  $\text{NO}_x$  (DIN) presented. Salinity not provided

Analyte	Normanby	Burdekin	Fitzroy	Herbert	Tully	GBR mean
Salinity	18.0 (11.4)	22.1 (11.6)	20.1 (6.7)	21.4 (13.7)	15.4 (15.2)	
SS ( $\text{mg L}^{-1}$ )	21.3 (30.3)	33.7 (75.4)	23.7 (42.5)	10.1 (14.5)	6.9 (11.3)	13.6 (29.3)
$\text{NH}_3$ ( $\mu\text{M}$ )	1.26 (1.30)	1.47 (1.96)	1.12 (0.93)	0.56 (0.77)	0.64 (0.66)	2.8 (3.1)
$\text{NO}_x$ ( $\mu\text{M}$ )	2.16 (1.50)	2.44 (3.52)	2.21 (2.22)	1.60 (2.62)	1.44 (2.57)	
PN ( $\mu\text{M}$ )	6.45 (7.01)	2.87 (5.01)	5.35 (6.77)	1.08 (2.83)	1.63 (2.58)	3.4 (4.7)
DON ( $\mu\text{M}$ )	13.64 (6.28)	7.19 (6.83)	14.10 (10.58)	5.97 (6.09)	4.51 (4.30)	8.8 (7.1)
FRP ( $\mu\text{M}$ )	0.19 (0.11)	0.31 (0.35)	0.79 (0.69)	0.16 (0.18)	0.23 (0.22)	0.4 (0.4)
DOP ( $\mu\text{M}$ )	0.43 (0.60)	0.17 (0.17)	0.29 (0.30)	0.14 (0.25)	0.16 (0.19)	0.2 (0.2)
PP ( $\mu\text{M}$ )	0.21 (0.14)	0.40 (1.01)	0.40 (0.56)	0.07 (0.16)	0.12 (0.18)	0.3 (0.6)
Chl- <i>a</i> ( $\mu\text{g L}^{-1}$ )	1.5 (1.8)	0.7 (1.2)	2.0 (3.7)	1.3 (1.4)	0.9 (0.9)	1.3 (1.8)

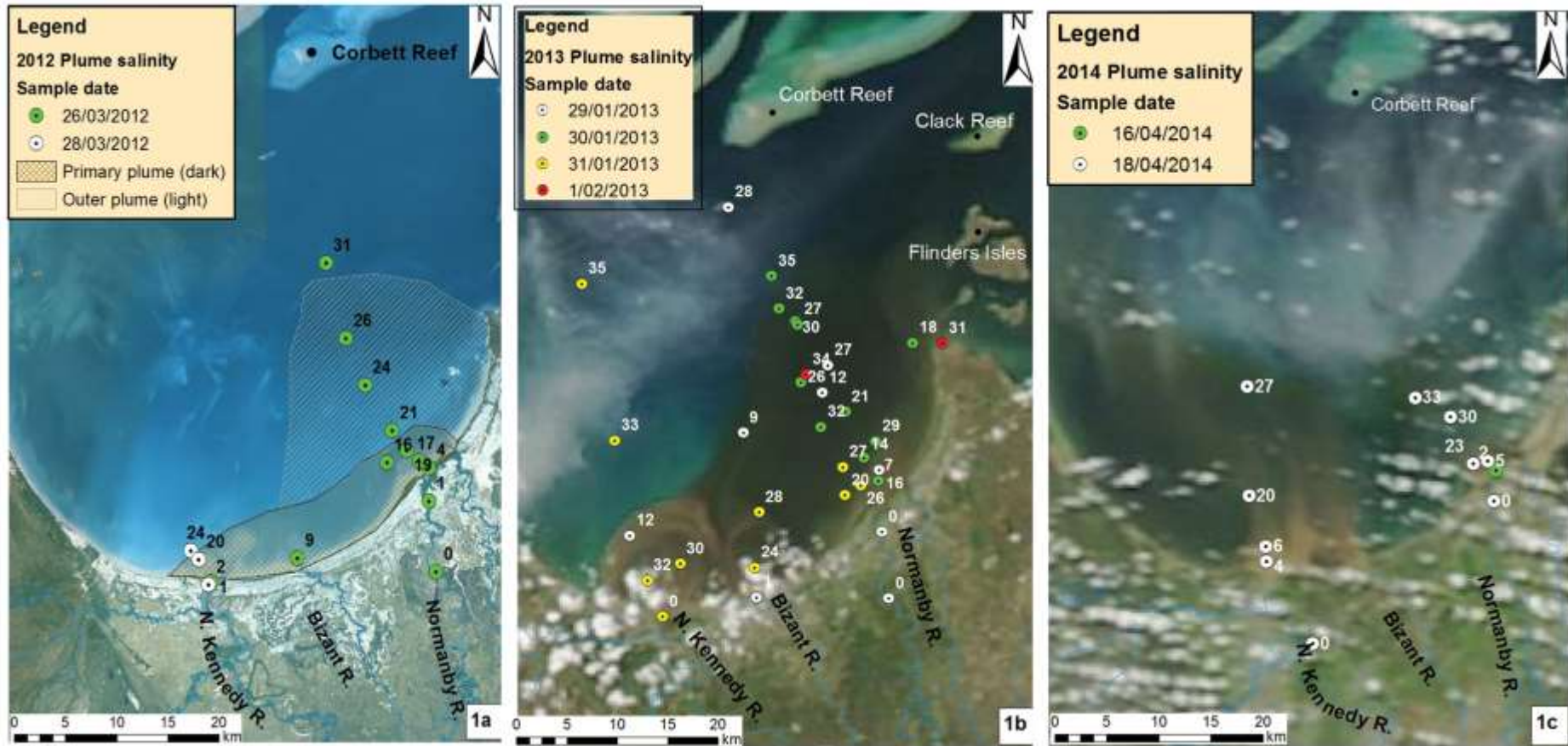
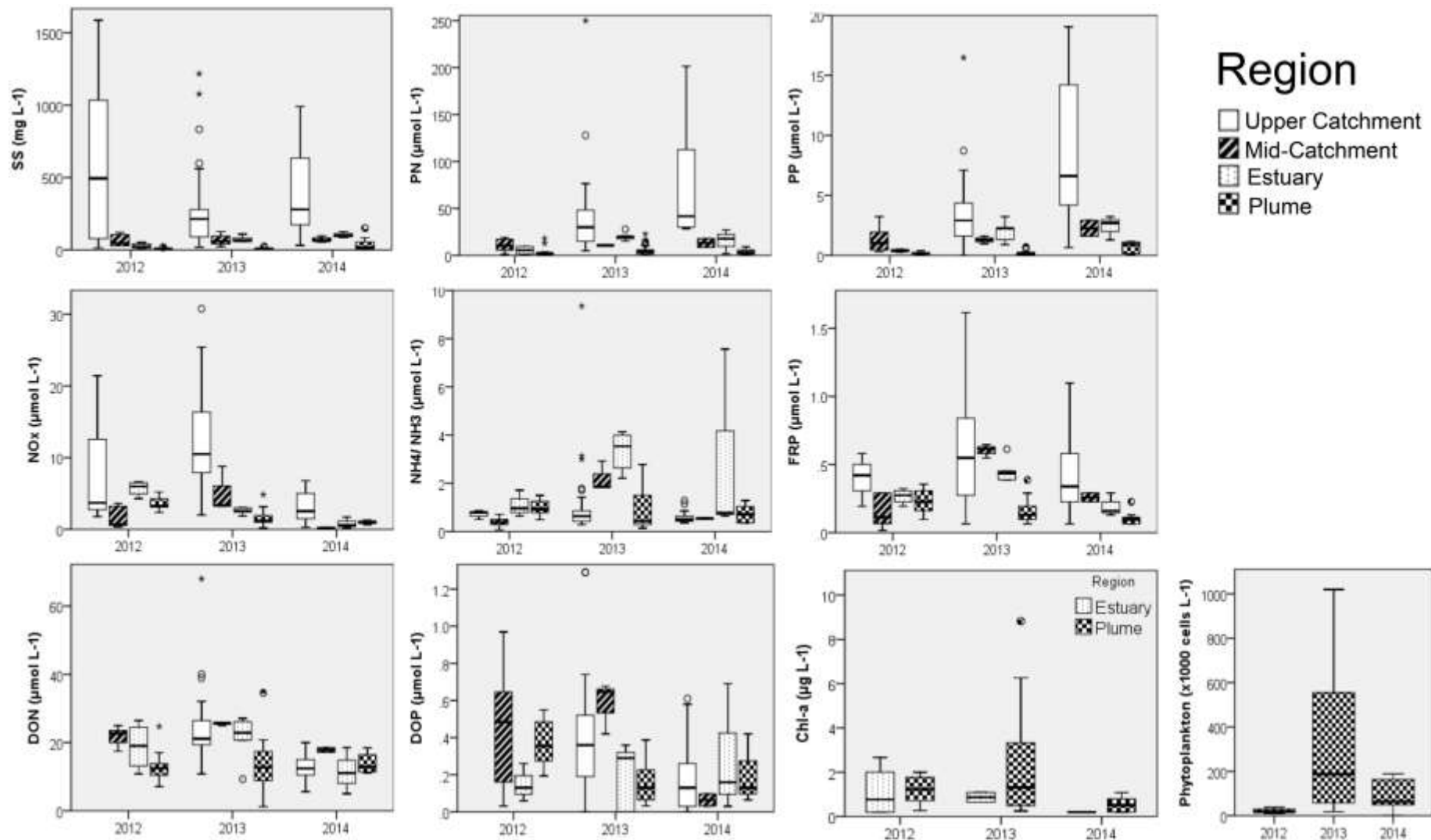


Fig. S1. Salinity measured at 2012 (1a), 2013 (1b), and 2014 (1c) PCB flood plume sample locations.



**Fig. S2.** Box plots comparing SS (mg L<sup>-1</sup>), FRP, NO<sub>x</sub>, NH<sub>3</sub>, PN, PP, DON, DOP (μM), Chl-a (μg L<sup>-1</sup>) and phytoplankton (cells L<sup>-1</sup>, ×100), for Normanby Catchment regions (upper catchment, mid-catchment, estuaries and plumes) during the March 2012, January 2013 and April 2014 flood events.

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