

TECHNICAL REPORT

PART 8: References and Appendices

Reporting on data collected 2022 - 2023



References

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Appendix A. Ross Basin Long-Term Annual Rainfall Trends

Mean annual rainfall in the Ross basin since 1911

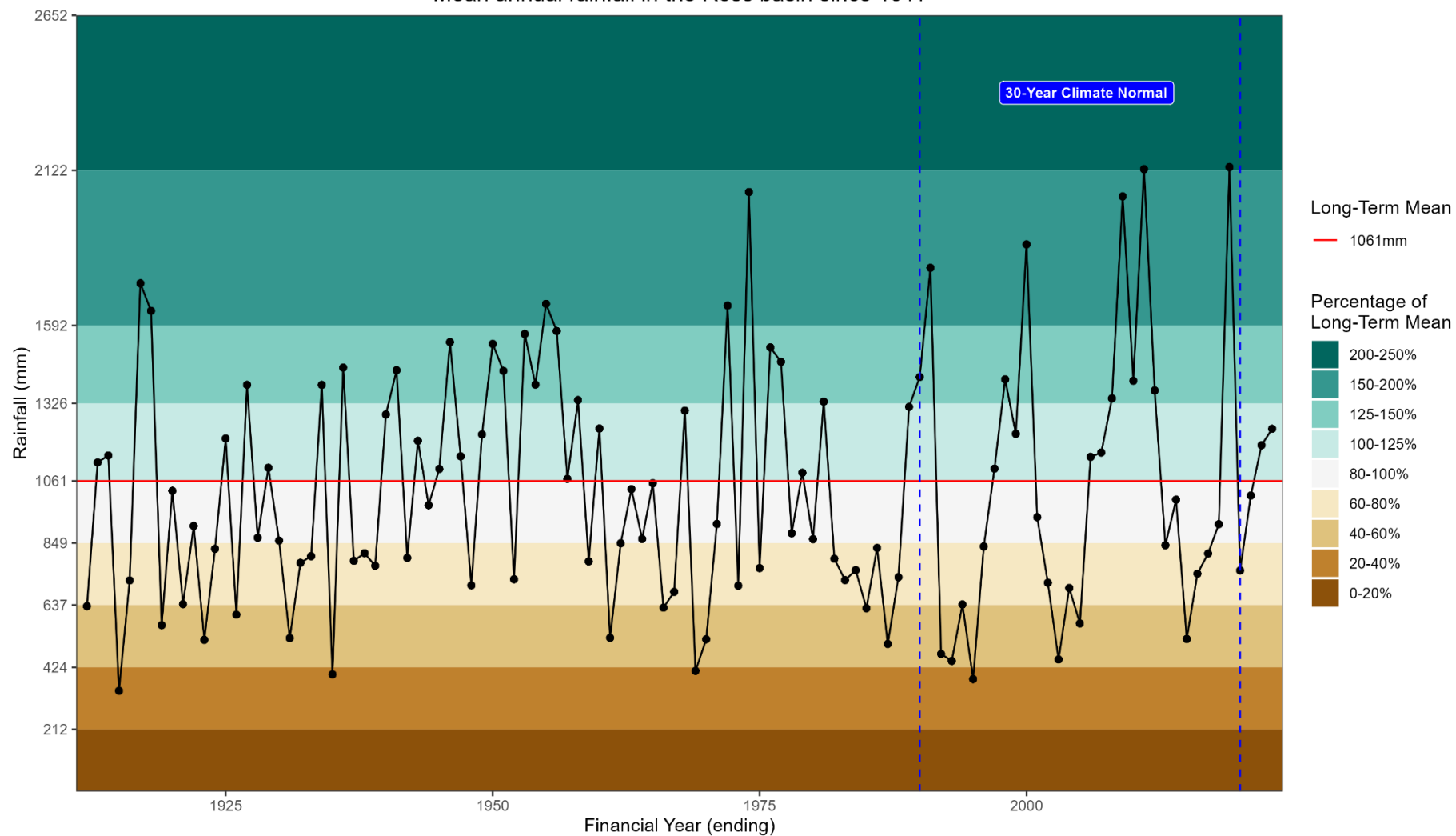


Figure 27. Ross Basin long-term annual rainfall trends.

Appendix B. Black Basin Long-Term Annual Rainfall Trends

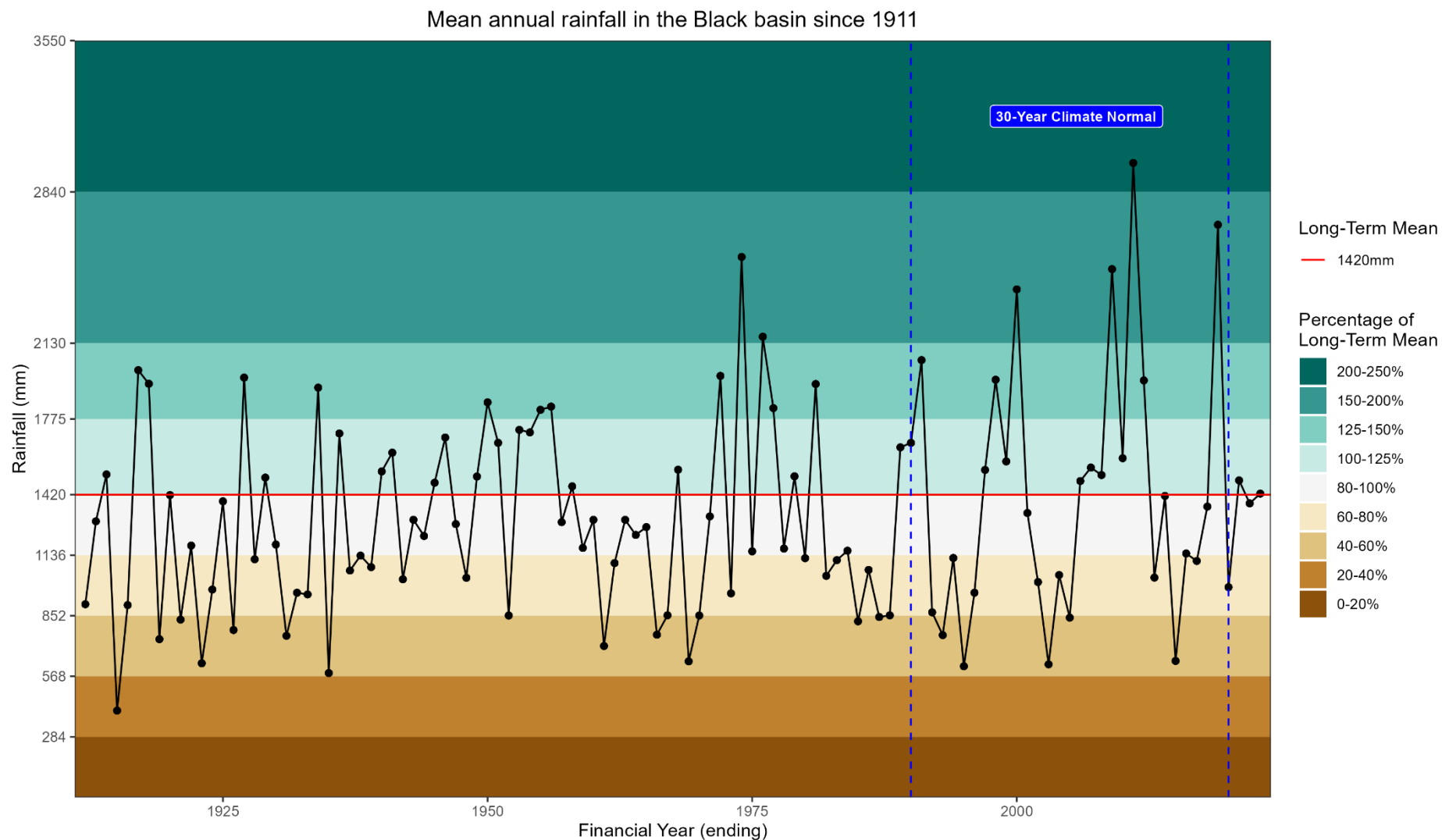


Figure 28. Black Basin long-term annual rainfall trends.

Appendix C. Season-specific Annual Rainfall Trends for the Ross and Black Basins

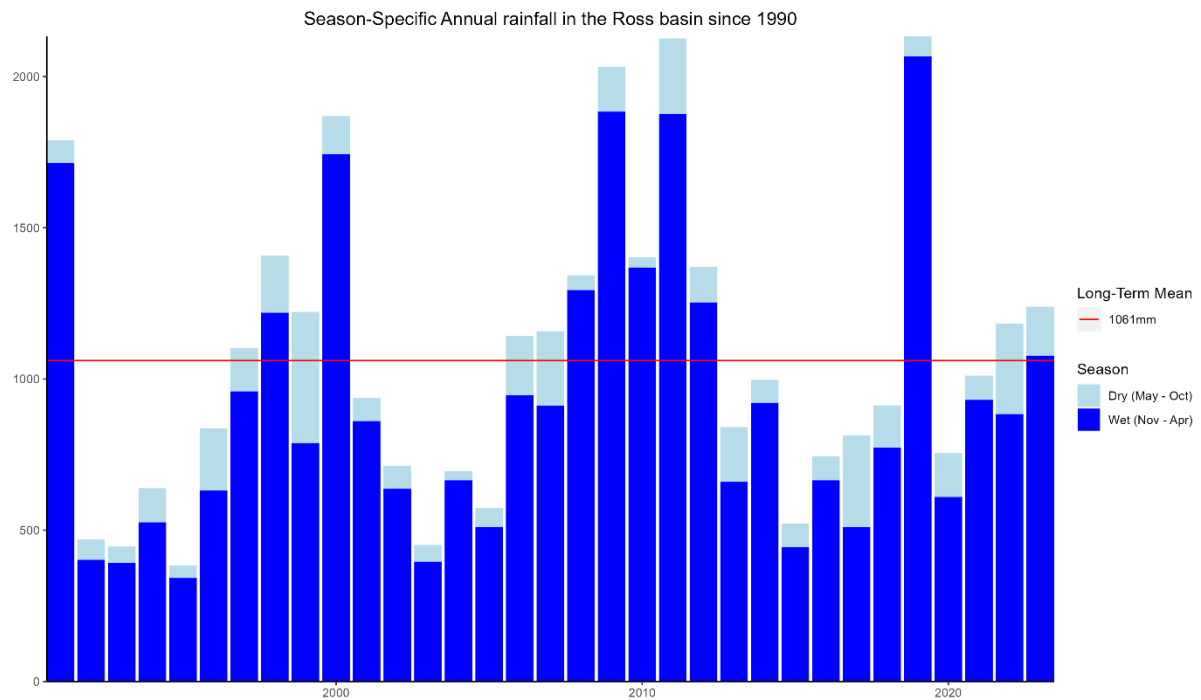


Figure 30. Season-specific annual rainfall in the Ross Basin since 1990.

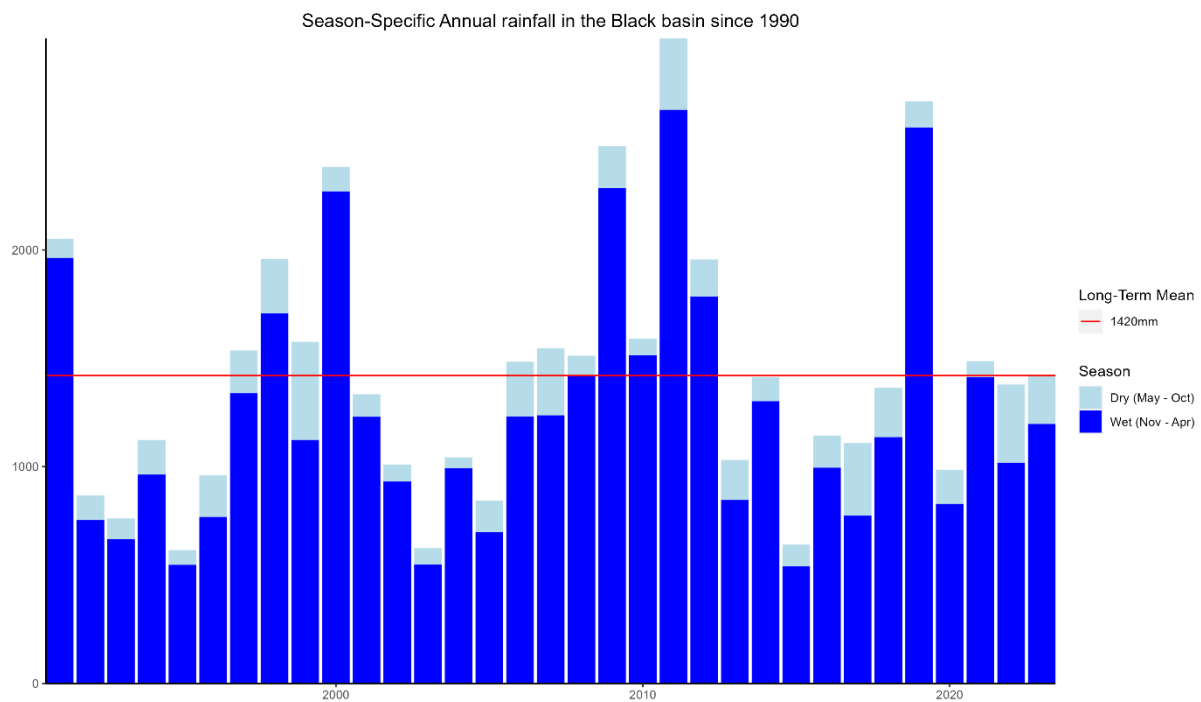


Figure 29. Season-specific annual rainfall in the Black Basin since 1990.

Appendix D. Ross Basin Long-Term Annual Air Temperature

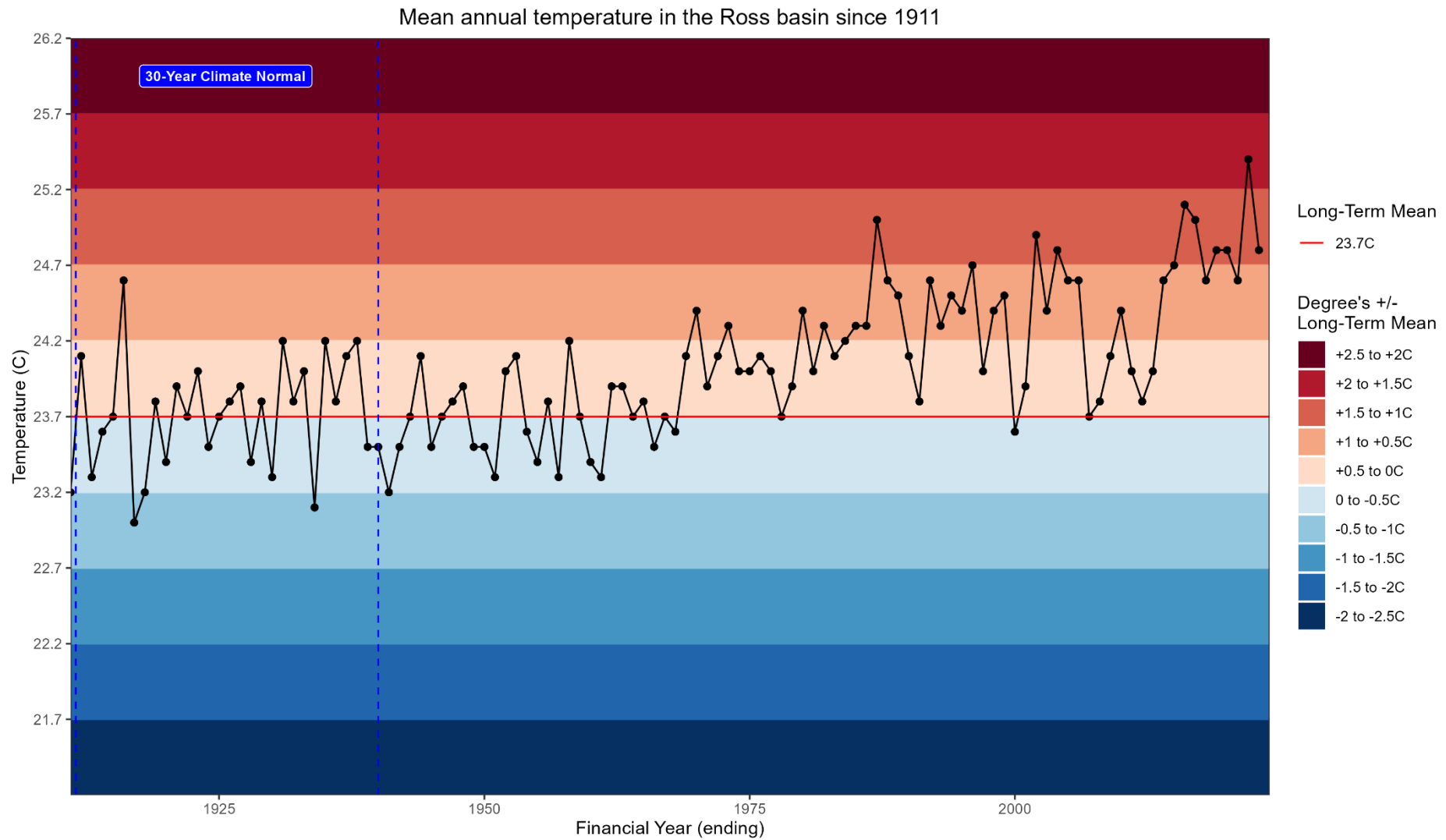


Figure 31. Ross Basin long-term annual air temperature trends.

Appendix E. Black Basin Long-Term Annual Air Temperature

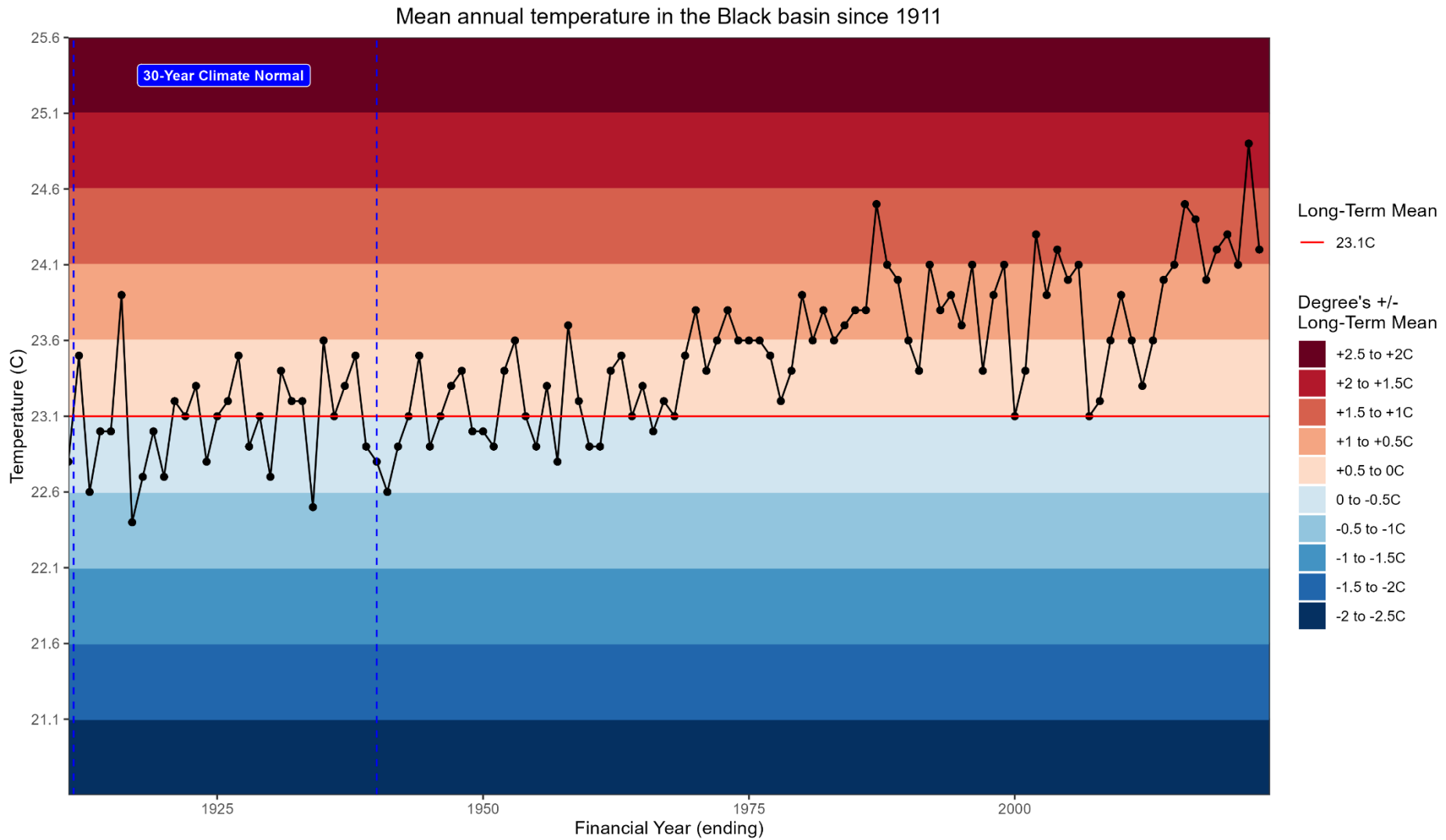


Figure 32. Black Basin long-term annual air temperature trends.

Appendix F. Townsville Dry Tropics Marine Waters Long-Term Annual Sea Surface Temperature

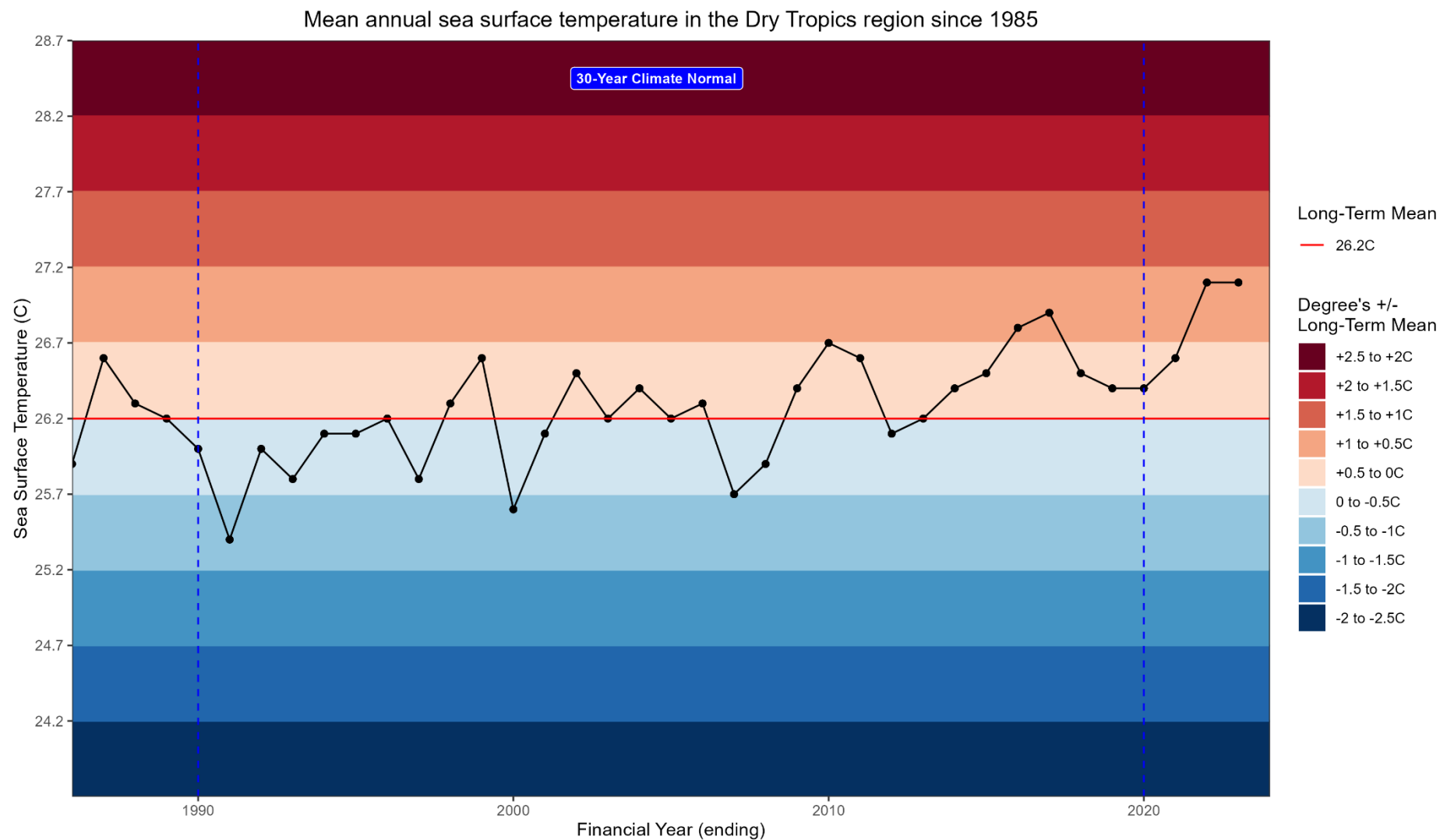
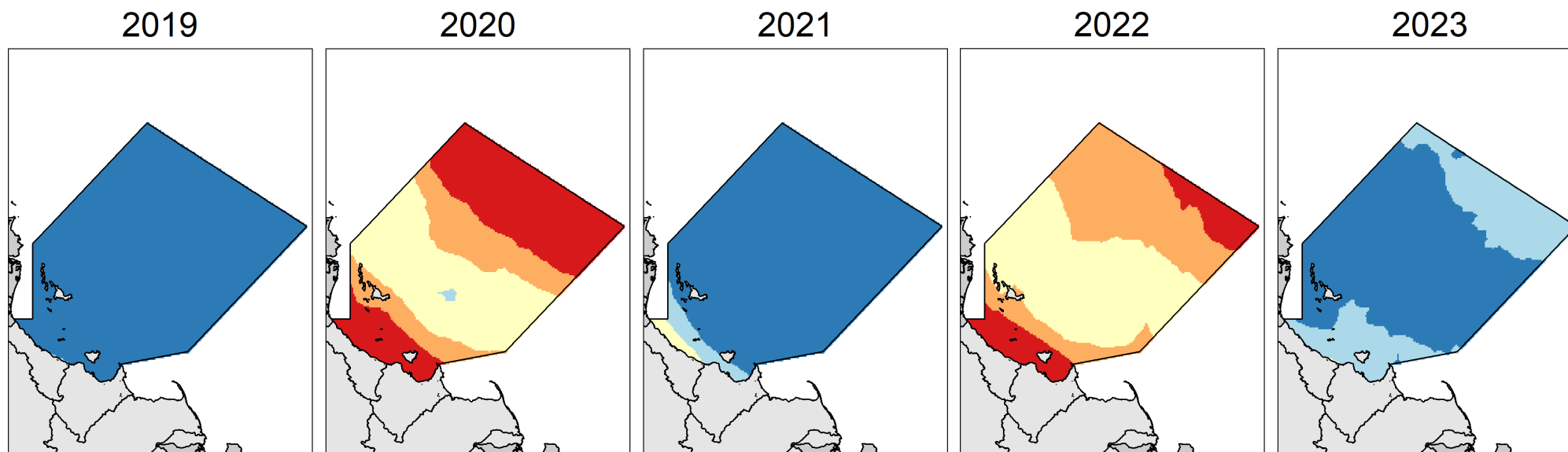


Figure 33. Dry Tropics long-term annual sea surface temperature trends.

Appendix G. Townsville Dry Tropics Marine Waters 5-year Historic Degree Heating Week Maps



Coral bleaching likelihood and number of DHW's

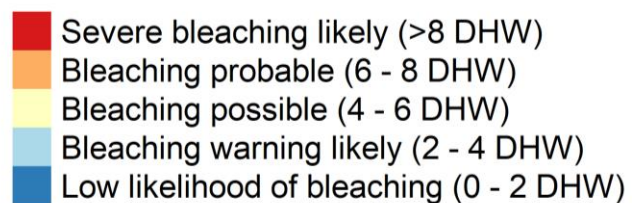


Figure 34. Dry Tropics Marine Region 5-year Historic Degree Heating Week Map.

Appendix H. Freshwater Water Quality Nutrients: Sampling Frequencies, Medians, Water Quality Objectives, and Scaling Factors

Table 78. Number of samples, number of months sampled, median, water quality objective values, and scaling factors for DIN and TP in the Townsville Dry Tropics Freshwater Environments.

Watercourse	DIN (mg/L)					TP (mg/L)				
	N.Samples	N.Months	Median	WQO	SF	N.Samples	N.Months	Median	WQO	SF
Ross Lake	NA	NA	NA	0.02	0.38	162	12	0.015	0.03	0.46
Aplin's Weir	63	12	0.017	0.02	0.38	ND	ND	ND	0.03	0.46
Gleasons Weir	10	10	0.028	0.02	0.38	ND	ND	ND	0.05	0.46
Blacks Weir	11	11	0.015	0.02	0.38	11	11	0.010	0.03	0.46
Bohle Mid-Field	12	11	2.663	0.08	0.38	12	11	3.800	0.05	0.46
Bohle Far-Field	12	11	0.583	0.08	0.38	12	11	1.100	0.05	0.46
Black River	63	12	0.016	0.02	0.05	12	12	0.024	0.02	0.03
Althaus Ck	11	11	0.004	0.02	0.05	11	11	0.027	0.02	0.03
Bluewater Ck	12	12	0.013	0.02	0.05	12	12	0.010	0.02	0.03
Sleeper Log Ck	12	12	0.003	0.02	0.05	12	12	0.016	0.02	0.03
Leichhardt Ck	12	12	0.005	0.02	0.05	12	12	0.013	0.02	0.03
Saltwater Ck	12	12	0.003	0.02	0.05	12	12	0.012	0.02	0.03
Rollingstone Ck	12	12	0.020	0.02	0.05	12	12	0.009	0.02	0.03
Ollera Ck	8	8	0.007	0.02	0.05	8	8	0.009	0.02	0.03
Crystal Ck	12	12	0.009	0.02	0.05	12	12	0.007	0.02	0.03
Paluma Lake	NA	NA	NA	0.02	0.05	12	12	0.010	0.03	0.06

Key: ■ = Mean/Median is lower than the guideline value | ■ = Mean/Median is higher than the guideline value | ND = No Data | NA = Not Applicable (data available but not usable).

Appendix I. Freshwater Water Quality Nutrients Scores Historic Comparison

Table 79. Townsville Dry Tropics freshwater water quality historic nutrient indicator scores.

Basin	Sub Basin	Watercourse	DIN				TP			
			22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20
Ross	Upper Ross	Ross Lake	NA	90	90	68	73	61	90	61
	Lower Ross	Aplin's Weir	62	61	59	66	ND	ND	ND	ND
		Gleesons Weir	59	90	62	74	ND	ND	ND	ND
		Blacks Weir	63	59	61	59	90	90	90	70
			61	70	60	66	90	90	90	70
	Bohle River	Bohle Mid-Field	0	36	43	0	0	0	0	0
		Bohle Far-Field	0	60	66	29	0	0	0	0
			0	48	54	15	0	0	0	0
Black			37	66	68	49	40	37	60	33
	Black River	Black River	63	63	61	78	39	61	54	9
	Bluewater Ck	Althaus Ck	90	90	67	74	18	48	90	90
		Bluewater Ck	73	66	63	90	90	90	73	66
		Sleeper Log Ck	90	71	74	62	77	90	90	90
			84	75	68	75	61	76	84	82
	Rollingstone Ck	Leichhardt Ck	90	90	74	90	90	90	76	55
		Saltwater Ck	90	90	70	90	90	90	90	90
		Rollingstone Ck	61	62	0	64	90	90	90	90
			80	80	48	81	90	90	85	78
	Crystal Ck	Ollera Ck	90	71	66	63	90	90	90	90
		Crystal Ck	90	69	90	90	90	90	90	90
			90	70	78	76	90	90	90	90
	Paluma Lake	Paluma Lake	NA	NA	63	90	90	90	90	90
			82	74	63	79	76	82	83	76

Standardised scoring range: ■ Very Poor (E) = 0 to <21 | ■ Poor (D) = 21 to <41 | ■ Moderate (C) = 41 to <61 | ■ Good (B) = 61 to <81 | ■ Very Good (A) = 81 – 100 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

Appendix J. Freshwater Water Quality Physical-Chemical Properties: Sampling Frequencies, Medians, Water Quality Objectives and Scaling Factors

Table 80. Number of samples, number of months sampled, median, water quality objective values, and scaling factors for Turbidity, High DO, Low DO, in the Townsville Dry Tropics Freshwater Environments.

Watercourse	Turbidity (NTU)					Dissolved Oxygen (%Sat)						
	N.Samples	N.Months	Median	WQO	SF	N.Samples	N.Months	Median	High DO WQO	High DO SF	Low DO WQO	Low DO SF
Ross Lake	139	12	5.600	10	35	162	12	100.760	110	120	90	70
Aplin's Weir	11	11	4.200	10	35	11	11	85.391	110	120	90	70
Gleesons Weir	10	10	3.600	10	35	10	10	93.900	110	120	90	70
Blacks Weir	11	11	2.800	10	35	11	11	84.773	110	120	90	70
Bohle Mid-Field	12	11	19.500	22	35	12	11	82.340	110	120	85	70
Bohle Far-Field	12	11	17.600	22	35	12	11	66.660	110	120	85	70
Black River	12	12	2.525	5	10	12	12	102.650	105	120	90	70
Althaus Ck	11	11	27.830	5	10	11	11	107.300	105	120	90	70
Bluewater Ck	12	12	2.865	5	10	12	12	90.350	105	120	90	70
Sleeper Log Ck	12	12	8.875	5	10	12	12	91.500	105	120	90	70
Leichhardt Ck	12	12	4.045	5	10	12	12	90.550	105	120	90	70
Saltwater Ck	12	12	5.255	5	10	12	12	96.450	105	120	90	70
Rollingstone Ck	12	12	0.790	5	10	12	12	86.800	105	120	90	70
Ollera Ck	8	8	1.485	5	10	8	8	54.700	105	120	90	70
Crystal Ck	12	12	0.505	5	10	12	12	98.350	105	120	90	70
Paluma Lake	12	12	1.650	10	20	12	12	87.383	110	120	90	70

Key: ■ = for Turbidity Mean/Median is lower than the guideline value, for DO, Median is within the range between the High and Low DO guideline values | ■ = for Turbidity Mean/Median is higher than the guideline value, for DO, the Median is higher than the High DO or Lower than the Low DO guideline value | ND = No Data | NA = Not Applicable (data available but not usable).

Appendix K. Freshwater Water Quality Physical-Chemical Properties Scores Historic Comparison

Table 81. Townsville Dry Tropics freshwater water quality historic physical-chemical indicator scores.

Basin	Sub Basin	Watercourse	Turbidity				High DO				Low DO			
			22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20
Ross	Upper Ross	Ross Lake	90	90	90	90	90	90	90	90	90	90	90	90
	Lower Ross	Aplin's Weir	90	90	90	90	90	80	90	90	46	55	74	90
		Gleesons Weir	90	90	90	90	90	90	90	90	67	11	50	73
		Blacks Weir	90	90	90	90	90	90	90	90	44	19	26	56
			90	90	90	90	90	90	90	90	53	28	50	73
	Bohle River	Bohle Mid-Field	62	67	90	90	90	90	90	90	50	26	0	0
		Bohle Far-Field	63	66	90	90	90	90	90	90	0	40	37	0
			63	66	90	90	90	90	90	90	25	33	18	0
Black			81	82	90	90	90	88	90	90	49	40	52	51
	Black River	Black River	72	90	69	90	64	47	53	62	90	90	90	90
	Bluewater Ck	Althaus Ck	0	0	12	90	51	90	69	4	90	90	90	81
		Bluewater Ck	70	90	90	90	90	79	90	90	62	66	77	11
		Sleeper Log Ck	13	0	90	70	90	90	90	90	72	20	76	32
			28	30	64	83	77	86	90	90	75	59	81	41
	Rollingstone Ck	Leichhardt Ck	68	90	90	90	90	90	90	90	62	61	61	27
		Saltwater Ck	57	75	90	90	90	90	90	90	90	90	66	90
		Rollingstone Ck	90	90	90	90	90	90	90	90	51	40	74	51
			72	90	90	90	90	90	90	90	67	63	67	56
	Crystal Ck	Ollera Ck	90	90	90	90	90	90	90	90	0	0	59	0
		Crystal Ck	90	90	90	90	90	90	90	90	90	90	73	75
			90	90	90	90	90	90	90	90	45	45	66	37
	Paluma Lake	Paluma Lake	90	90	90	90	90	90	90	90	52	55	90	69
			64	70	80	88	83	85	85	79	66	60	75	53

Standardised scoring range: ■ Very Poor (E) = 0 to <21 | ■ Poor (D) = 21 to <41 | ■ Moderate (C) = 41 to <61 | ■ Good (B) = 61 to <81 | ■ Very Good (A) = 81 – 100 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

Appendix L. Freshwater Water Quality Sub Basin Historic Scores

Table 82. A comparison of nutrient and physical chemical properties indicator category scores, and the water quality index scores, for freshwater sub basins between years.

Sub Basin	Nutrients				Phys-Chem				Water Quality			
	22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20
Upper Ross	81	75			90	90			85	82		
Lower Ross	66	75			71	57			68	66		
Bohle River	0	24			44	58			22	41		
Black River	51	62			68	68			60	65		
Bluewater Ck	73	76			45	44			59	60		
Rollingstone Ck	85	85			69	74			77	79		
Crystal Ck	90	79			67	67			78	73		
Paluma Lake	62	65			71	72			67	69		

Appendix M. Freshwater Water Quality 2022–2023 Boxplots

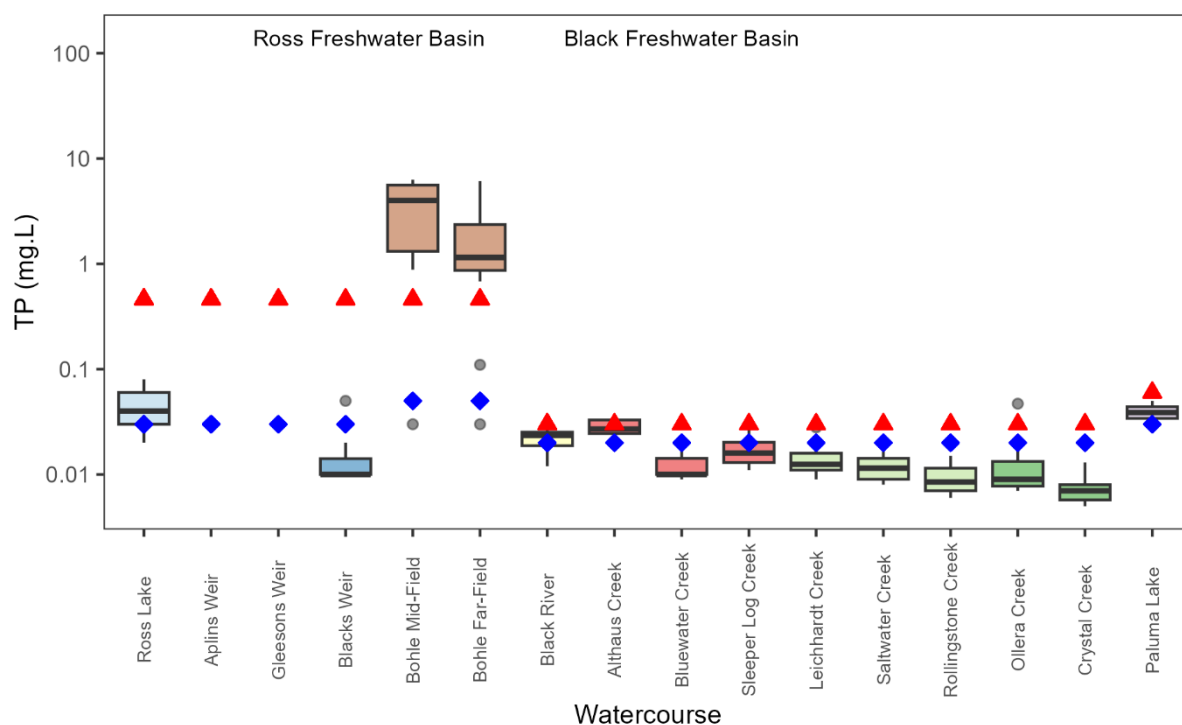


Figure 35. Total Phosphorus (TP) (mg/L) boxplot: red triangles indicate the scaling factor, blue diamonds indicate the water quality objective.

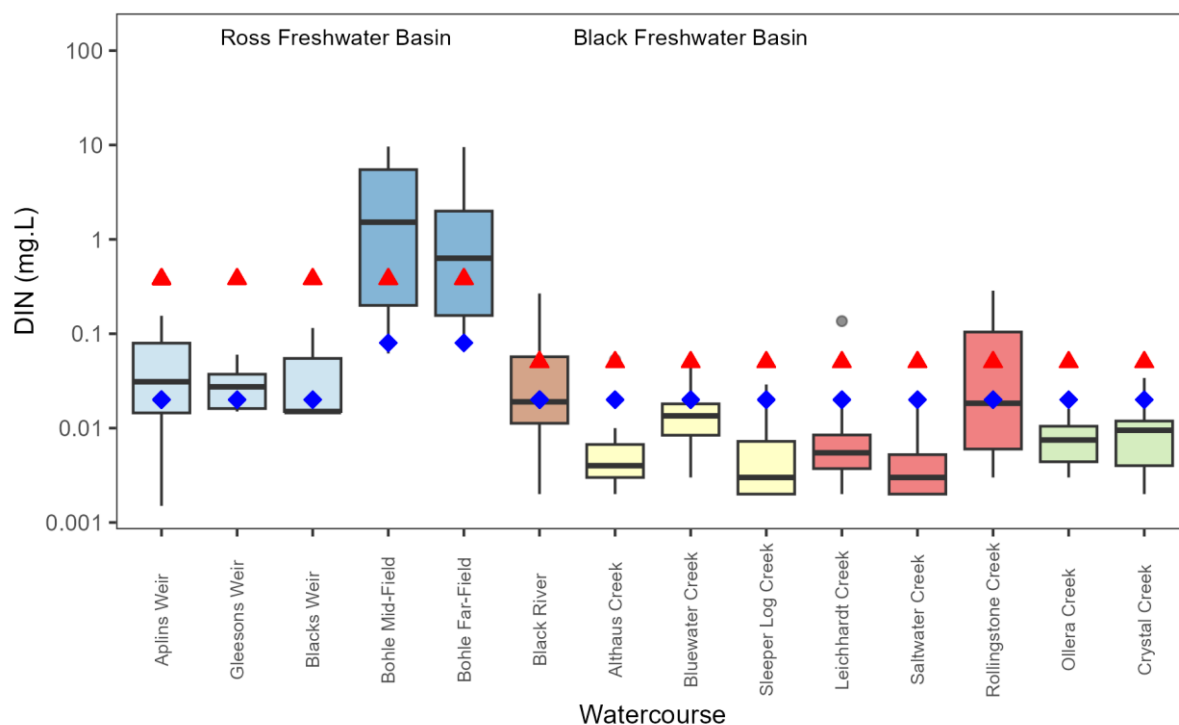


Figure 36. Dissolved Inorganic Nitrogen (DIN) (mg/L) Boxplot: red triangles indicate the scaling factor, blue diamonds indicate the water quality objective.

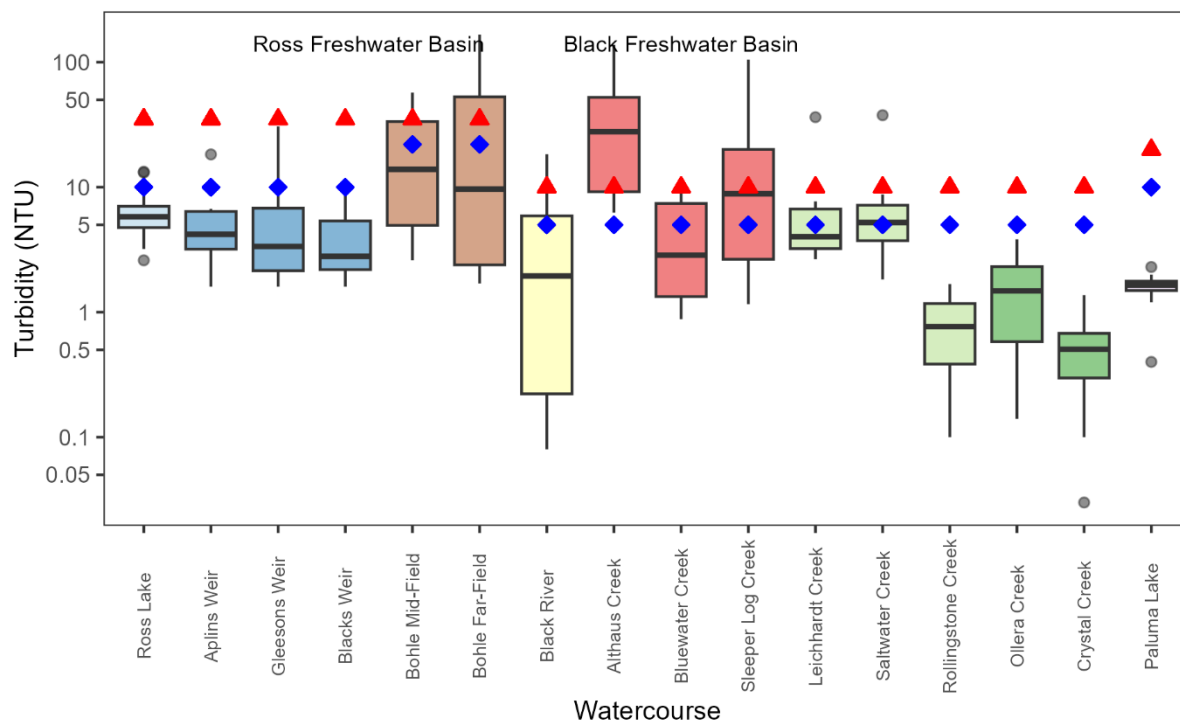


Figure 38. Turbidity (NTU) boxplot: red triangles indicate the scaling factor, blue diamonds indicate the water quality objective.

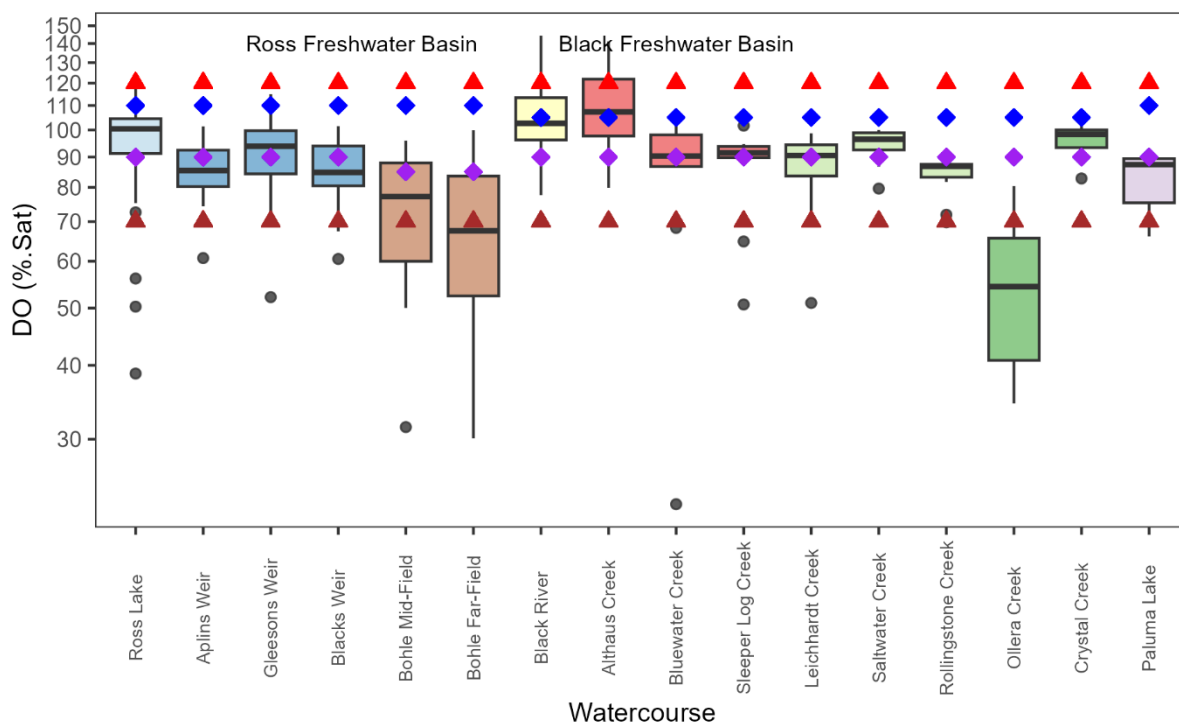


Figure 37. Dissolved Oxygen (DO) (% Saturation) boxplot: red triangles indicate the high DO scaling factor, blue diamonds indicate the high DO water quality objective, purple diamonds indicate the low DO water quality objective, and brown triangles indicate the low DO scaling factor.

Appendix N. Freshwater Water Quality Line Plots

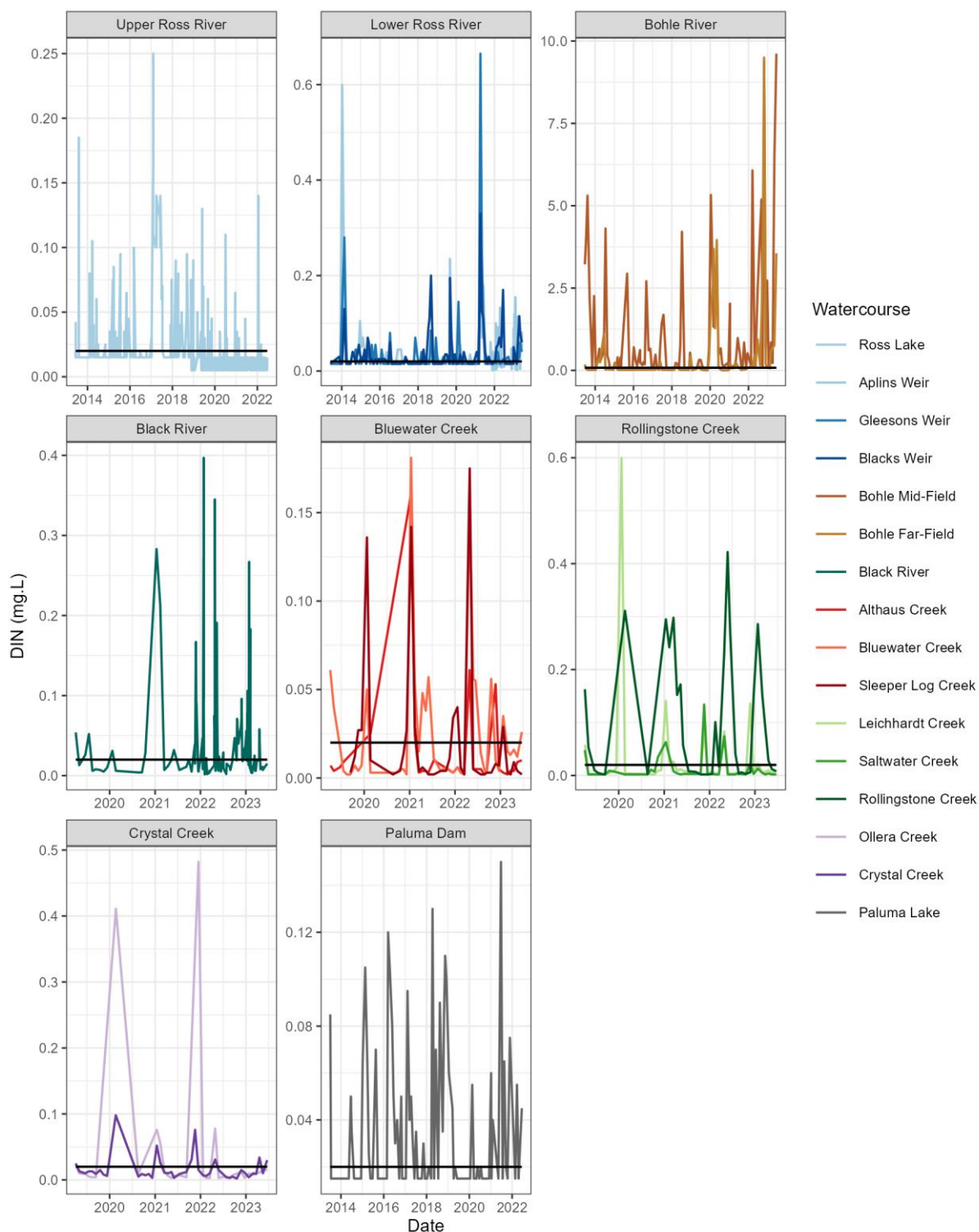


Figure 39. Historical concentrations of dissolved inorganic nitrogen (DIN) in the freshwater sub basins. Black line indicates the water quality objective.

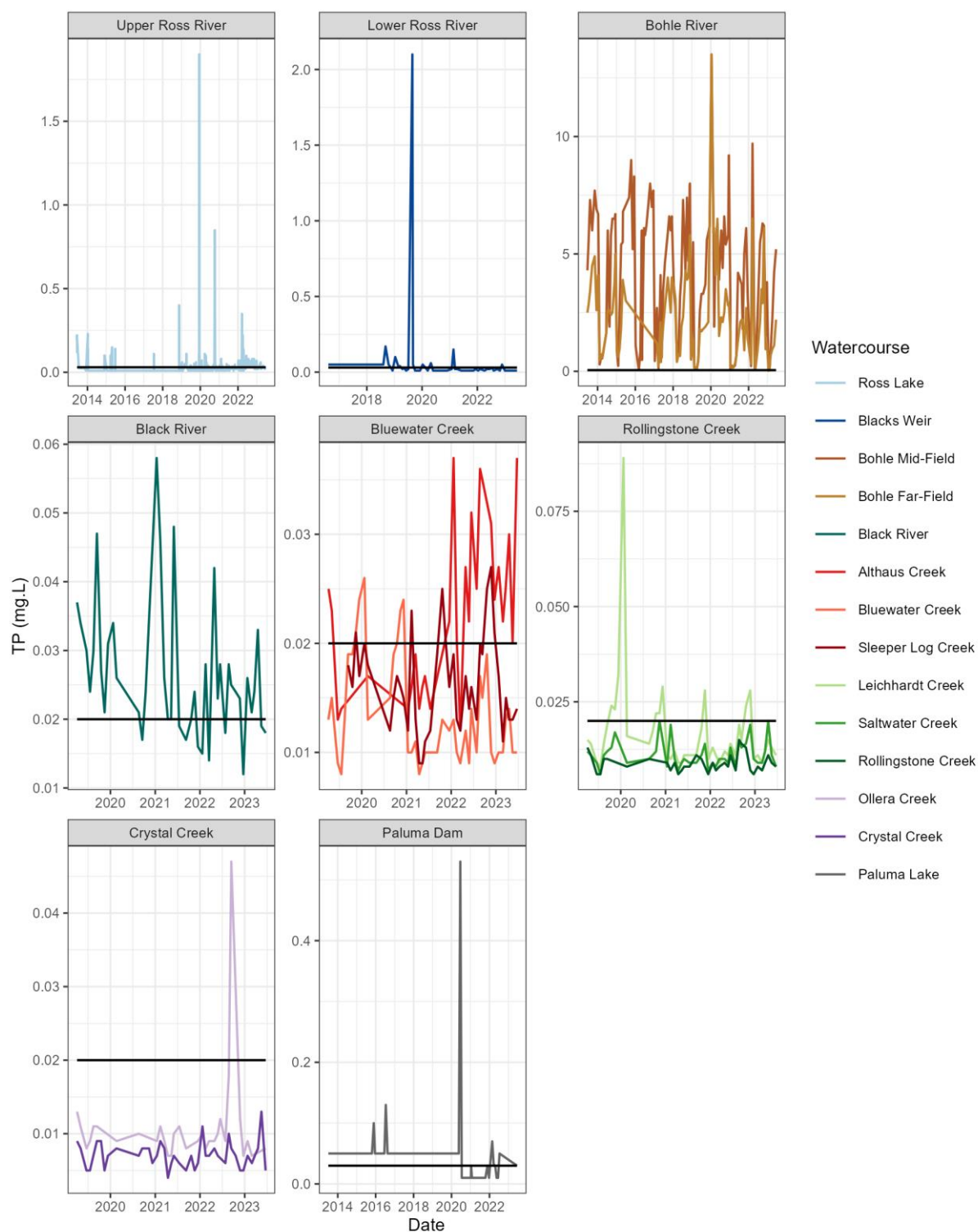


Figure 40. Historical data for total phosphorus in the freshwater sub basins. Black line indicates the water quality objective.

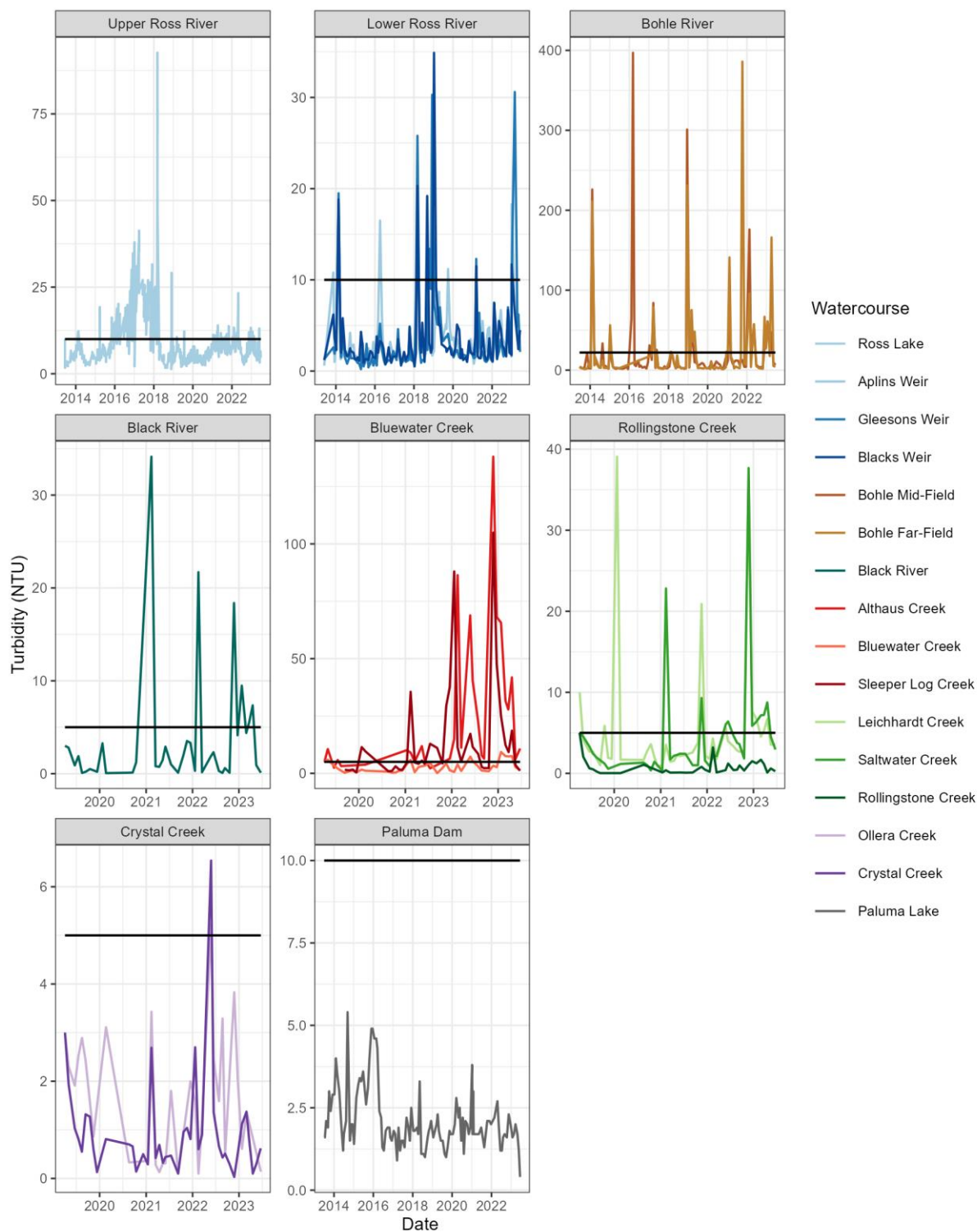


Figure 41. Historical turbidity in the freshwater sub basins. Black lines indicates the water quality objectives.

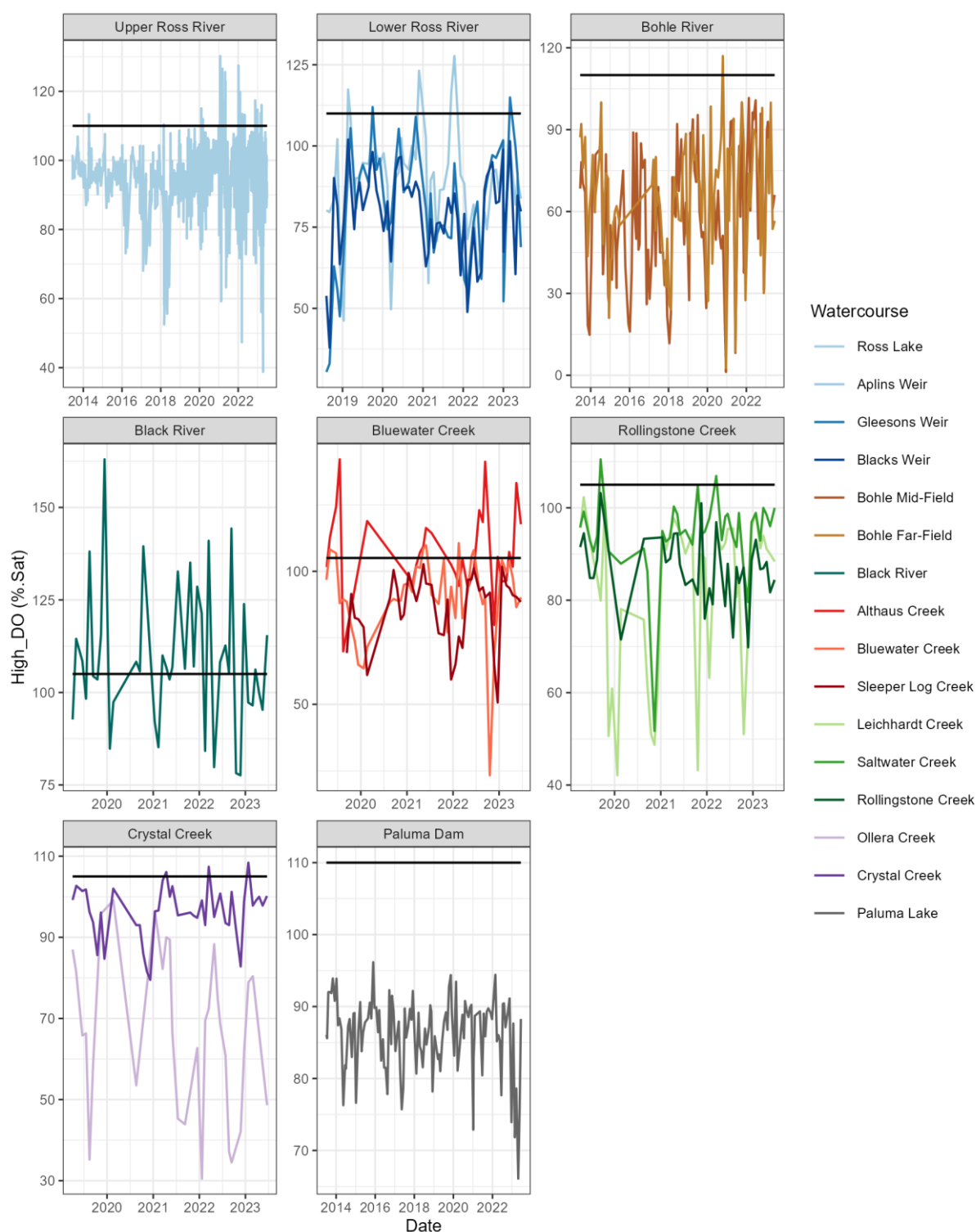


Figure 42. Historical dissolved oxygen in the freshwater sub basins. Black lines indicate the water quality objective (High DO).

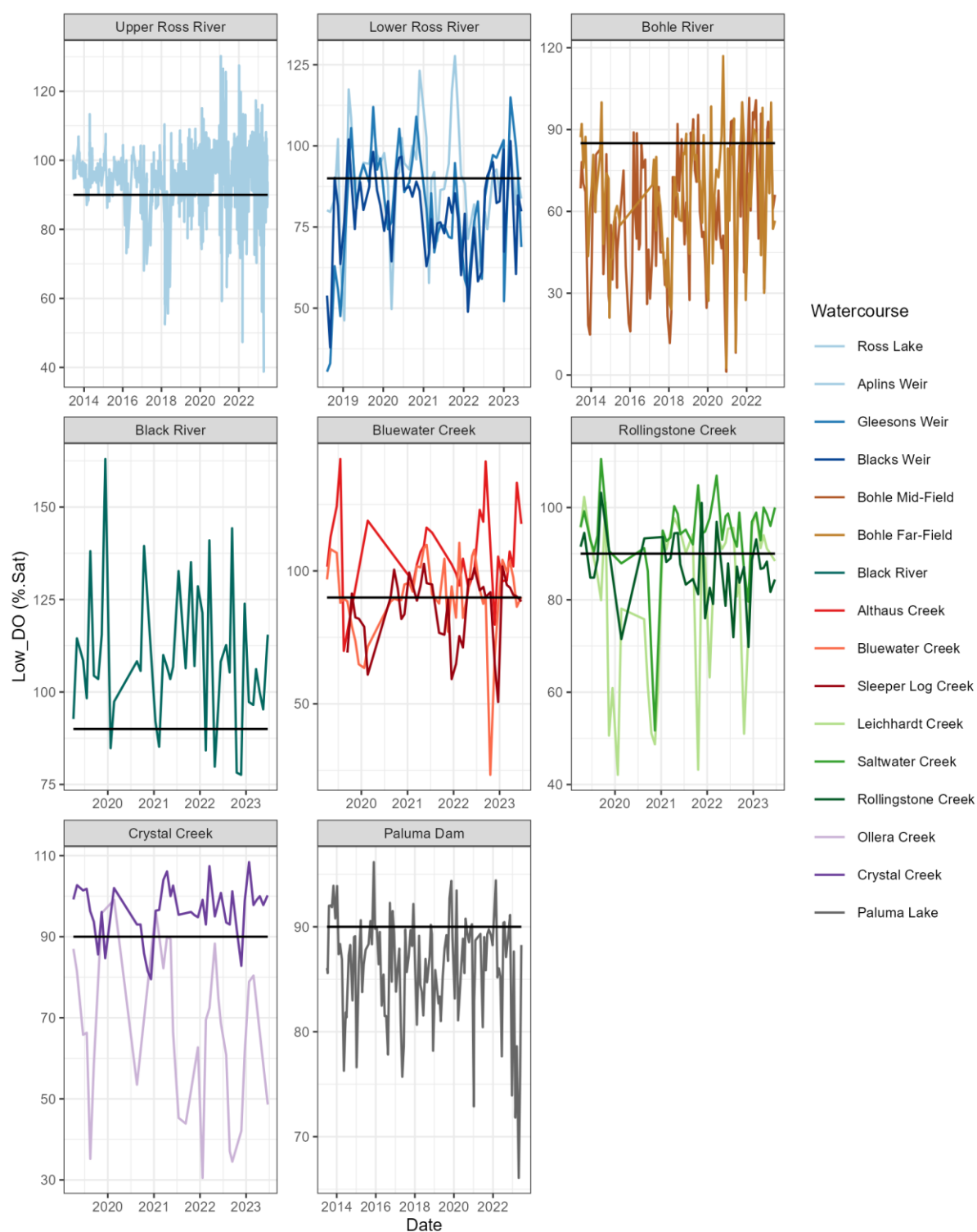


Figure 43. Historical dissolved oxygen in the freshwater sub basins. Black lines indicate the water quality objective (Low DO).

Appendix O. Freshwater Pesticides Sampling Locations

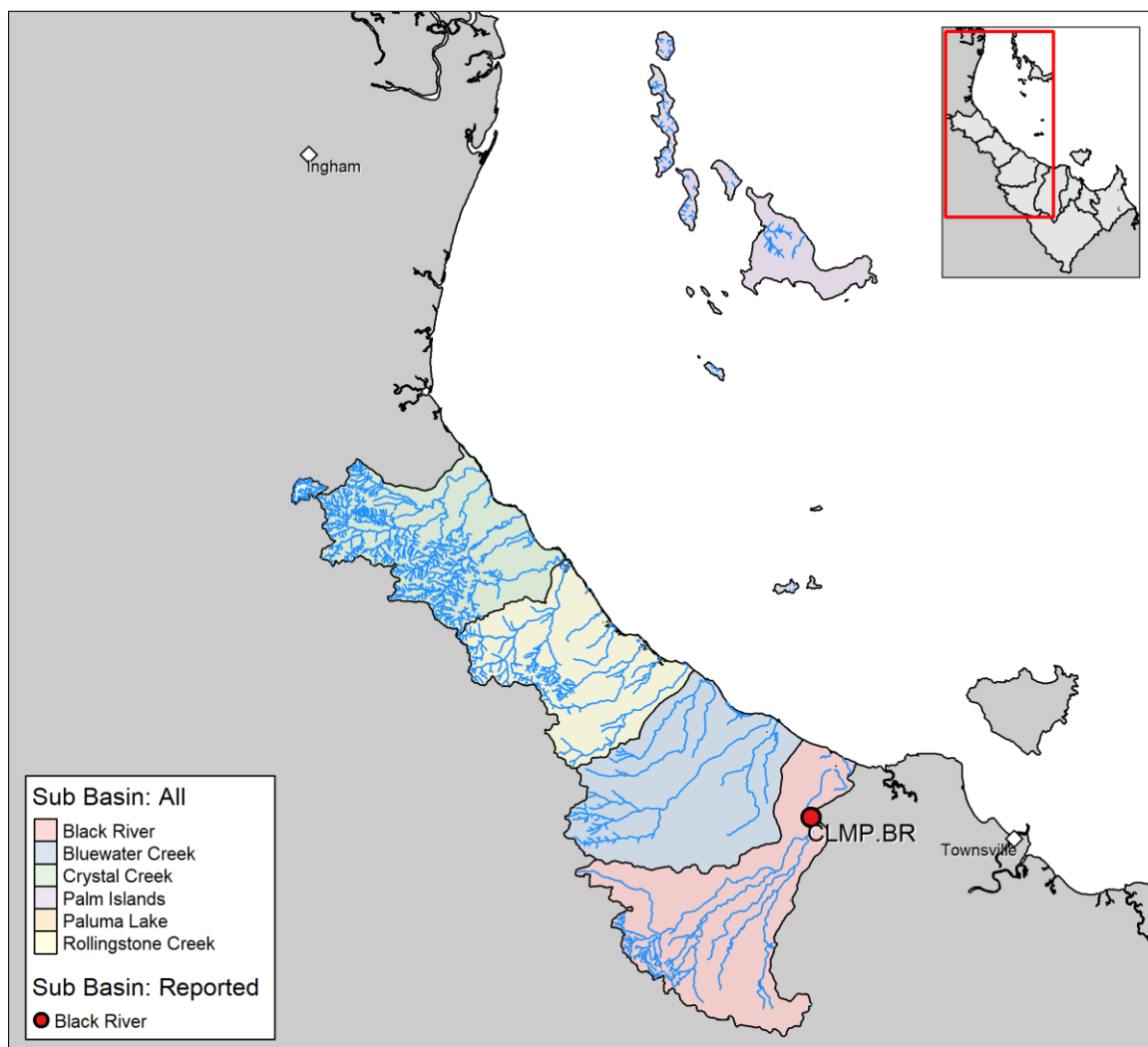


Figure 44. Black Freshwater Basin pesticide site locations.

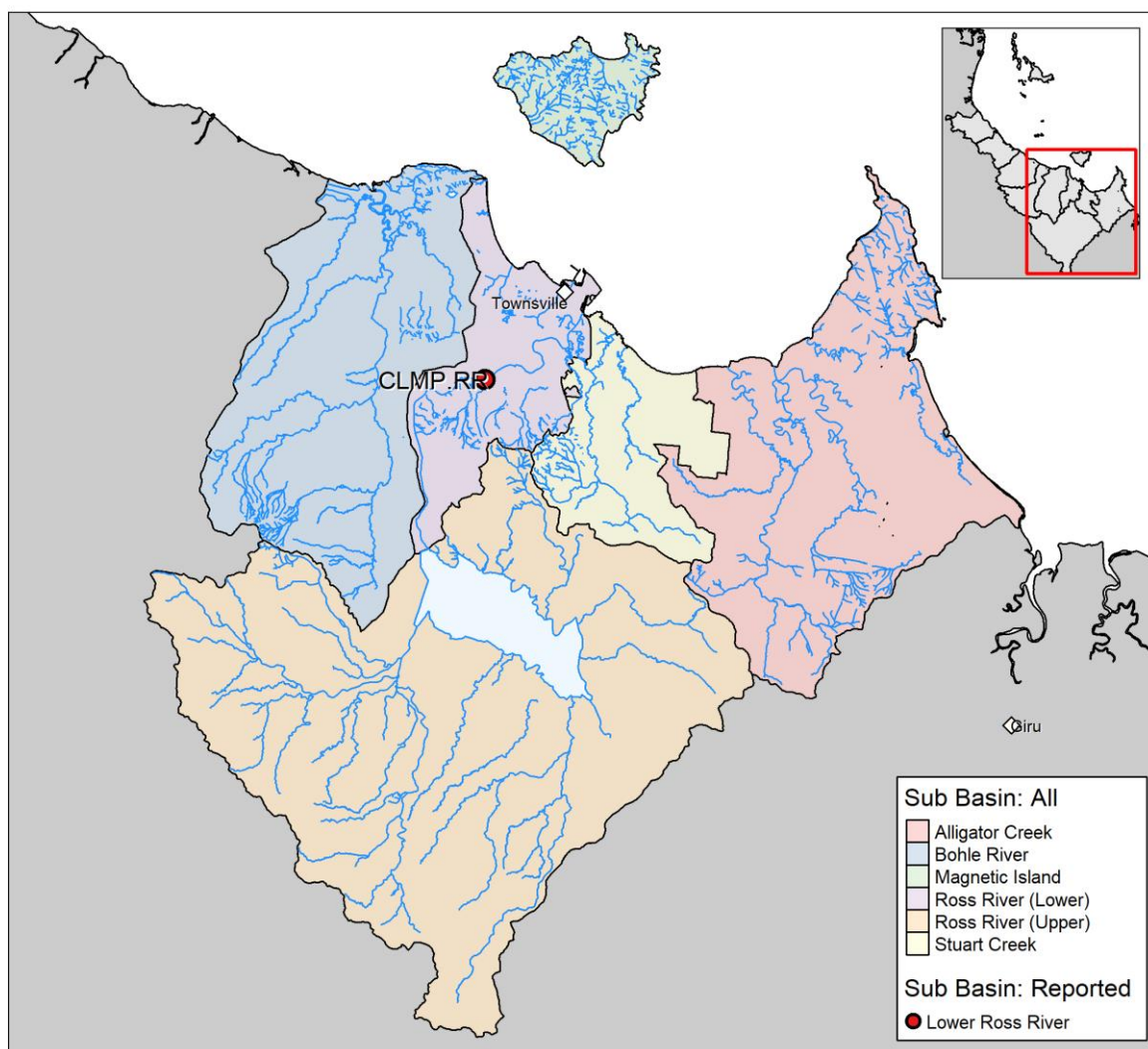


Figure 45. Ross Freshwater Basin pesticide site locations.

Appendix P. Freshwater Pesticides Historical Species Affected

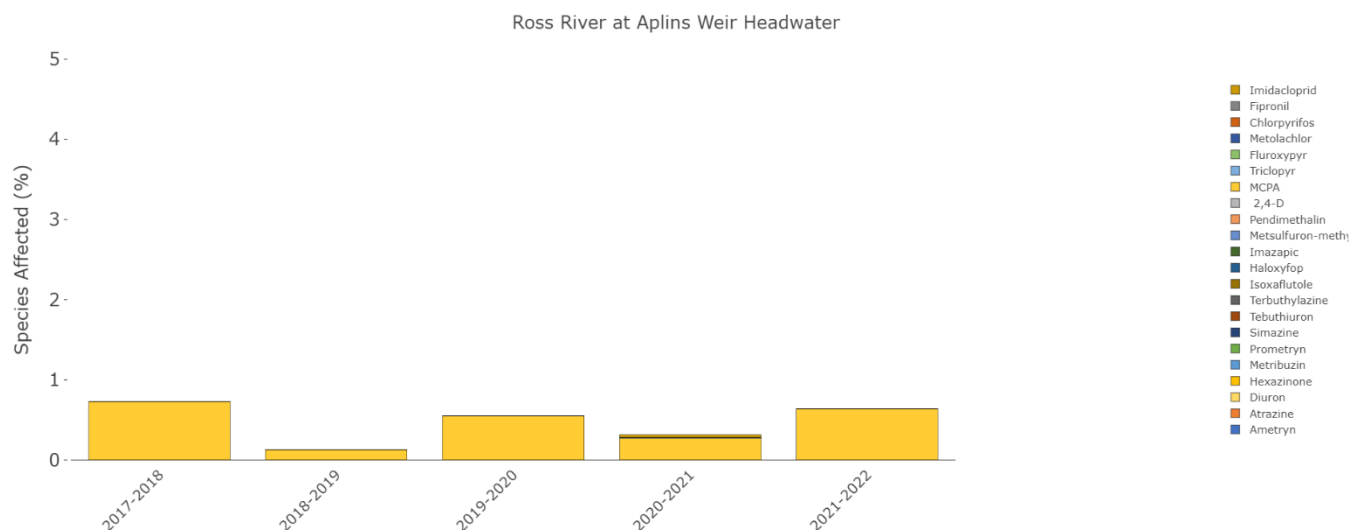


Figure 47. Historic pesticide proportions at the Ross River at Aplins Weir Headwater CLMP monitoring site.

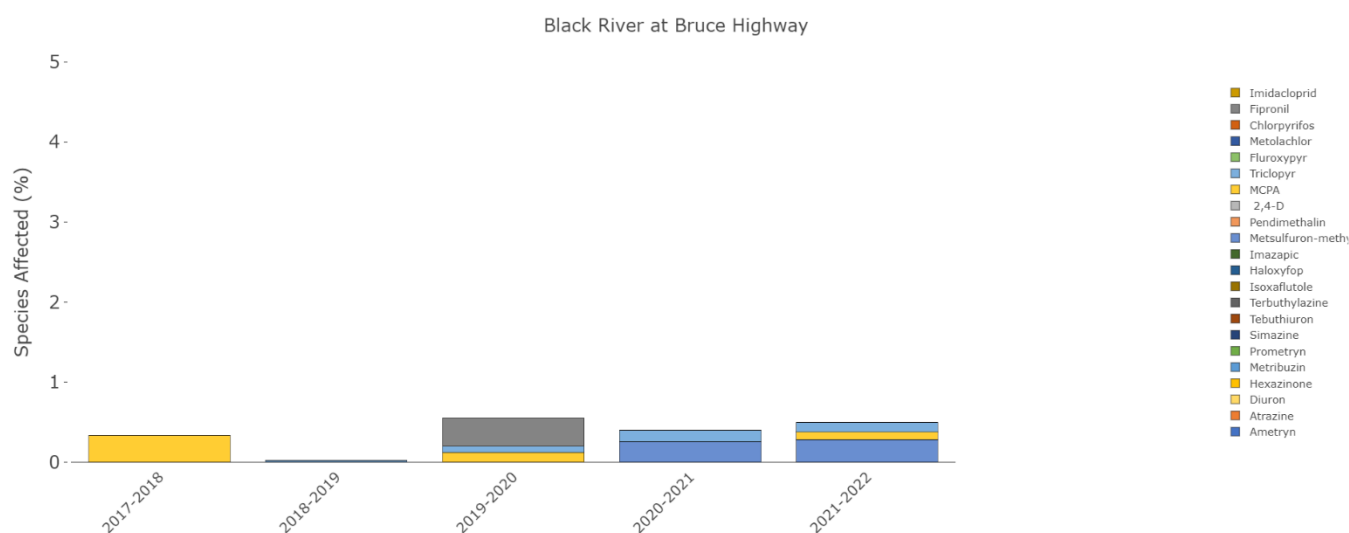


Figure 46. Historic pesticide proportions at the Black River CLMP monitoring site.

Appendix Q. Freshwater Riparian Extent: Assessed Area in the Ross Basin of the Townsville Dry Tropics Region

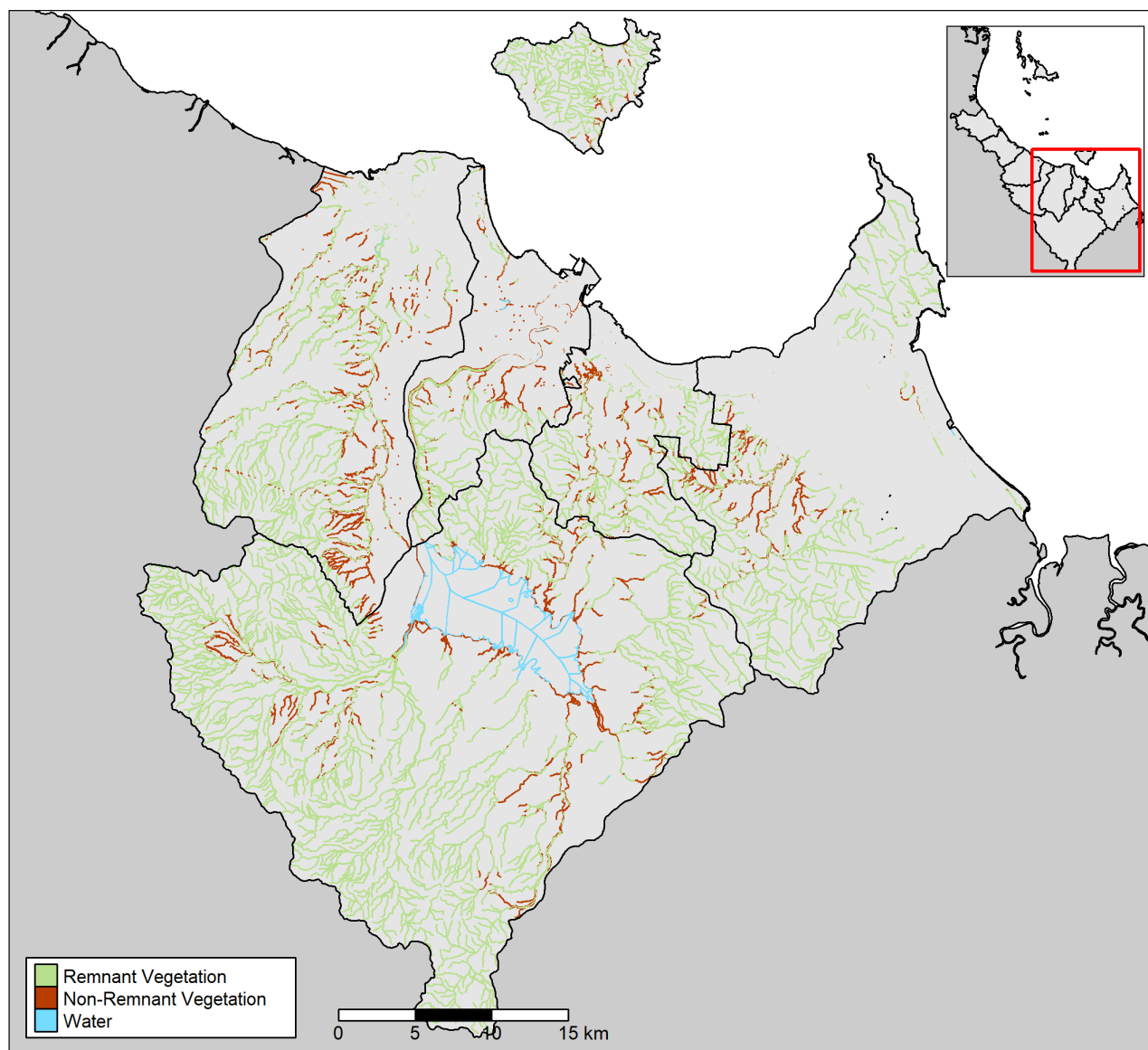


Figure 48. Freshwater riparian extent assessed for vegetation in the Ross Basin of the Dry Tropics region.

Appendix R. Freshwater Riparian Extent: Assessed Area in the Black Basin of the Townsville Dry Tropics Region

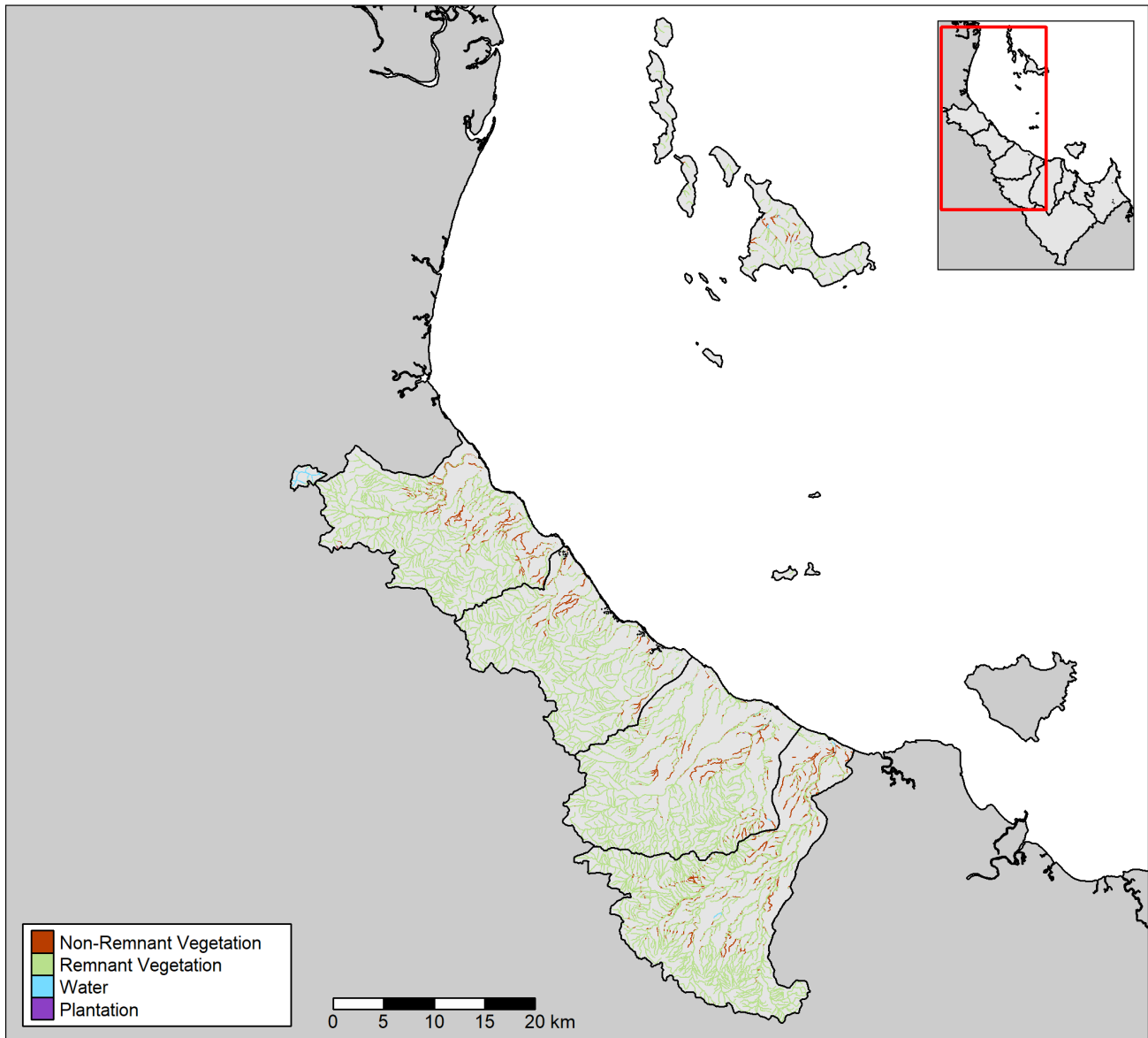


Figure 49. Freshwater riparian extent assessed for vegetation in the Black Basin of the Dry Tropics region.

Appendix S. Freshwater Riparian Extent Historical Scores

Basin/Sub Basin	Extent Change: 19-21 Report Card Year: 22-23	Extent Change: 19-21 Report Card Year: 21-22	Extent Change: 19-21 Report Card Year: 20-21	Extent Change: 19-21 Report Card Year: 19-20
Alligator Creek	57	X	X	
Bohle River	60	X	X	
Magnetic Island	80	X	X	
Ross River (Lower)	80	X	X	
Ross River (Upper)	52	X	X	
Stuart Creek	35	X	X	
Ross freshwater	54	X	X	
Black River	81	X	X	
Bluewater Creek	81	X	X	
Crystal Creek	81	X	X	
Palm Islands	80	X	X	
Paluma Lake	80	X	X	
Rollingstone Creek	81	X	X	
Black freshwater	81	X	X	

Appendix T. Ross Freshwater Riparian Vegetation Change Over Time

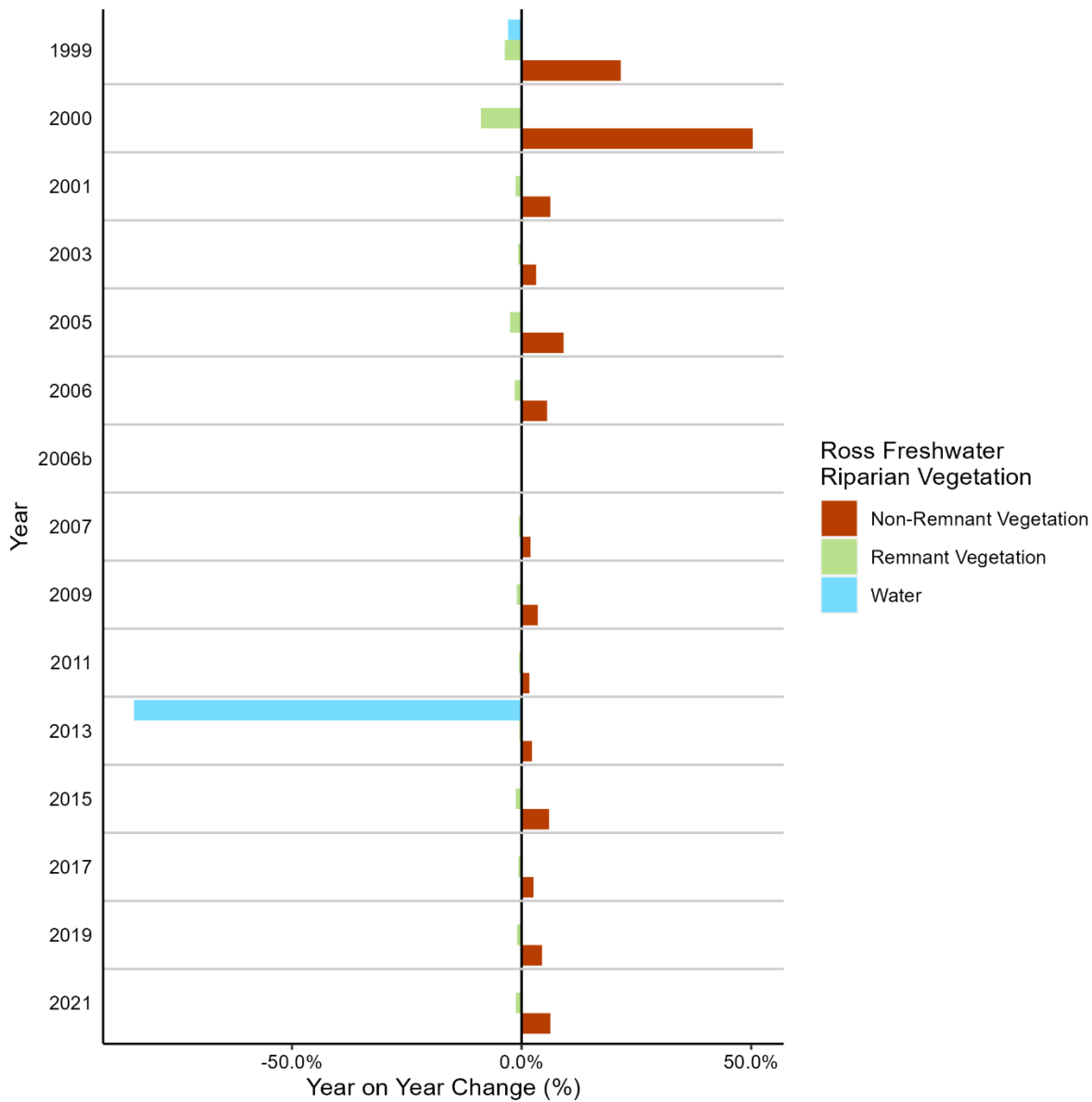


Figure 50. Ross Freshwater riparian vegetation change over time.

Appendix U. Black Freshwater Riparian Vegetation Change Over Time

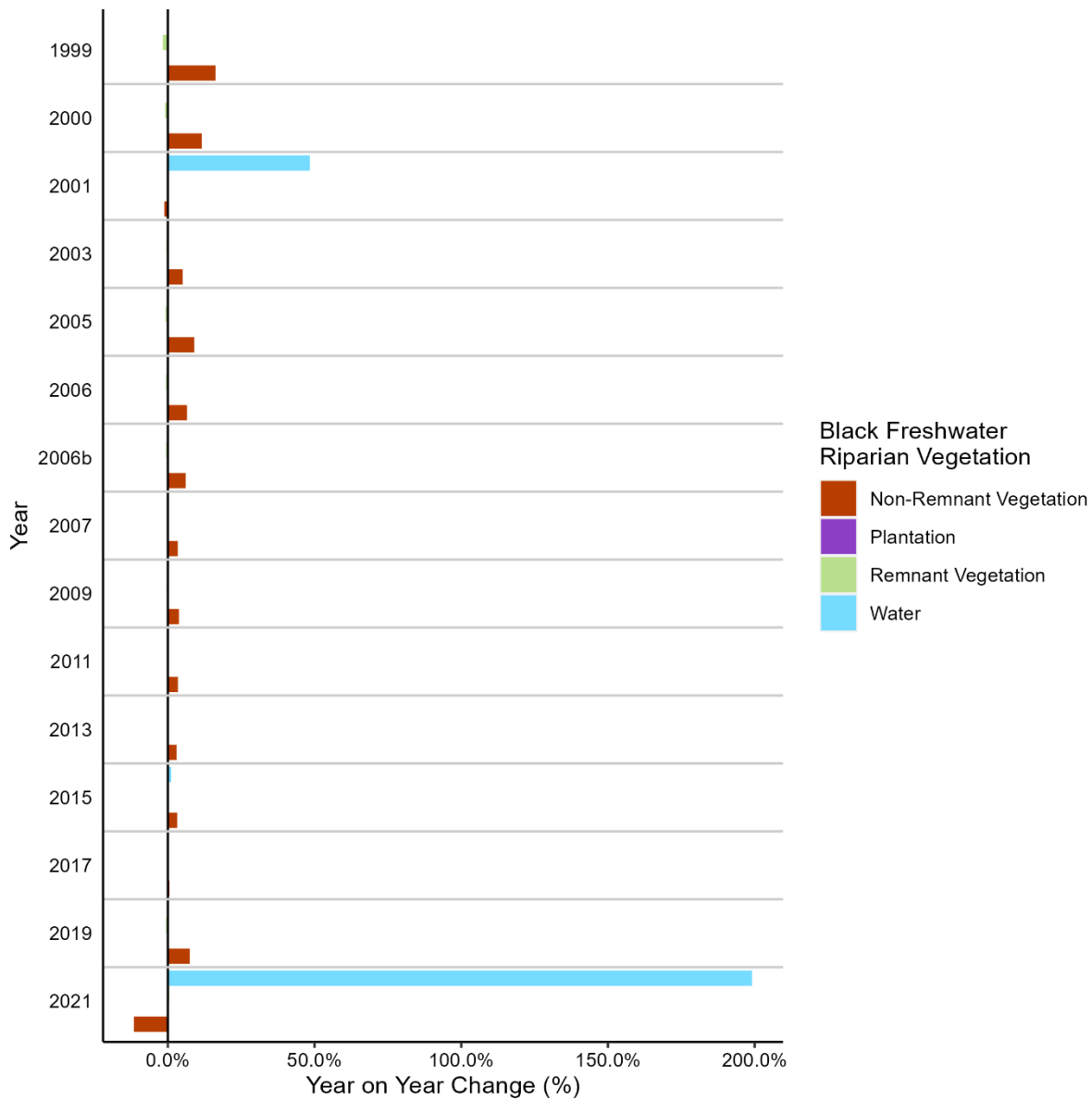


Figure 51. Black Freshwater riparian vegetation change over time.

Appendix V. Freshwater Wetland Extent: Assessed Area in the Ross Basin of the Townsville Dry Tropics Region

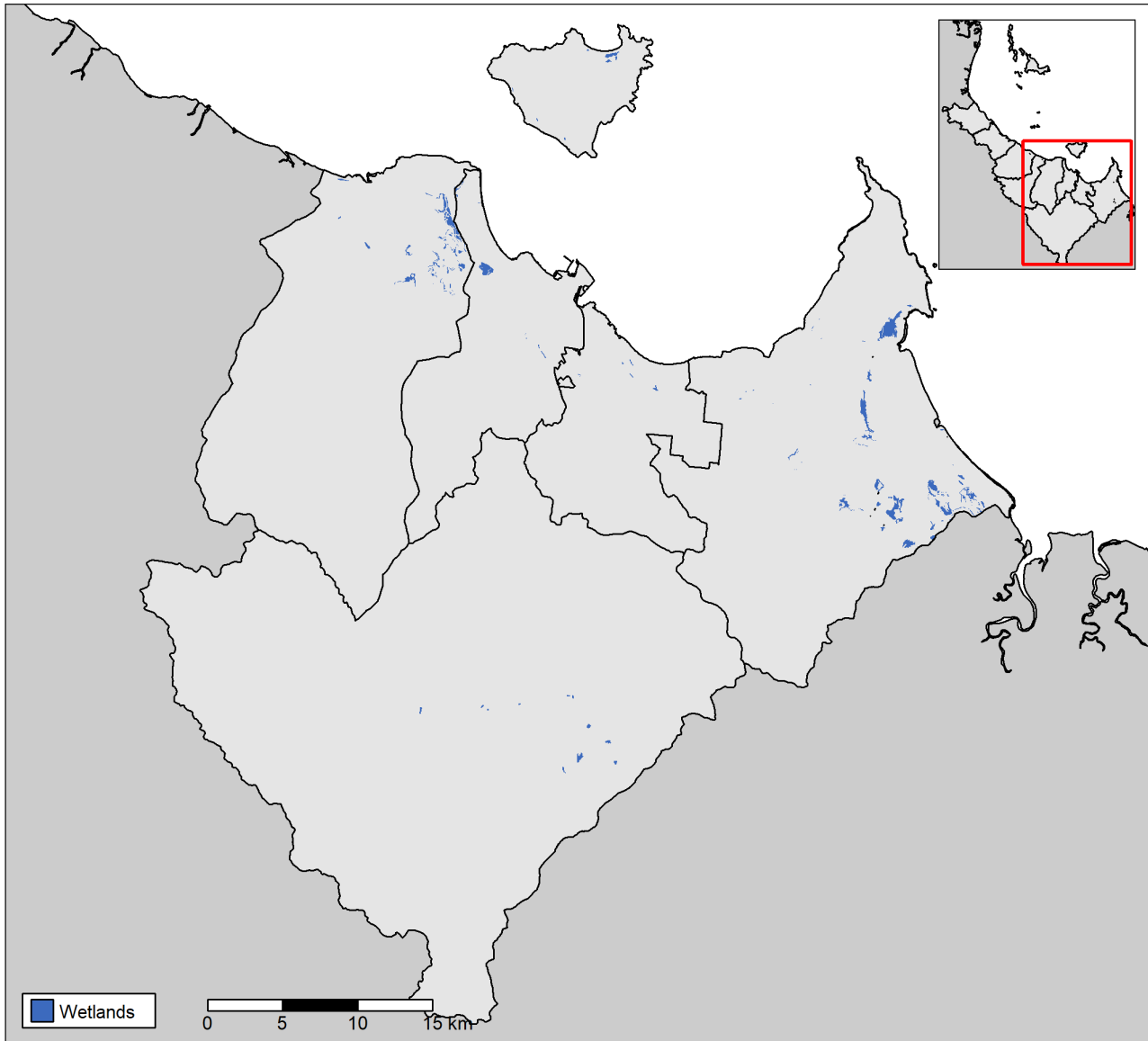


Figure 52. Freshwater wetlands assessed in the Ross freshwater environment of the Dry Tropics region.

Appendix W. Freshwater Wetland Extent: Assessed Area in the Black Basin of the Townsville Dry Tropics Region

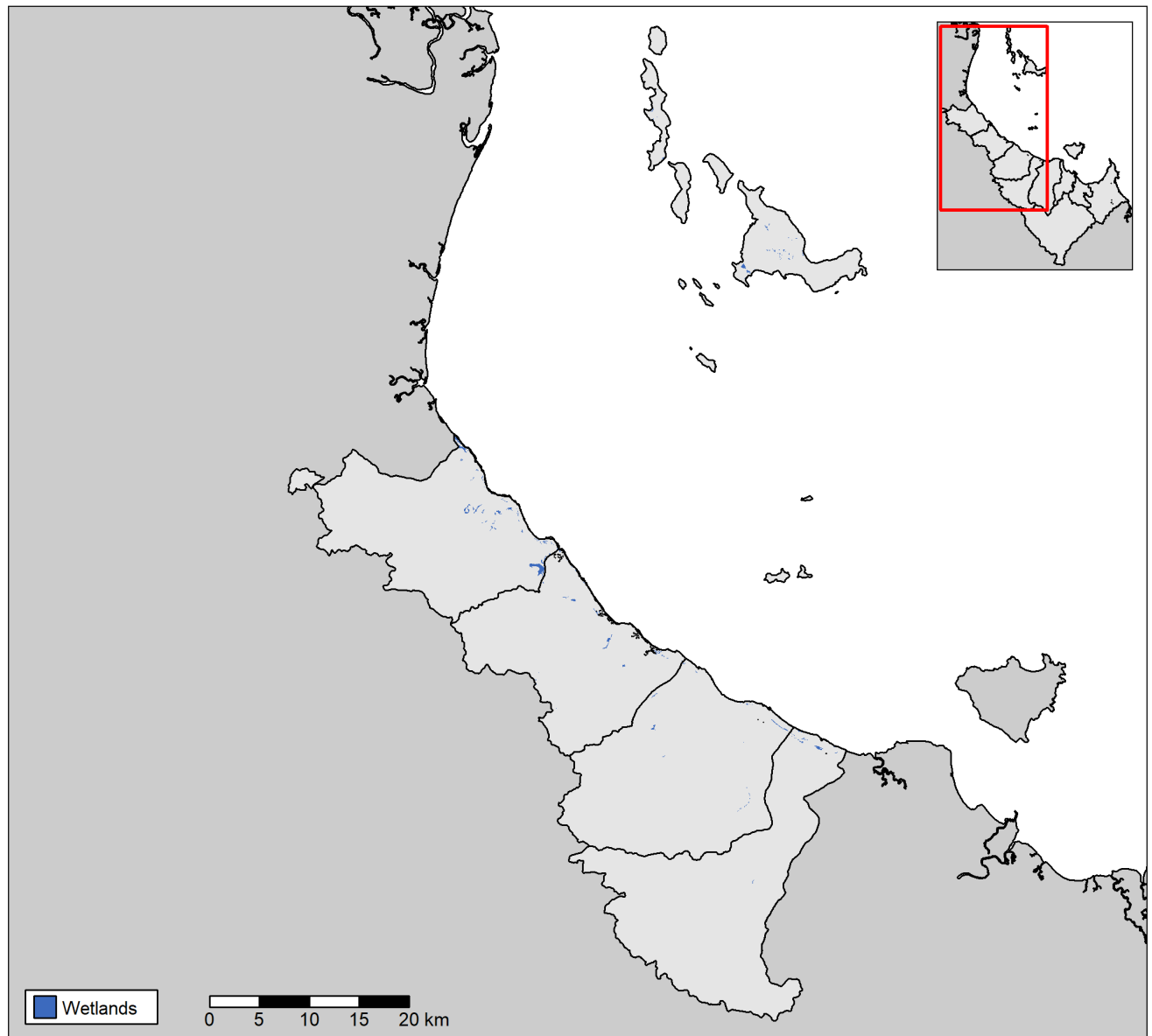


Figure 53. Freshwater wetlands assessed in the Black freshwater environment of the Dry Tropics region.

Appendix X. Ross Freshwater Wetland Vegetation Change Over Time

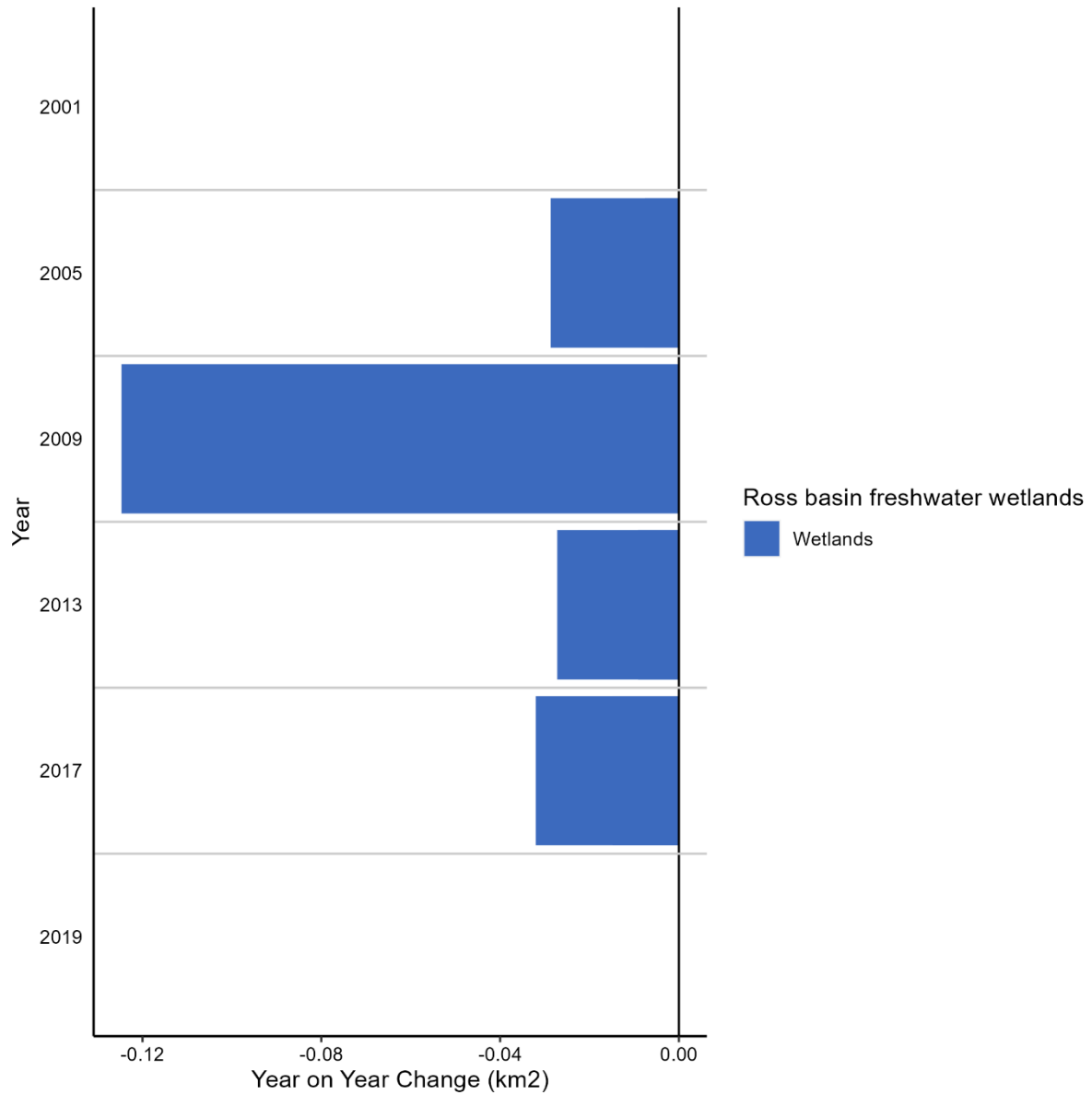


Figure 54. Ross freshwater wetland vegetation change over time.

Appendix Y. Black Freshwater Wetland Vegetation Change Over Time

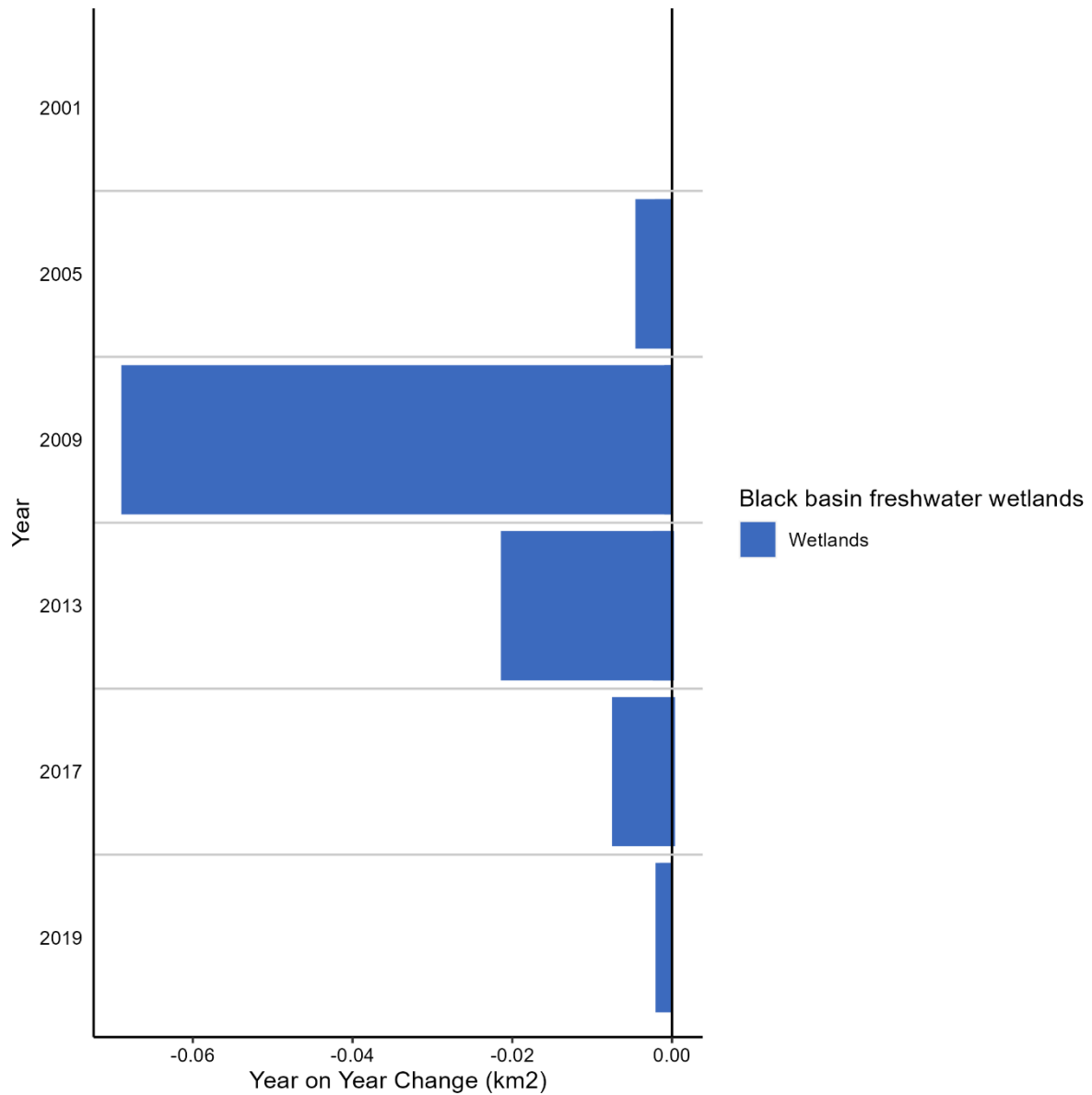


Figure 55. Black freshwater wetland vegetation change over time.

Appendix Z. Effect of the New Wetland Vegetation Dataset

Table 83. Old (version 5.0 data) and new (version 6.0 data) freshwater wetland extent in 2017.

Basin/Sub Basin	Freshwater Wetland Extent		Difference (ha)
	Area (NEW) 2017 (ha)	Area (OLD) 2017 (ha)	
Alligator Creek	526.5	364	162.5
Bohle River	206.1	192.6	13.5
Magnetic Island	28.3	11.8	16.5
Ross River (Lower)	61.0	43.3	17.7
Ross River (Upper)	46.0	46	0
Stuart Creek	11.1	10.1	1
Ross freshwater	879.0	667.7	211.3
Black River	33.5	13.6	19.9
Bluewater Creek	45.1	43.6	1.5
Crystal Creek	219.1	213.8	5.3
Palm Islands	61.9	47.4	14.5
Paluma Lake	NA	NA	NA
Rollingstone Creek	76.9	77.3	-0.4
Black freshwater	436.6	395.6	41

Appendix AA. Freshwater Impoundment Length Assessed Area in the Townsville Dry Tropics Region

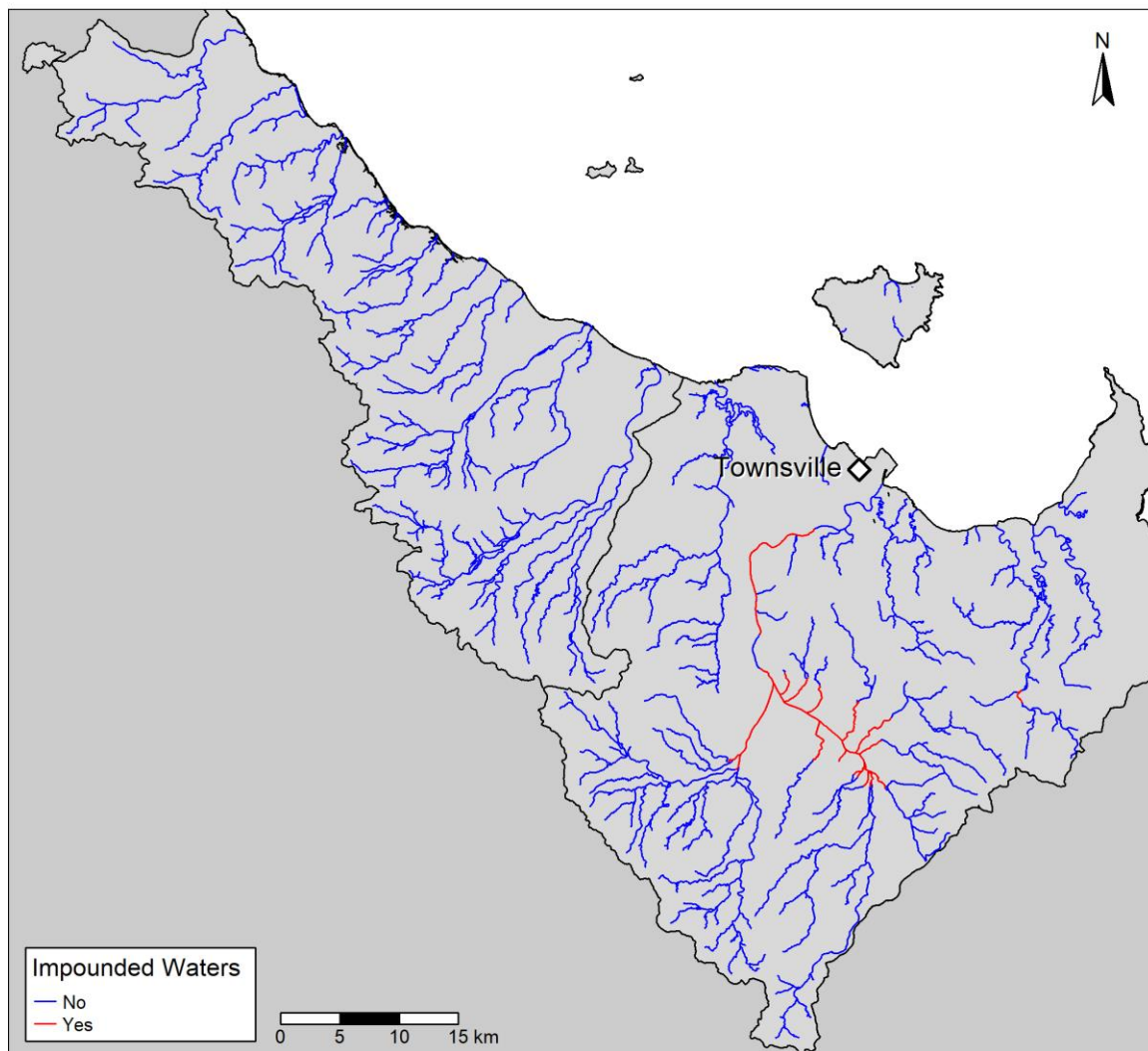


Figure 56. Impounded and non-impounded waters in the Dry Tropics region.

Appendix BB.Freshwater Fish Barrier Locations in the Townsville Dry Tropics Region

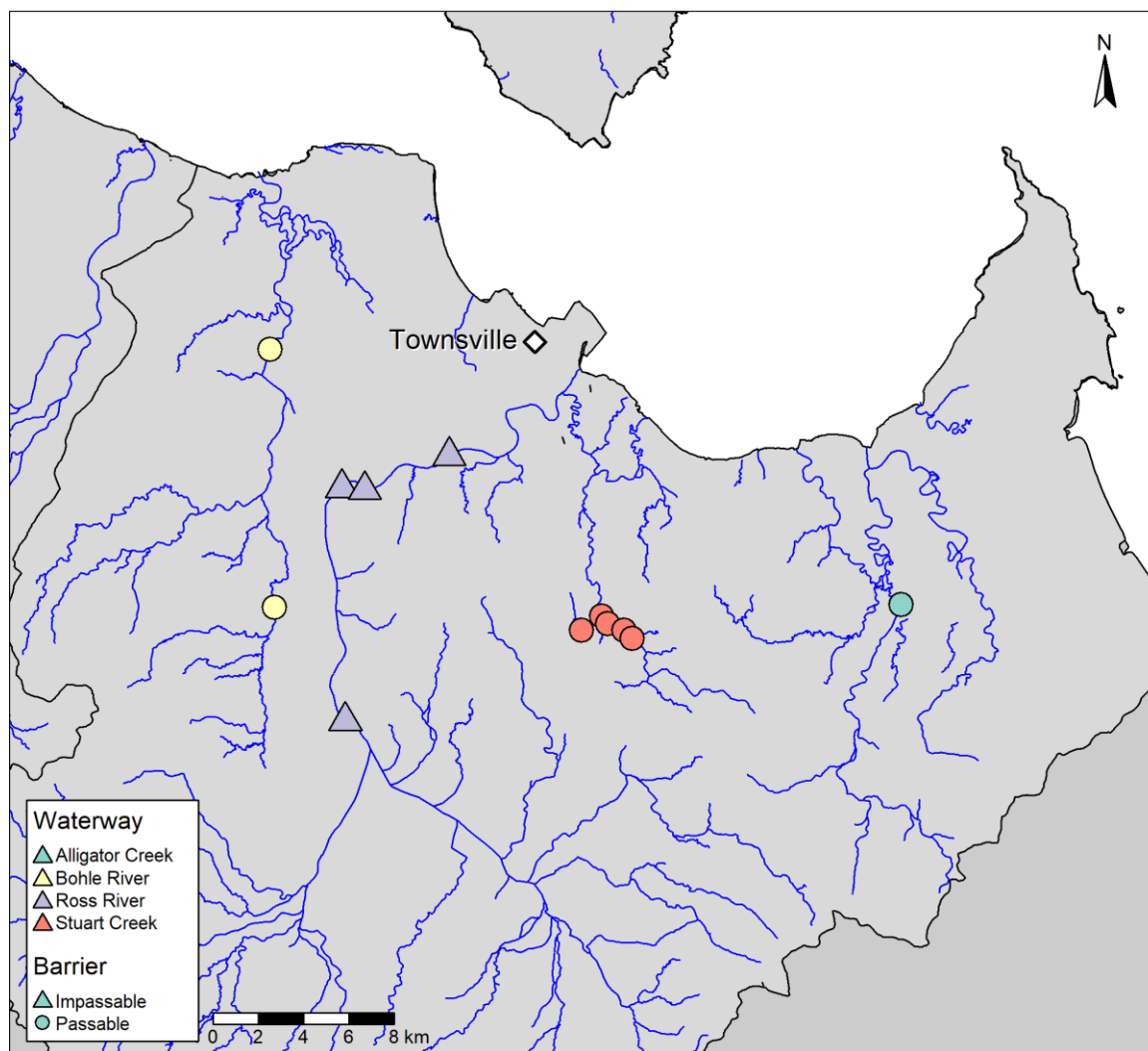


Figure 57. Fish barriers located on major and high importance waterways in the Dry Tropics region.

Appendix CC. Freshwater Fish Sampling Locations in the Dry Tropic Reporting Region

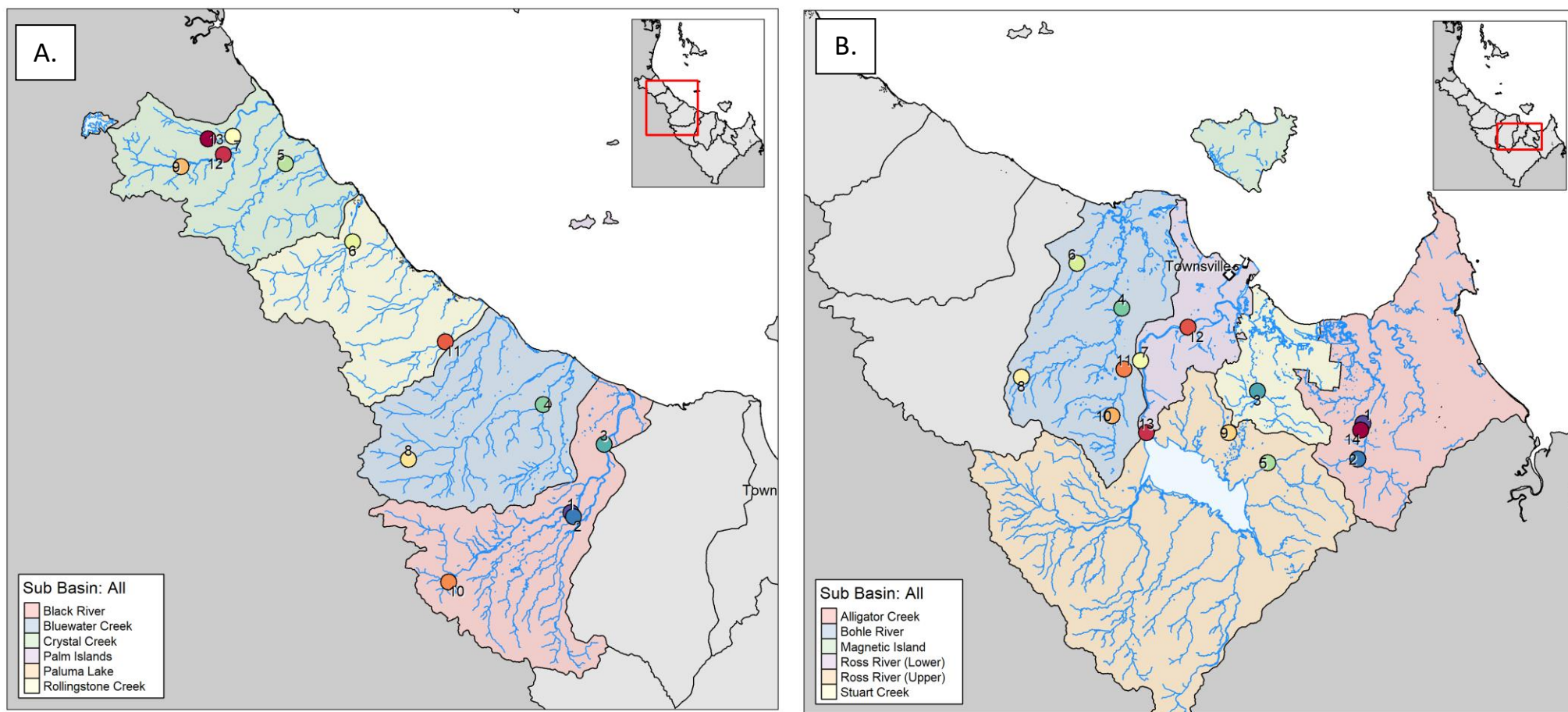


Figure 58. 2022-2023 freshwater fish sampling locations in the Townsville Dry Tropics Region. (A. = Black Basin, B. = Ross Basin). For Site ID's refer to Table 84 below.

Table 84. List of Site Names and Site Numbers for the 2022-2023 fish monitoring locations.

Basin	Site	Site Number
Ross	Alligator Creek Road, Alligator Creek	1
	Alligator Creek Road, Bowling Green Bay National Park, Mount Elliot	2
	Bougainville Street, Roseneath	3
	Dalrymple Road, Mount Louisa	4
	Flinders Highway, Ross River	5
	Geaney Lane, Deeragun	6
	Gollogly Drive, Rasmussen	7
	Granitevale Road, Alice River	8
	Kavenagh Court, Oak Valley	9
	Off Laudberg Road, Kelso	10
	Off S Beck Drive, Rasmussen	11
	Riverview Park, Annandale	12
	Riverway Drive, Kelso	13
	Strachan Road, Alligator Creek	14
Black	Adrenaline Paintball, Black River	1
	Black River Road, Black River	2
	Bruce Highway, Black River	3
	Bruce Highway, Bluewater	4
	Bruce Highway, Mutarnee	5
	Bruce Highway, Rollingstone	6
	Daly Road, Mutarnee	7
	Forestry Road, Paluma Range National Park, Lynam	8
	Intake Road, Paluma Range National Park, Crystal Creek	9
	Page Road, Hervey Range	10
	Setter Road, Bluewater	11
	Spiegelhauer Road, Mutarnee	12
	Volk Road, Mutarnee	13

Appendix DD. Key of Freshwater Fish Species Found in the Townsville Dry Tropics Region

Table 85. Key of freshwater fish species found in the Townsville Dry Tropics region.

Basin	Species	Type	Key
Ross	Barred grunter	Indigenous	1
Ross	Blue gourami	Alien	2
Ross	Bony bream	Indigenous	3
Ross	Freshwater longtom	Indigenous	4
Ross	Midas cichlid	Alien	5
Ross	Mouth almighty	Indigenous	6
Ross	Northern carp gudgeon (undescribed)	Indigenous	7
Ross	Rendahl's tandan	Indigenous	8
Ross	Seven-spot archerfish	Indigenous	9
Ross	Sleepy cod	Translocated	10
Ross	Speckled goby	Indigenous	11
Black/Ross	Barramundi	Indigenous	12
Black/Ross	Butter jew	Indigenous	13
Black/Ross	Eastern rainbowfish	Indigenous	14
Black/Ross	Empire gudgeon	Indigenous	15
Black/Ross	False Celebes goby	Indigenous	16
Black/Ross	Fly-specked hardyhead	Indigenous	17
Black/Ross	Gambusia	Alien	18
Black/Ross	Guppy	Alien	19
Black/Ross	Hyrtl's tandan	Indigenous	20
Black/Ross	Jungle perch	Indigenous	21
Black/Ross	Long-finned eel	Indigenous	22
Black/Ross	Mangrove jack	Indigenous	23
Black/Ross	Mozambique tilapia	Alien	24
Black/Ross	Northern perchlet (undescribed)	Indigenous	25
Black/Ross	Platy	Alien	26
Black/Ross	Southern purple-spotted gudgeon	Indigenous	27
Black/Ross	Spangled perch	Indigenous	28
Black/Ross	Swamp eel	Indigenous	29
Black	Black spine-cheek gudgeon	Indigenous	30
Black	Brown spine-cheek gudgeon	Indigenous	31
Black	Giant mottled eel	Indigenous	32
Black	Roman-nose goby	Indigenous	33
Black	Scaleless goby	Indigenous	34
Black	Sea mullet	Indigenous	35
Black	Snake-head gudgeon	Indigenous	36

Appendix EE. Presence/Absence of Fish Species in Waterways Across the Ross Freshwater Basin and Black Freshwater Basin

Table 86. Fish species present within waterways across the Ross Freshwater Basin.

Site #.	Species #																																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	1	0	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
3	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0
5	0	0	1	0	0	1	1	0	0	1	0	0	0	1	0	0	1	1	0	1	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0
7	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	1	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0
11	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0
12	1	0	1	1	1	1	1	0	1	1	1	1	0	1	0	0	1	1	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
13	1	0	0	0	0	1	1	0	0	1	0	0	0	1	0	0	1	1	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0
14	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0

Legend: ■ = Species Present | ■ = Species Absent. Note: where multiple sites occur in a river or creek, they are combined to create the site score.

Table 87. Fish species present within waterways across the Black Freshwater Basin.

Site #.	Species #.																																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	1	0	1	1	0	1	0	1	0	1	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1
12	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0

Legend: ■ = Species Present | ■ = Species Absent. Note: where multiple sites occur in a river or creek, they are combined to create the site score.

Appendix FF. Distribution of Fish Data Across All Monitoring Sites in The Ross Freshwater Basin and Black Freshwater Basin

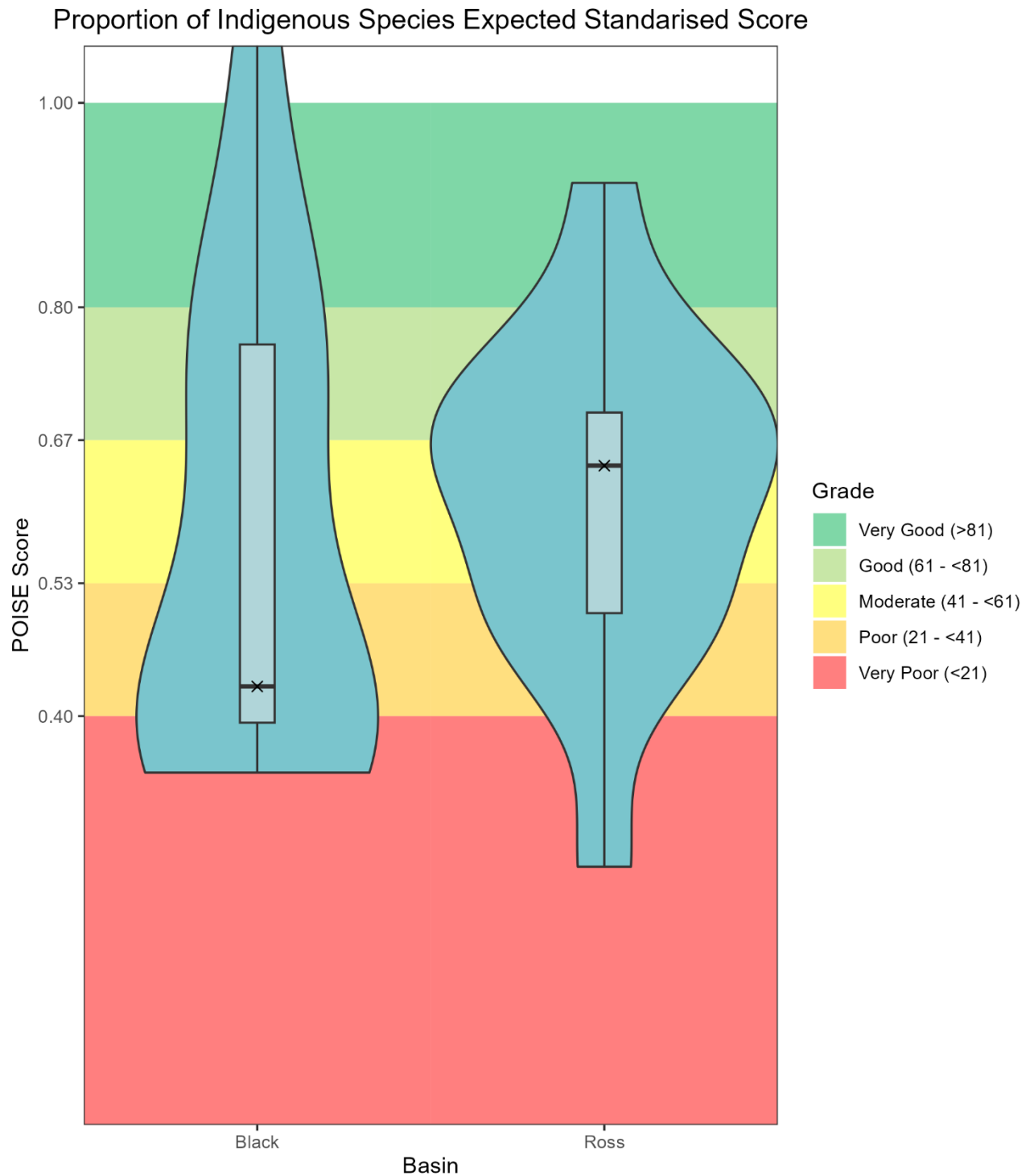


Figure 59. POISE scores for sites in each basin of the Townsville Dry Tropics region.

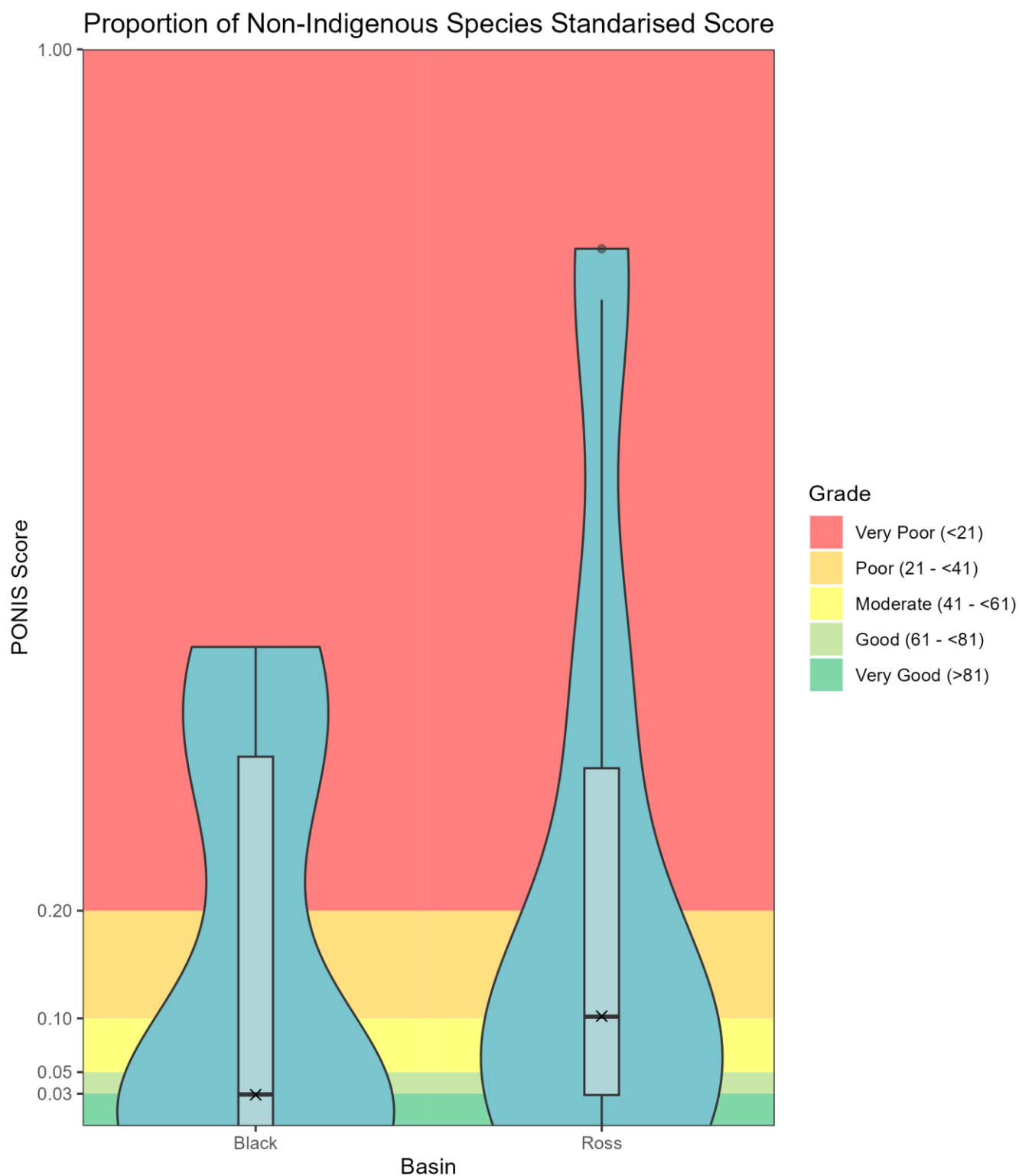


Figure 60. PONIS scores for sites in each basin of the Townsville Dry Tropics region.

Appendix GG. Estuarine Water Quality Nutrients: Sample Frequencies, Medians, Water Quality Objectives, and Scaling Factors

Table 88. Number of samples, number of months sampled, median, water quality objective values, and scaling factors for DIN and TP in the Townsville Dry Tropics Estuarine Environments.

Watercourse	DIN (mg/L)					TP (mg/L)				
	N.Samples	N.Months	Median	WQO	SF	N.Samples	N.Months	Median	WQO	SF
Bohle River	17	10	0.011	0.07	0.09	17	10	0.007	0.05	0.09
Louisa Creek	42	10	0.039	0.07	0.09	46	10	0.110	0.05	0.09
Ross Creek	8	4	0.010	0.07	0.09	8	4	0.002	0.05	0.09
Ross River	4	4	0.004	0.07	0.09	4	4	0.006	0.05	0.09
Sandfly Creek	31	10	0.033	0.07	0.09	31	10	0.028	0.05	0.09
Alligator Creek	16	11	0.006	0.07	0.09	16	11	0.005	0.05	0.09
Althaus Creek	12	12	0.034	0.02	0.09	12	12	0.026	0.025	0.04
Bluewater Creek	12	12	0.019	0.02	0.09	12	12	0.014	0.025	0.04
Sleeper Log Creek	17	11	0.020	0.02	0.09	17	11	0.016	0.025	0.04
Camp Oven Creek	34	12	0.009	0.02	0.09	34	12	0.002	0.025	0.04
Saltwater Creek	45	12	0.014	0.02	0.09	45	12	0.002	0.025	0.04
Rollingstone Creek	12	12	0.050	0.02	0.09	12	12	0.013	0.025	0.04
Crystal Creek	12	12	0.025	0.02	0.09	12	12	0.018	0.025	0.04

Key: ■ = Mean/Median is lower than the guideline value | ■ = Mean/Median is higher than the guideline value | ND = No Data | NA = Not Applicable (data available but not usable).

Appendix HH. Estuarine Water Quality Nutrients Scores Historic Comparison

Table 89. Townsville Dry Tropics estuarine water quality historic nutrient indicator scores.

Basin	Sub Basin	Watercourse	DIN				TP			
			22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20
Ross Estuarine	Bohle	Bohle River	90	90	90	90	90	90	90	90
		Louisa Creek	67	79	75	74	0	22	30	30
			78	85	83	82	45	56	60	60
	Lower Ross	Ross Creek	90	90	90	90	90	90	90	90
		Ross River	90	90	90	90	90	90	90	90
			90	90	90	90	90	90	90	90
	Stuart	Sandfly Creek	90	76	90	90	90	90	90	90
	Alligator	Alligator	90	90	90	90	90	90	90	90
			86	85	88	88	75	82	83	83
Black Estuarine	Bluewater Creek	Althaus Ck	49	90	69	90	56	90	90	72
		Bluewater Ck	65	63	53	70	90	90	90	90
		Sleeper Log Ck	61	90	90	ND	90	90	90	ND
			58	81	71	80	78	90	90	81
	Rollingstone Creek	Camp Oven Creek	80	80	90	ND	90	90	83	ND
		Saltwater Ck	78	70	90	66	90	90	90	90
		Rollingstone Ck	34	61	36	49	90	90	90	90
			64	71	72	58	90	90	88	90
	Crystal Creek	Crystal Ck	56	65	27	58	90	90	90	90
			60	72	57	65	85	90	89	87

Standardised scoring range: ■ Very Poor (E) = 0 to <21 | ■ Poor (D) = 21 to <41 | ■ Moderate (C) = 41 to <61 | ■ Good (B) = 61 to <81 | ■ Very Good (A) = 81 – 100 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

Appendix II. Estuarine Water Quality Physical-Chemical Properties: Sampling Frequencies, Medians, Water Quality Objectives and Scaling Factors

Table 90. Number of samples, number of months sampled, median, water quality objective values, and scaling factors for Turbidity and DO in the Townsville Dry Tropics Estuarine Environments.

Watercourse	Turbidity (NTU)					Dissolved Oxygen (%Sat)						
	N.Samples	N.Months	Median	WQO	SF	N.Samples	N.Months	Median	High DO WQO	High DO SF	Low DO WQO	Low DO SF
Bohle River	17	10	15.350	20	45	17	10	94.175	105	120	85	70
Louisa Creek	40	10	16.800	20	45	40	10	67.640	105	120	85	70
Ross Creek	8	4	3.485	20	45	6	3	91.750	105	120	85	70
Ross River	4	4	13.575	20	45	3	3	93.410	105	120	85	70
Sandfly Creek	30	10	30.725	20	45	26	9	89.920	105	120	85	70
Alligator Creek	15	11	24.900	20	45	13	10	90.750	105	120	85	70
Althaus Creek	12	12	20.390	8	15	12	12	101.050	105	120	85	70
Bluewater Creek	12	12	7.400	8	15	12	12	93.350	105	120	85	70
Sleeper Log Creek	17	11	8.160	8	15	17	11	89.300	105	120	85	70
Camp Oven Creek	31	11	8.658	8	15	28	11	80.555	105	120	85	70
Saltwater Creek	38	12	5.661	8	15	37	12	92.489	105	120	85	70
Rollingstone Creek	12	12	4.920	8	15	12	12	91.800	105	120	85	70
Crystal Creek	12	12	10.015	8	15	12	12	92.200	105	120	85	70

Key: ■ = for Turbidity Mean/Median is lower than the guideline value, for DO, Median is within the range between the High and Low DO guideline values | ■ = for Turbidity Mean/Median is higher than the guideline value, for DO, the Median is higher than the High DO or Lower than the Low DO guideline value | ND = No Data | NA = Not Applicable (data available but not usable).

Appendix JJ. Estuarine Water Quality Physical-Chemical Properties Scores Historic Comparison

Table 91. Townsville Dry Tropics estuarine water quality historic physical-chemical indicator scores.

Basin	Sub Basin	Watercourse	Turbidity				High DO				Low DO			
			22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20
Ross Estuarine	Bohle	Bohle River	67	66	90	90	90	90	90	90	90	90	90	90
		Louisa Creek	65	66	68	90	90	90	25	90	0	24	21	90
			66	66	79	90	90	90	57	90	45	41	56	90
	Lower Ross	Ross Creek	90	90	90	90	90	90	90	90	90	90	90	ND
		Ross River	75	90	90	90	90	90	70	90	90	90	90	ND
			82	90	90	90	90	90	80	90	90	90	90	ND
	Stuart	Sandfly Creek	34	76	33	52	90	90	90	90	90	90	90	90
	Alligator	Alligator	48	90	69	90	90	90	90	90	90	90	90	90
			63	81	68	81	90	90	79	90	75	90	81	90
Black Estuarine	Bluewater Creek	Althaus Ck	0	0	0	3	80	33	90	68	90	28	90	90
		Bluewater Ck	63	90	90	7	90	76	90	73	73	0	90	90
		Sleeper Log Ck	59	63	84	ND	90	90	90	90	90	90	90	ND
			40	51	58	5	86	66	90	77	84	39	90	90
	Rollingstone Creek	Camp Oven Creek	55	42	63	ND	90	90	53	90	42	54	65	ND
		Saltwater Ck	69	83	86	90	90	77	90	90	90	75	90	90
		Rollingstone Ck	80	69	65	73	90	90	90	90	77	64	90	90
			68	65	71	82	90	86	78	90	70	64	81	90
	Crystal Creek	Crystal Ck	43	7	68	90	90	90	90	90	90	69	90	34
			53	41	66	59	88	81	86	86	79	57	87	71

Standardised scoring range: ■ Very Poor (E) = 0 to <21 | ■ Poor (D) = 21 to <41 | ■ Moderate (C) = 41 to <61 | ■ Good (B) = 61 to <81 | ■ Very Good (A) = 81 – 100 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

Appendix KK. Estuarine Water Quality Sub Basin Historic Scores

Table 92. A comparison of nutrient and physical chemical properties indicator category scores, and the water quality index scores, for estuarine sub basins between years.

Sub Basin	Nutrients				Phys-Chem				Water Quality			
	22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20
Bohle River	61	63			55	55			58	59		
Lower Ross	90	90			86	85			88	87		
Stuart Ck	90	81			62	77			76	79		
Alligator Ck	90	90			69	90			79	90		
Bluewater Ck	68	85			61	58			64	71		
Rollingstone Ck	77	82			69	73			73	77		
Crystal Ck	73	77			66	48			69	63		

Appendix LL. Estuarine Water Quality 2022–2023 Boxplots

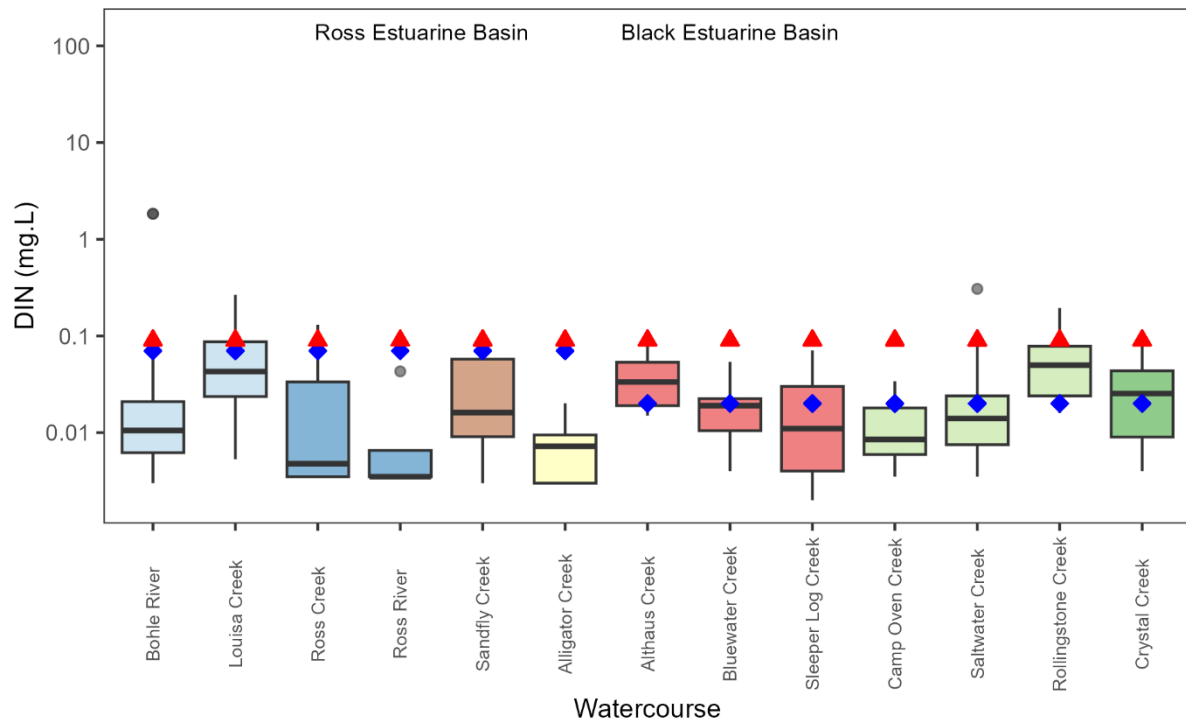


Figure 62. Dissolved Inorganic Nitrogen (DIN) (mg/L) Boxplot: red triangles indicate the scaling factor, blue diamonds indicate the water quality objective.

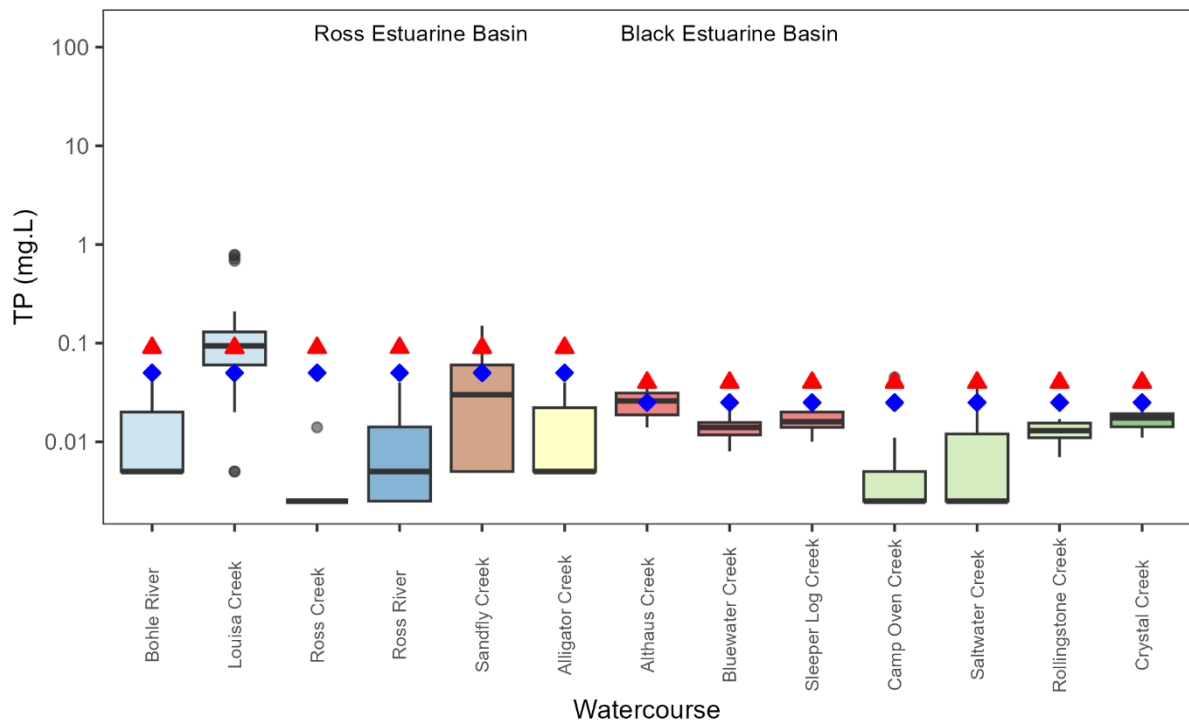


Figure 61. Total Phosphorus (TP) (mg/L) Boxplot: red triangles indicate the scaling factor, blue diamonds indicate the water quality objective.

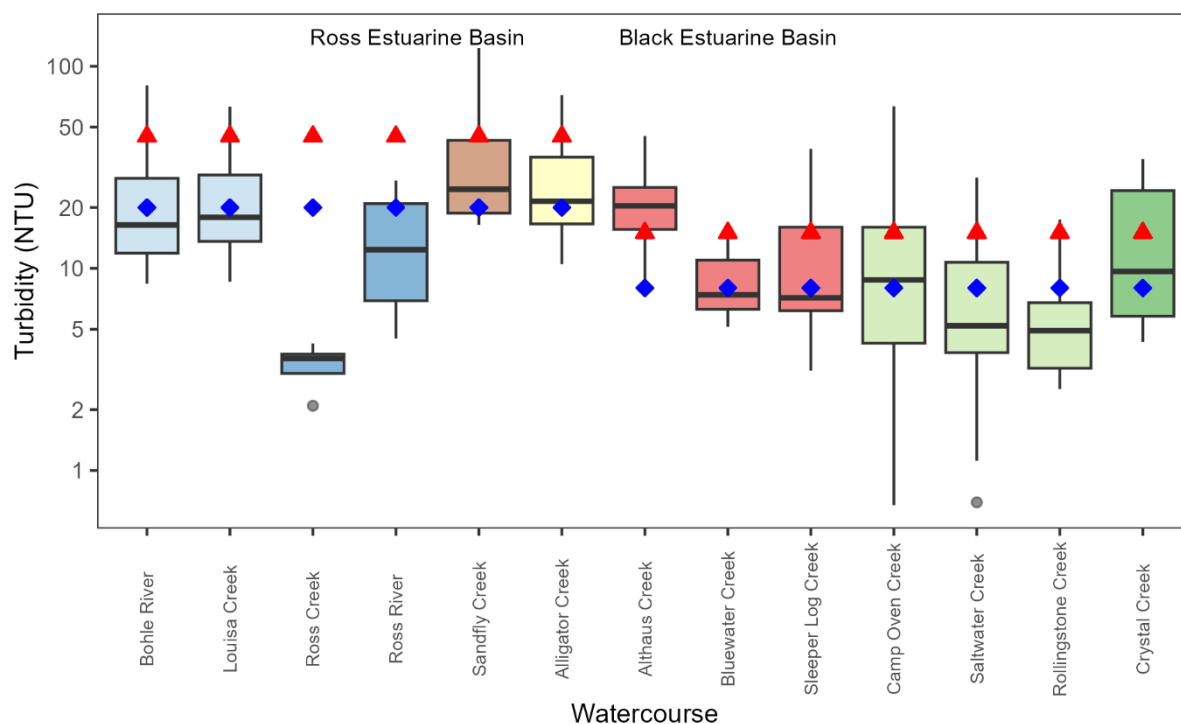


Figure 64. Turbidity (NTU) Boxplot: red triangles indicate the scaling factor, blue diamonds indicate the water quality objective.

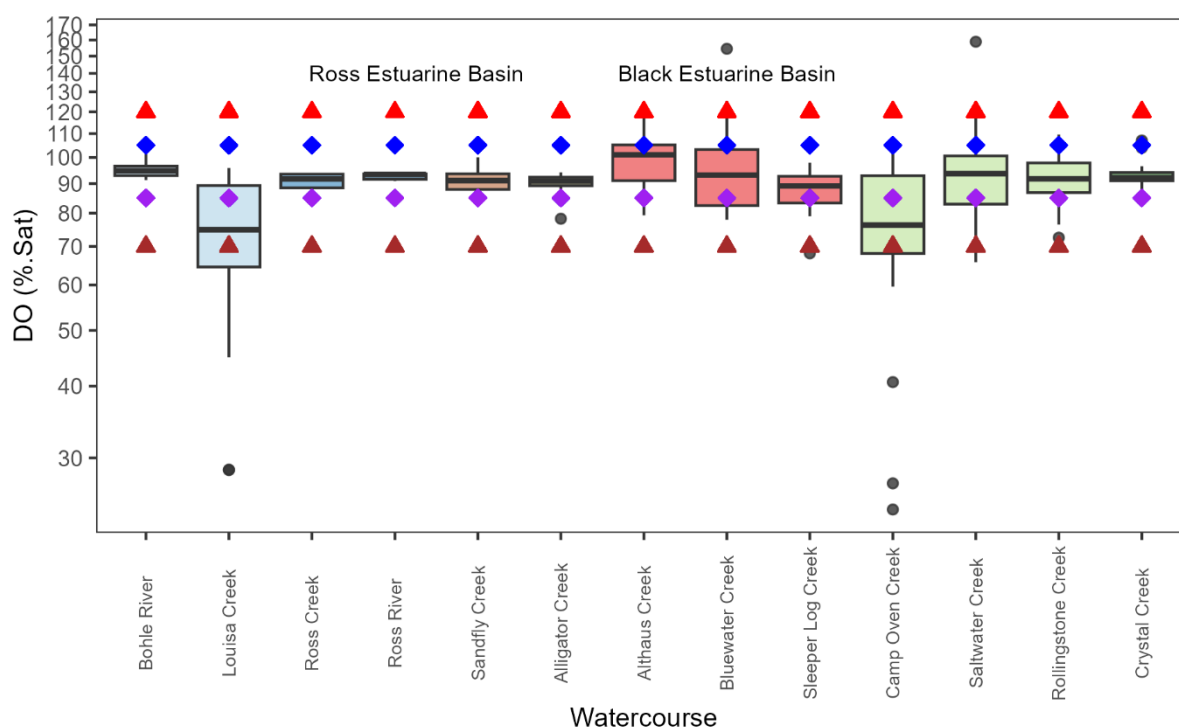


Figure 63. Dissolved Oxygen (DO) (% Saturation) boxplot: red triangles indicate the high DO scaling factor, blue diamonds indicate the high DO water quality objective, purple diamonds indicate the low DO water quality objective, and brown triangles indicate the low DO scaling factor.

Appendix MM. Estuarine Water Quality Line Plots

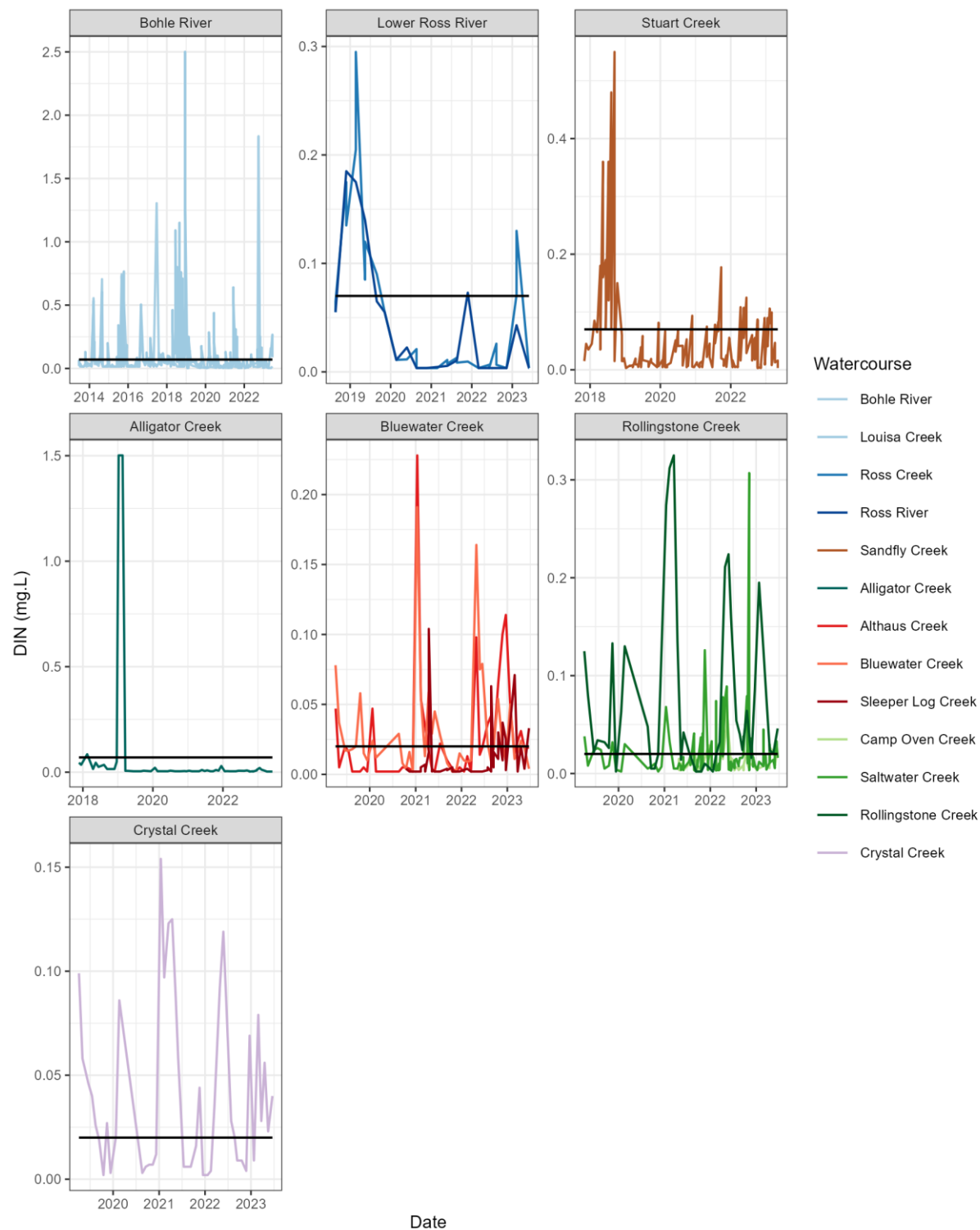


Figure 65. Historical concentrations of dissolved inorganic nitrogen (DIN) in the freshwater sub basins. Black line indicates the water quality objective.

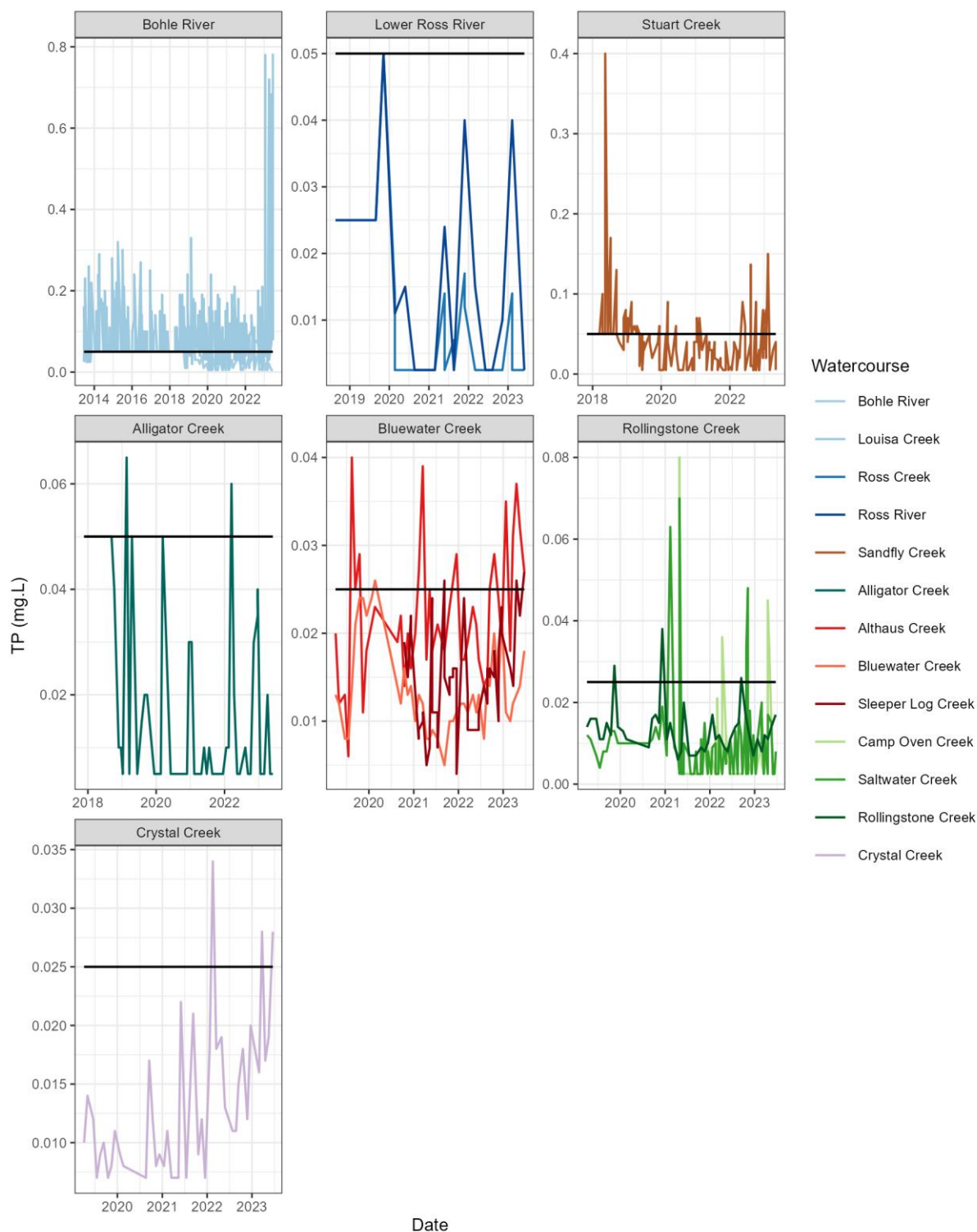


Figure 66. Historical concentrations of Total Phosphorus (TP) in the freshwater sub basins. Black line indicates the water quality objective.

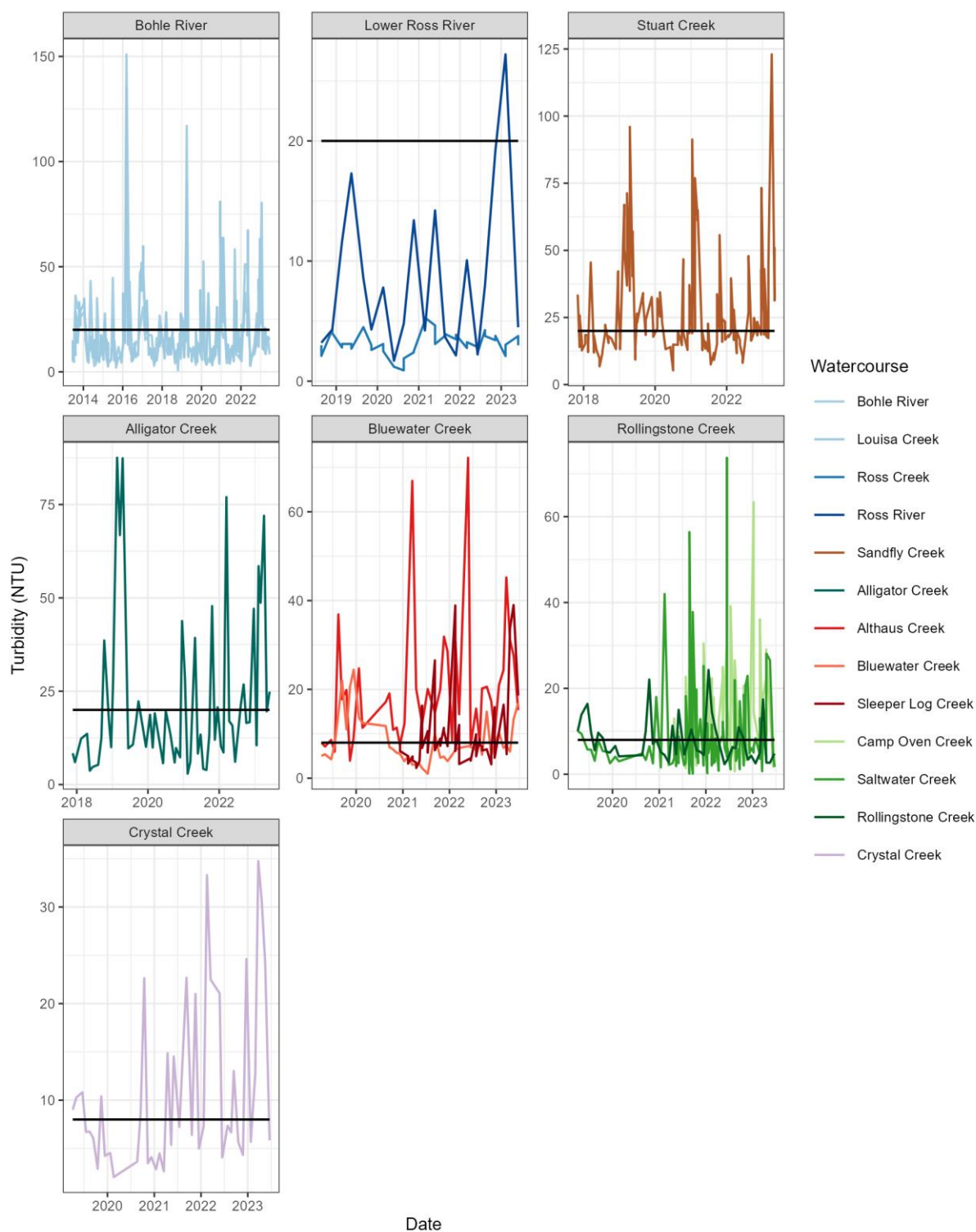


Figure 67. Historical concentrations of turbidity (NTU) in the freshwater sub basins. Black line indicates the water quality objective.

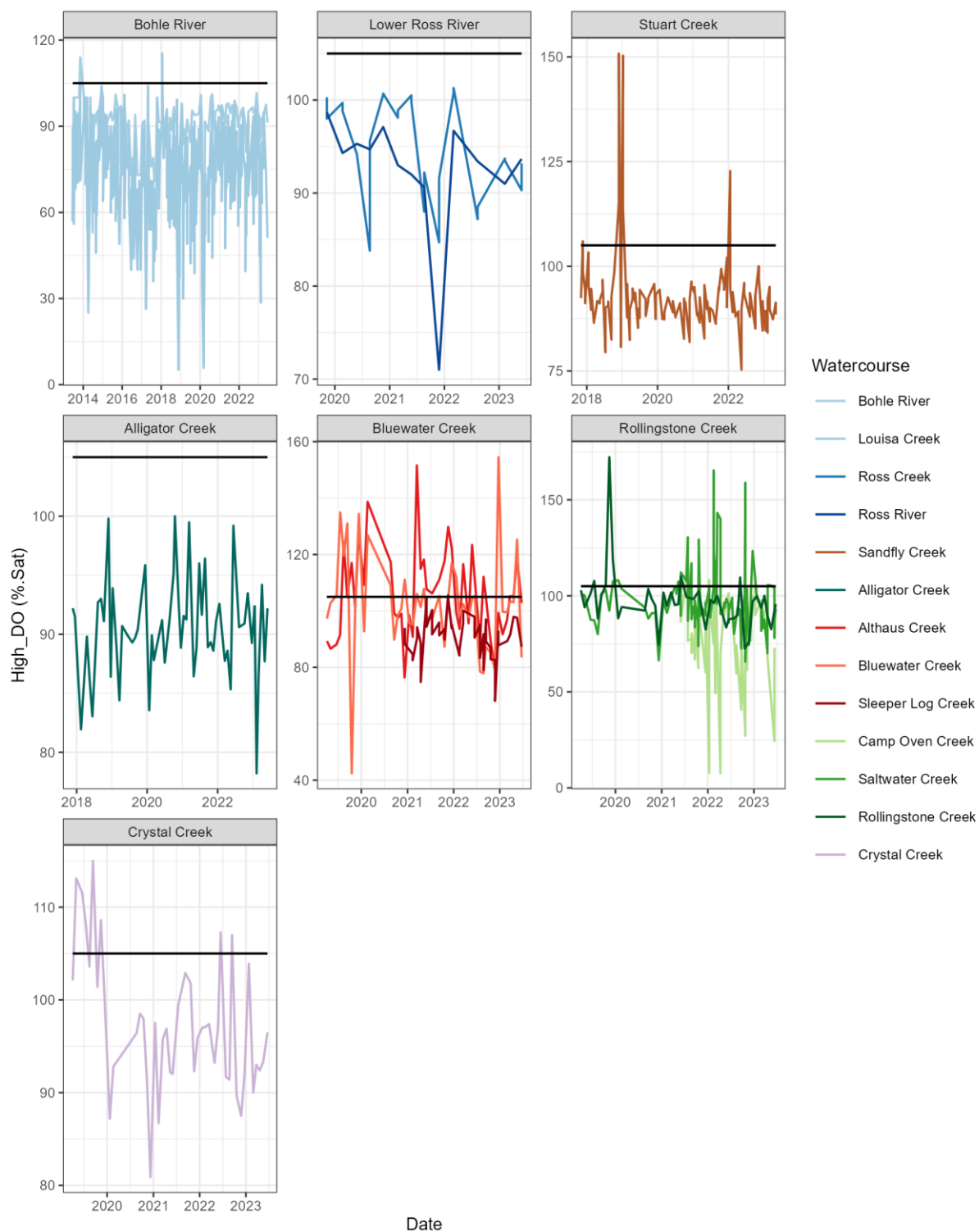


Figure 68. Historical dissolved oxygen in the freshwater sub basins. Black lines indicate the water quality objective (High DO).

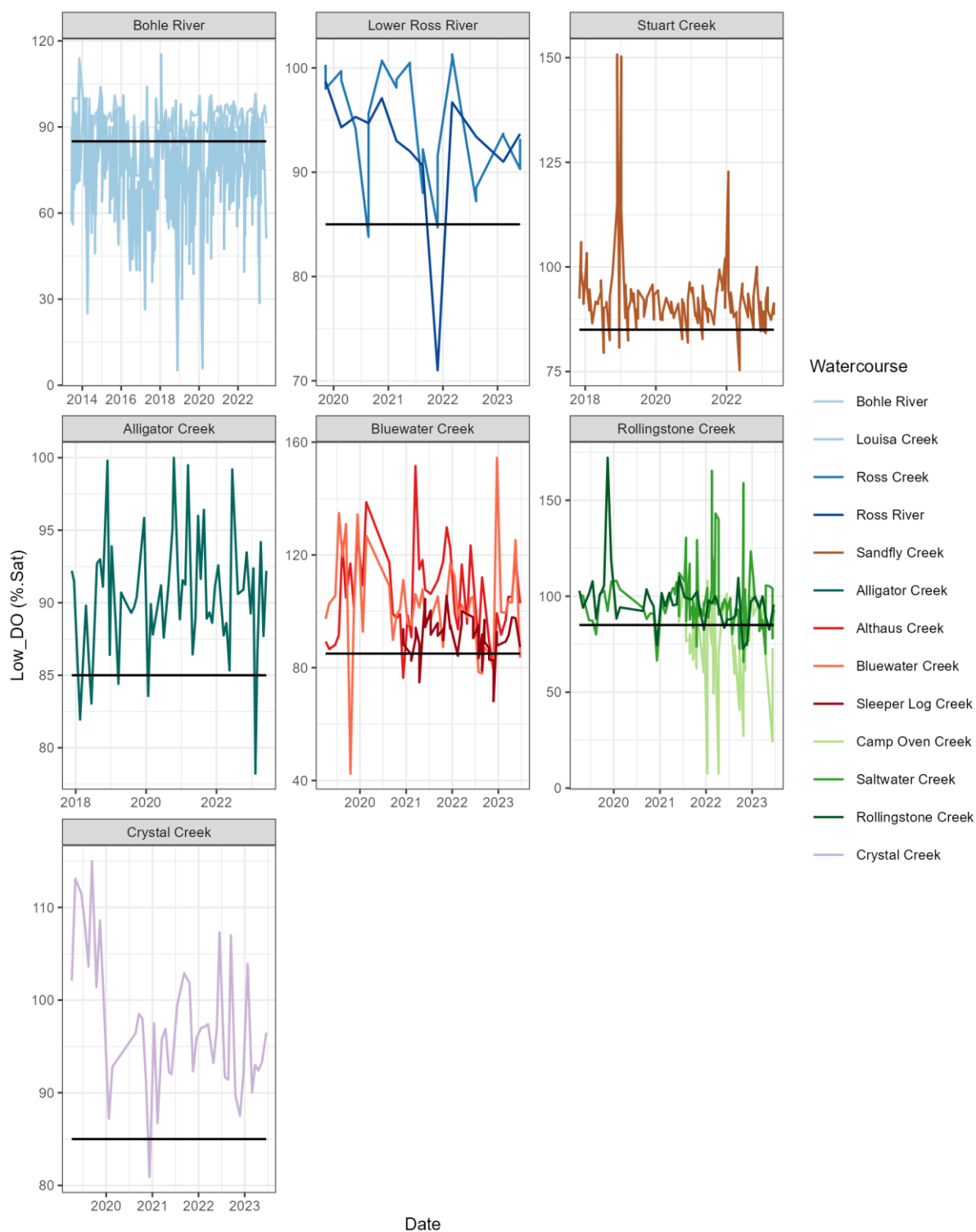


Figure 69. Historical dissolved oxygen in the freshwater sub basins. Black lines indicate the water quality objective (Low DO).

Appendix NN. Estuarine Mangrove and Saltmarsh Extent: Assessed Area in the Ross Basin of the Townsville Dry Tropics Region

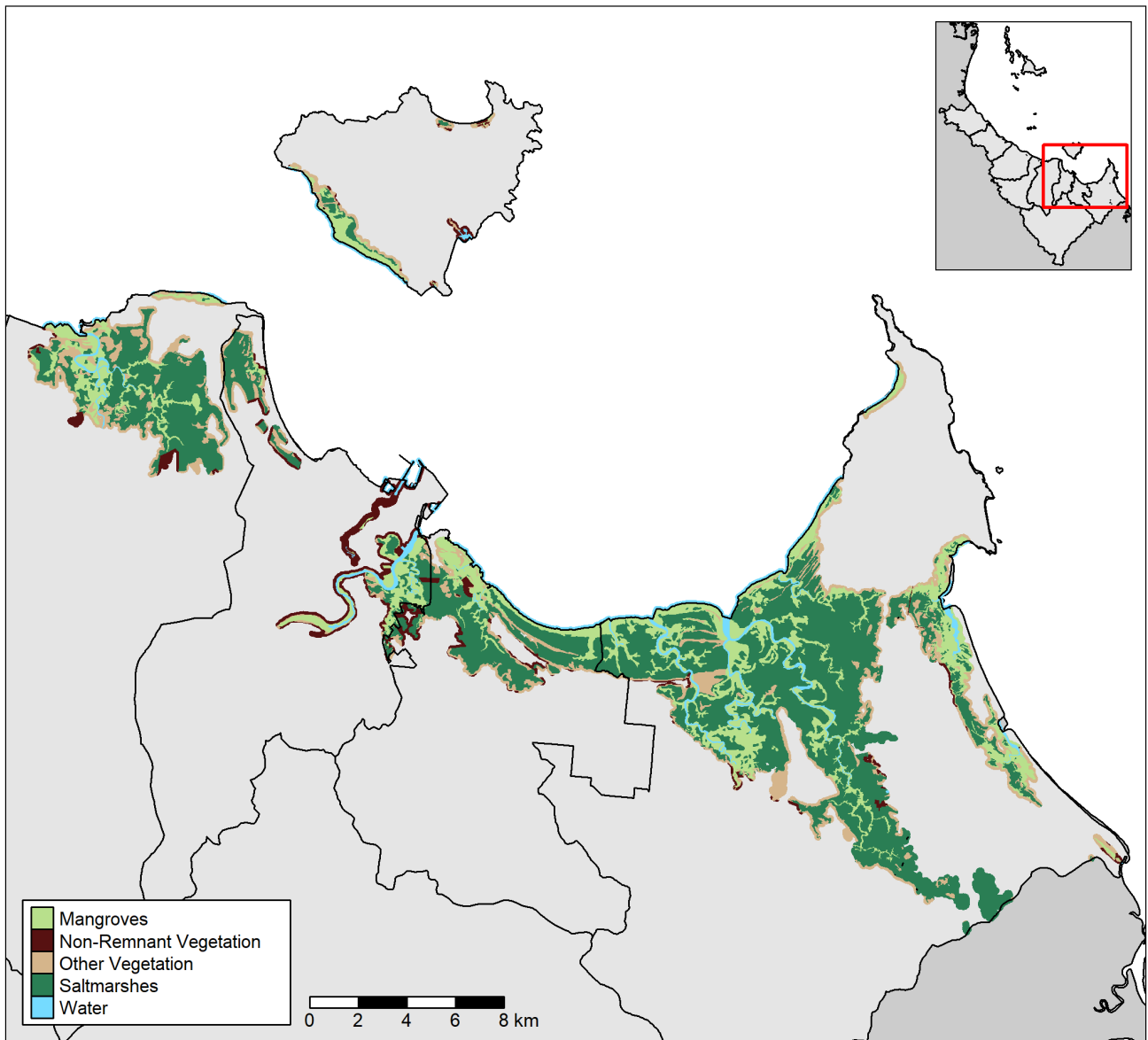


Figure 70. Total area in the Ross Basin of the Dry Tropics region that was assessed for changes in Mangrove and Saltmarsh extent.

Appendix OO. Estuarine Mangrove and Saltmarsh Extent: Assessed Area in the Black Basin of the Townsville Dry Tropics Region

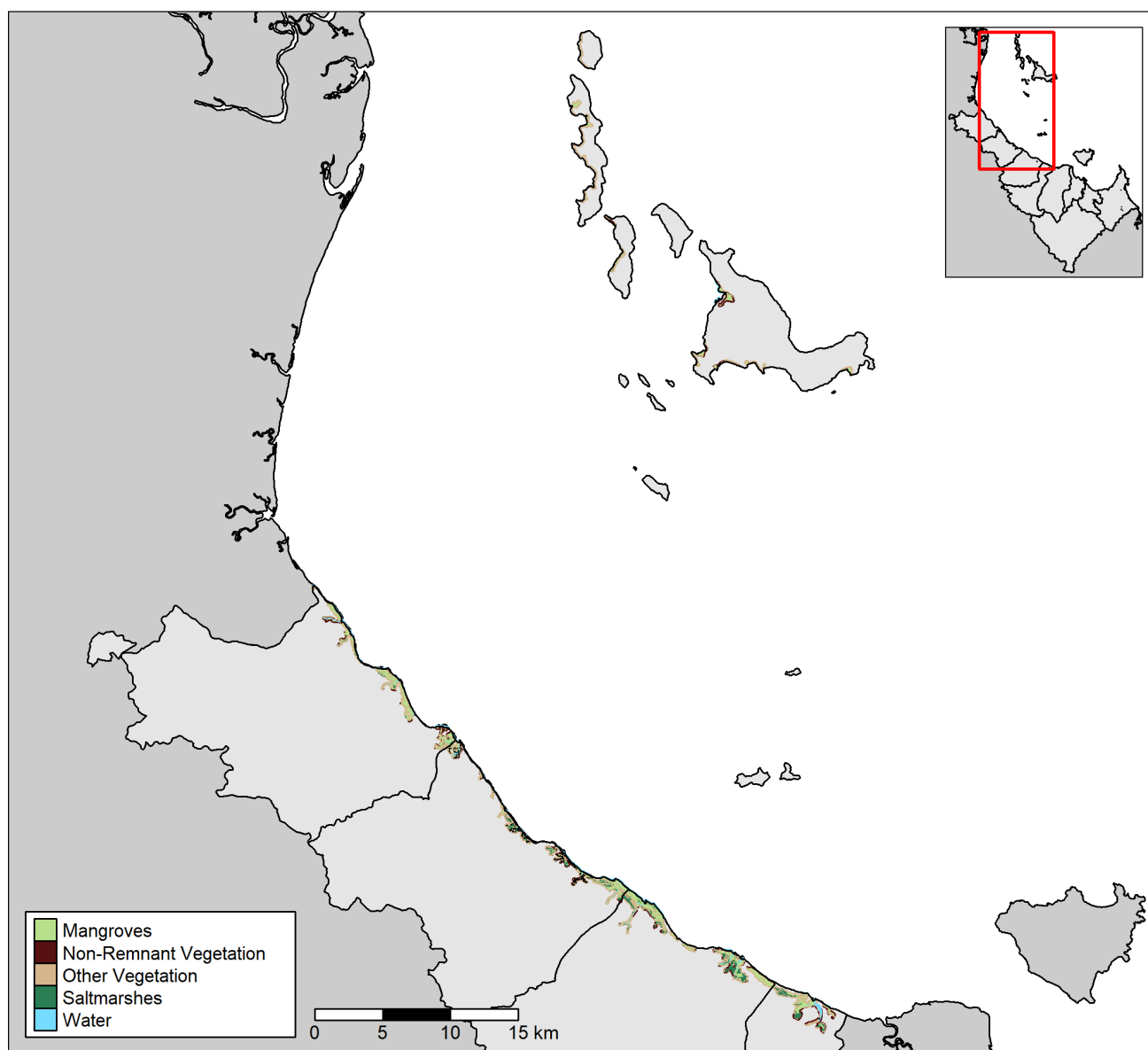


Figure 71. Total area in the Black Basin of the Dry Tropics region that was assessed for changes in Mangrove and Saltmarsh extent.

Appendix PP. Ross Estuarine Area Mangrove and Saltmarsh Vegetation Change Over Time

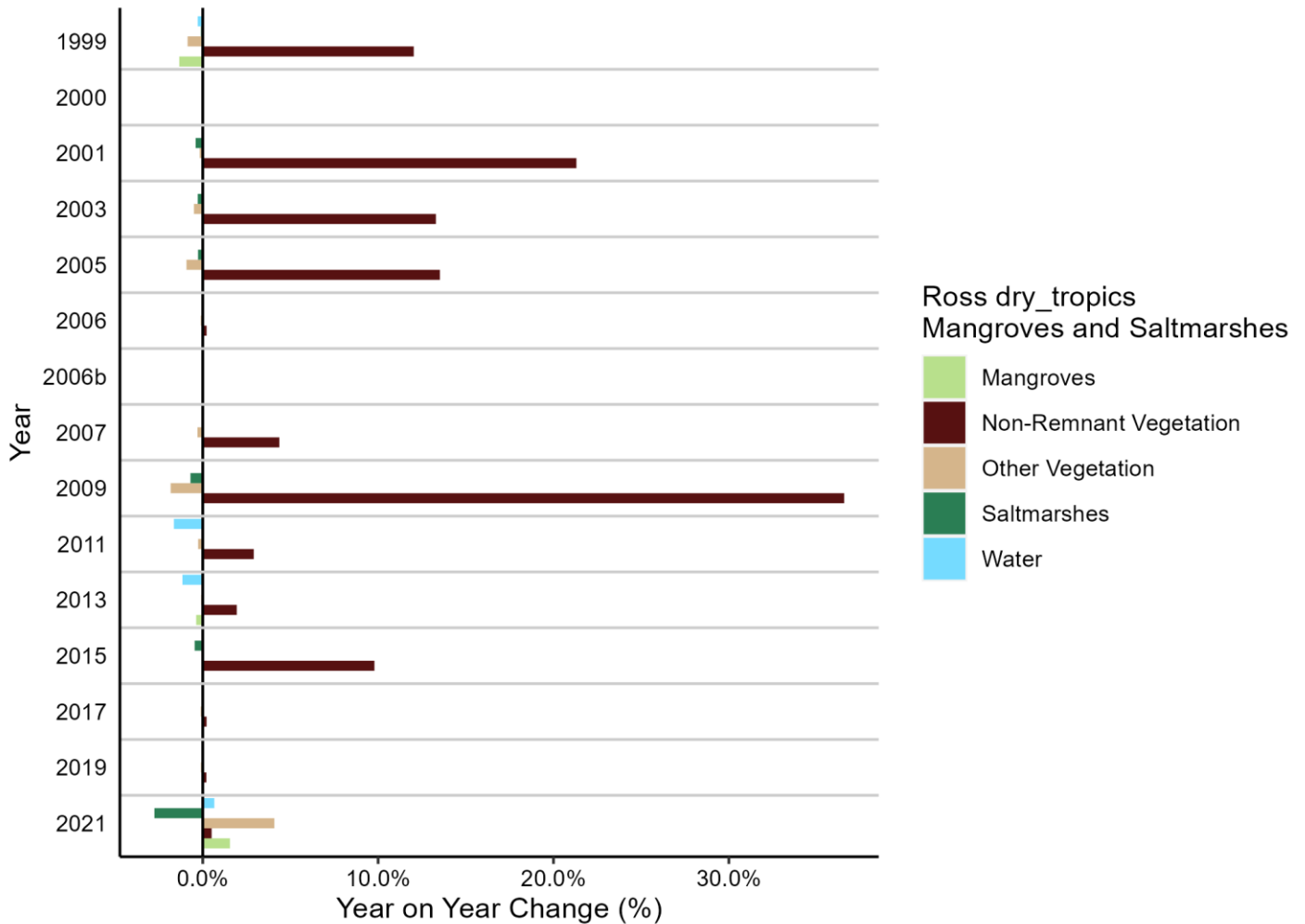


Figure 72. Ross Estuarine Area Mangrove and Saltmarsh Vegetation Change.

Appendix QQ. Black Estuarine Area Mangrove and Saltmarsh Vegetation Change Over Time

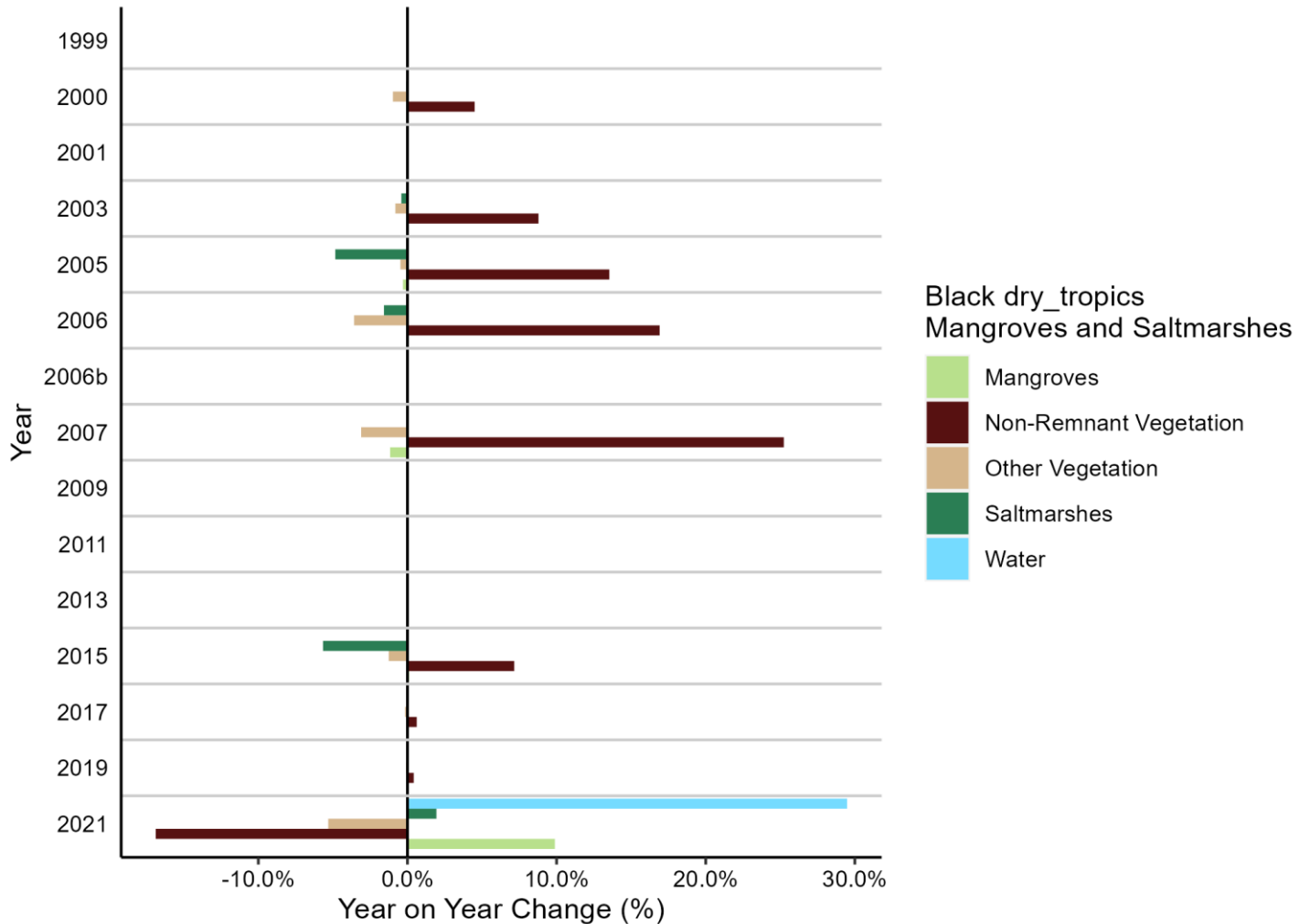


Figure 73. Black Estuarine Area Mangrove and Saltmarsh Vegetation Change.

Appendix RR. Estuarine Riparian Extent: Assessed Area in the Ross Basin of the Townsville Dry Tropics Region

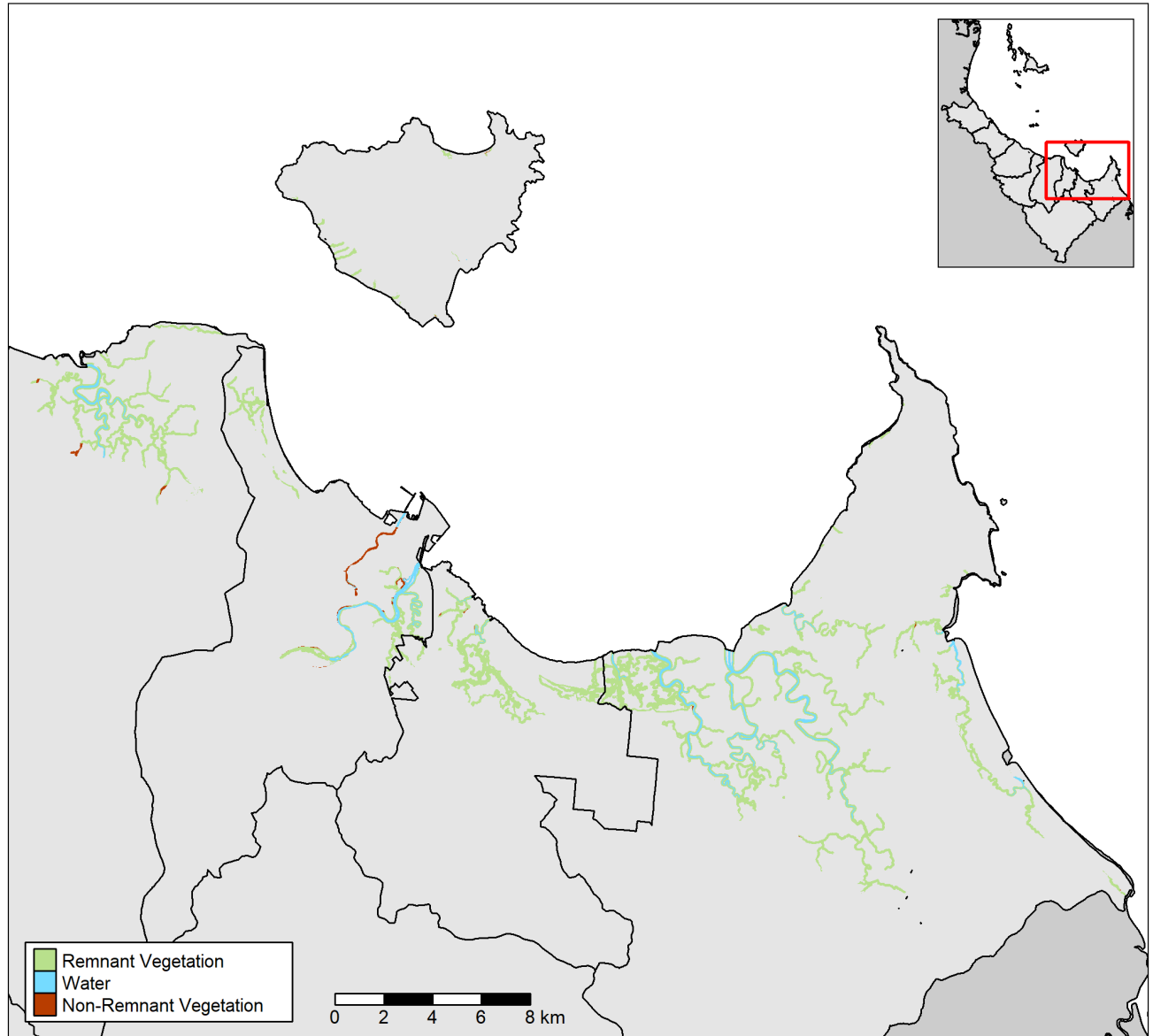


Figure 74. Ross Estuarine Riparian Vegetation Change.

Appendix SS. Estuarine Riparian Extent: Assessed Area in the Black Basin of the Townsville Dry Tropics Region

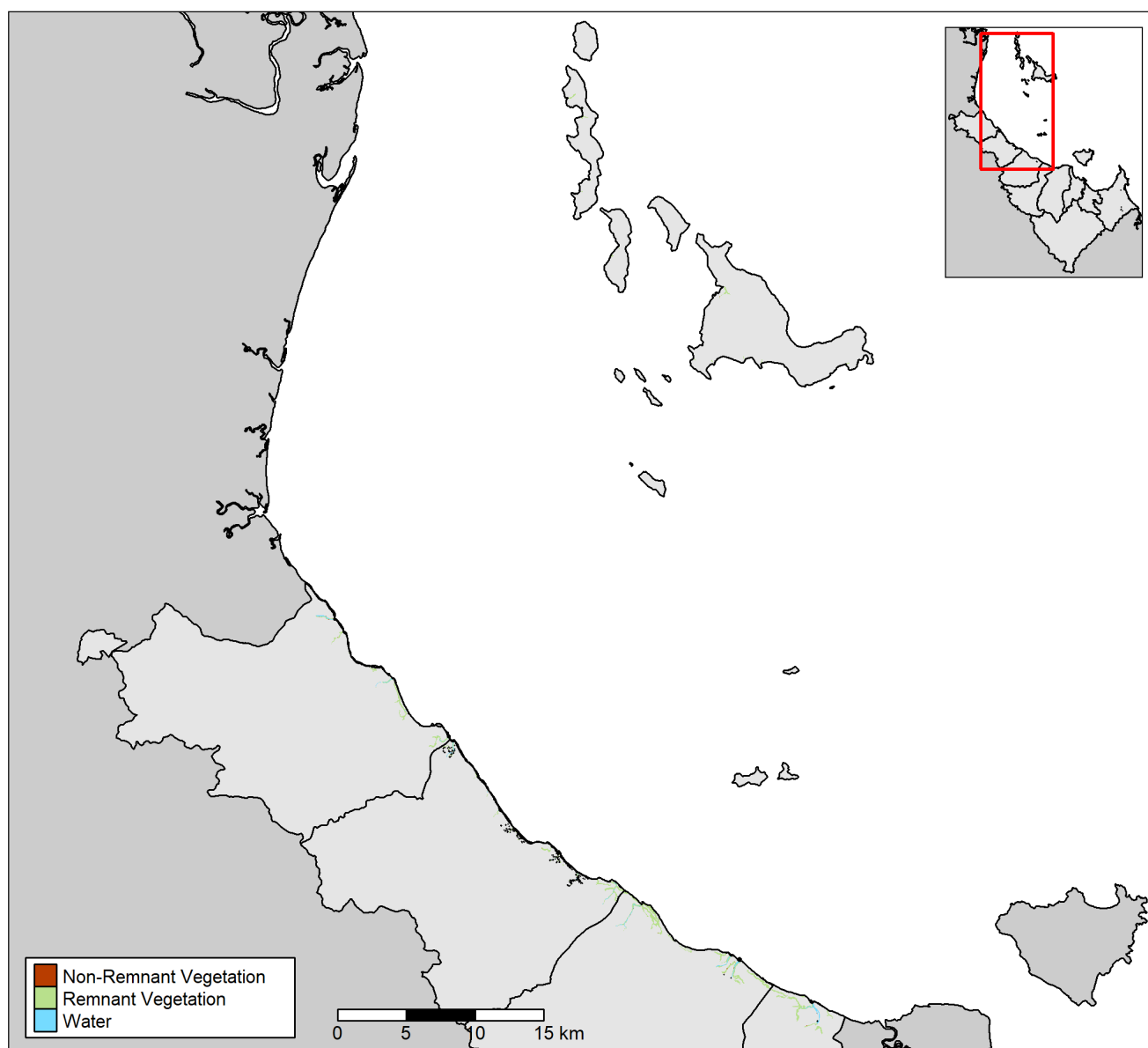


Figure 75. Black Estuarine Riparian Vegetation Change.

Appendix TT. Ross Estuarine Riparian Vegetation Change Over Time

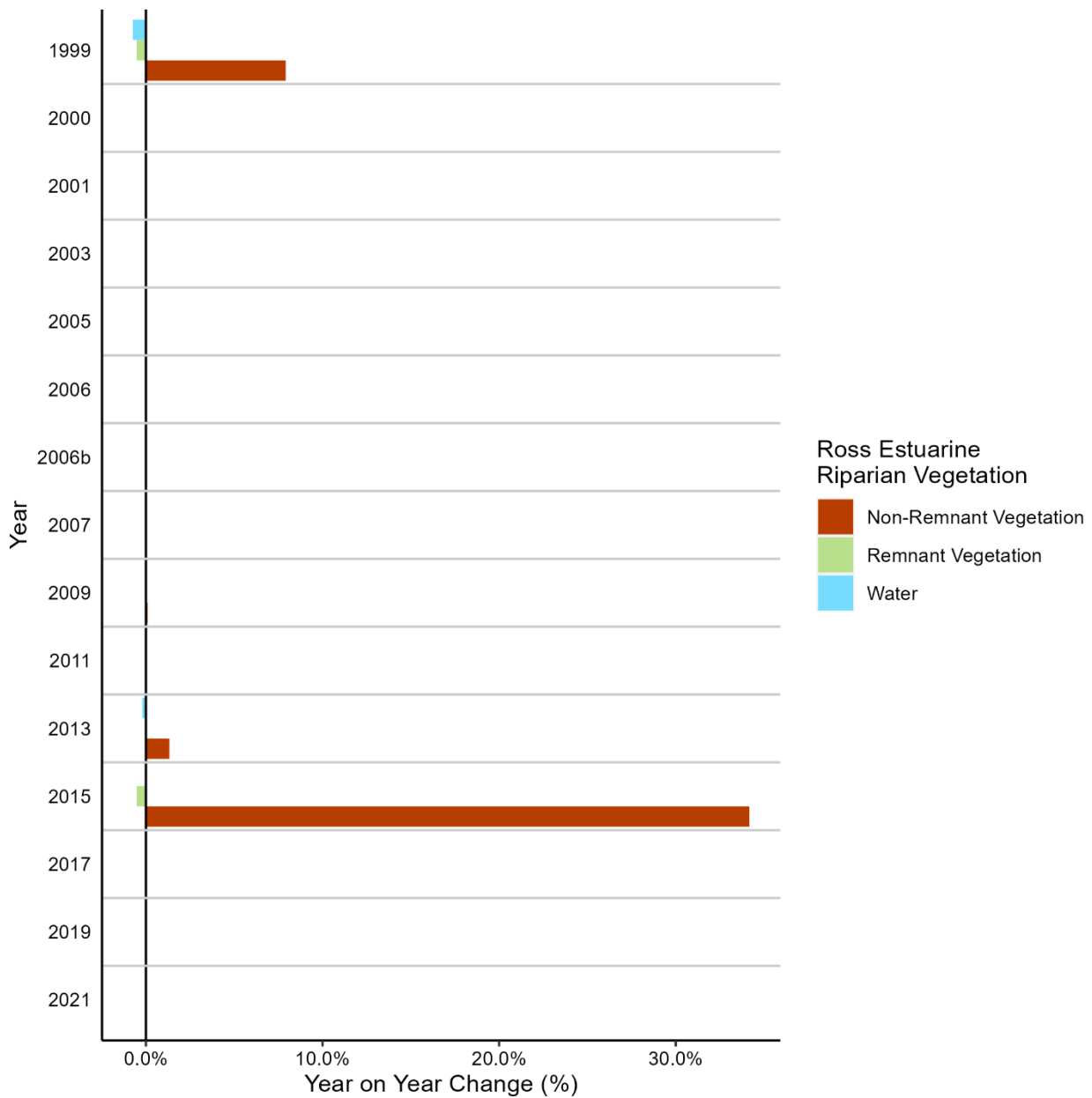


Figure 76. Ross Estuarine riparian vegetation change over time.

Appendix UU. Black Estuarine Riparian Vegetation Change Over Time

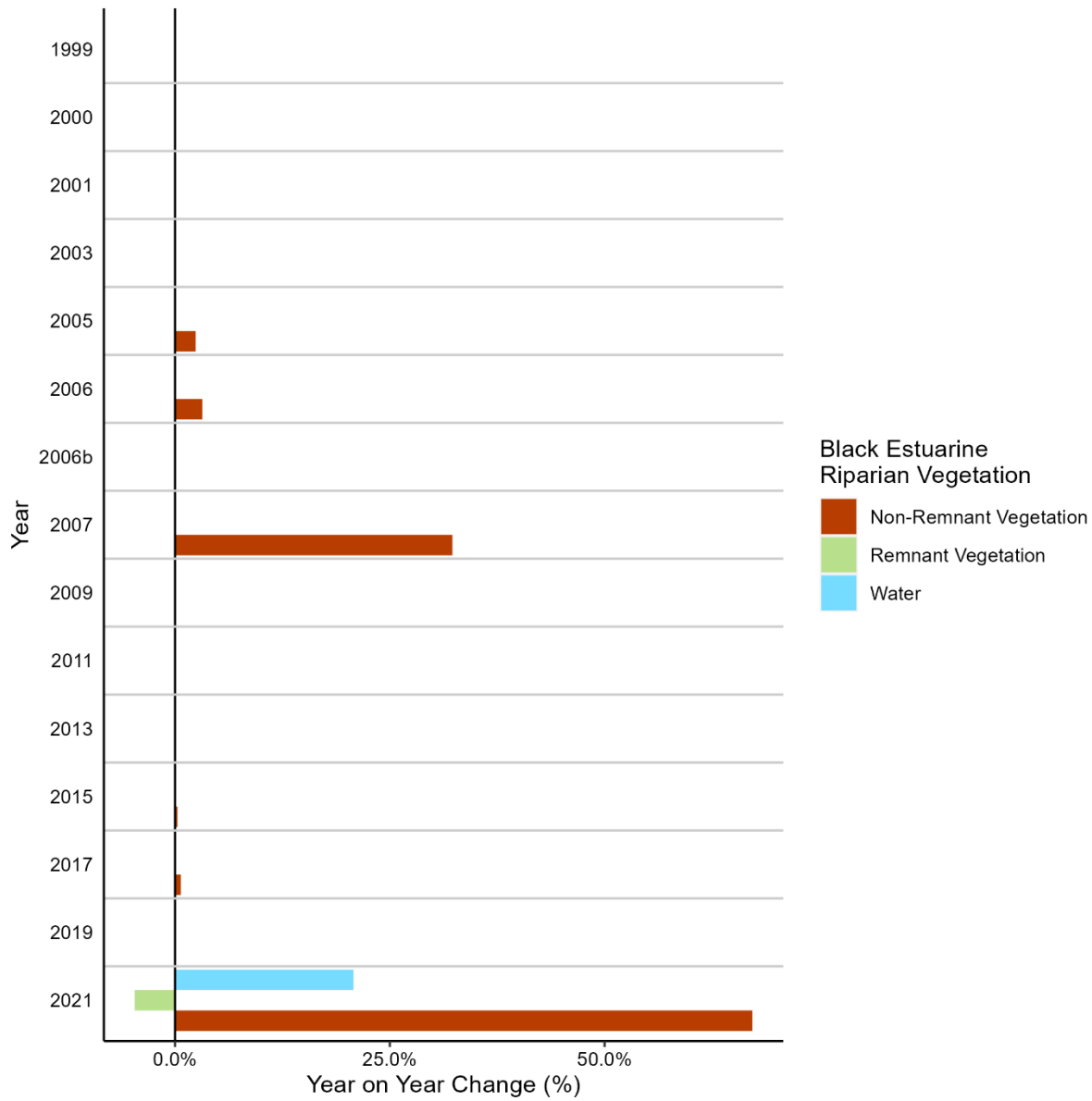


Figure 77. Black Estuarine riparian vegetation change over time.

Appendix VV. Inshore Marine Water Quality Nutrients: Sample Frequencies, Means, Medians, and WQOs

Table 93. Number of samples, days sampled, mean, median and water quality objective values for nutrient indicators in the Townsville Dry Tropics Inshore Marine Environment.

Area	NOx (mg/L)				PN (ug/L)				PP (mg/L)				TP (mg/L)			
	N. Samples	N. Months	Median	WQO	N. Samples	N. Months	Mean	WQO	N. Samples	N. Months	Mean	WQO	N. Samples	N. Months	Median	WQO
E.C.IPZ	12	4	0.0010	0.009	ND	ND	ND	ND	ND	ND	ND	ND	12	4	0.0025	0.03
E.C.OPZ	34	11	0.0015	0.009	ND	ND	ND	ND	ND	ND	ND	ND	26	11	0.0050	0.03
O.C.IPZ	4	4	0.0010	0.009	ND	ND	ND	ND	ND	ND	ND	ND	4	4	0.0025	0.03
O.C.OPZ	NA	NA	NA	0.002	ND	ND	ND	ND	ND	ND	ND	ND	8	4	0.0025	0.02
Mag. Is.	9	7	0.0016	0.001	9	7	0.0381	0.021	9	7	0.0035	0.0028	ND	ND	ND	ND
E.C.W	24	12	0.0001	0.003	ND	ND	ND	ND	ND	ND	ND	ND	24	12	0.0025	0.02
O.C.W	9	7	0.0007	0.002	9	7	0.0277	0.02	9	7	0.0027	0.0028	ND	ND	ND	ND
Mid	9	7	0.0009	0.002	9	7	0.0301	0.02	9	7	0.0023	0.0028	ND	ND	ND	ND

Key: = Mean/Median is lower than the guideline value | = Mean/Median is higher than the guideline value | ND = No Data | NA = Not Applicable (data available but not usable).

Appendix WW. Inshore Marine Water Quality Nutrient: Scores Historic Comparison

Table 94. Townsville Dry Tropics inshore marine environment historic nutrient indicator scores.

Zone	Sub Zone	Area	NOX				PN				PP				TP			
			22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20
Cleveland Bay	Enclosed Coastal	E.C.IPZ	100	100	100	100	ND	ND	ND	ND	ND	ND	ND	ND	100	100	100	100
		E.C.OPZ	100	100	94	94	ND	ND	ND	ND	ND	ND	ND	ND	100	100	16	16
			100	100	97	97	ND	ND	ND	ND	ND	ND	ND	ND	100	100	58	58
	Open Coastal	O.C.IPZ	100	100	100	100	ND	ND	ND	ND	ND	ND	ND	ND	100	100	100	100
		O.C.OPZ	NA	100	100	NA	ND	ND	ND	ND	ND	ND	ND	ND	100	100	100	100
			100	100	100	100	ND	ND	ND	ND	ND	ND	ND	ND	100	100	100	100
	Magnetic Island	Mag. Is.	19	23	0	4	8	3	23	13	40	36	55	29	ND	ND	ND	ND
			79	80	73	74	8	3	23	13	40	36	55	29	100	100	79	79
Halifax Bay	Enclosed Coastal	E.C.W	100	100	100	ND	ND	ND	ND	ND	ND	ND	ND	ND	100	100	100	ND
	Open Coastal	O.C.W	100	97	75	36	32	18	33	0	63	76	38	66	ND	ND	ND	ND
	Midshelf	Midshelf	100	55	94	19	25	32	27	0	71	82	73	64	ND	ND	ND	ND
			100	84	90	28	29	25	30	0	67	79	55	65	100	100	100	ND

Standardised scoring range: ■ Very Poor (E) = 0 to <21 | ■ Poor (D) = 21 to <41 | ■ Moderate (C) = 41 to <61 | ■ Good (B) = 61 to <81 | ■ Very Good (A) = 81 – 100 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

Appendix XX. Inshore Marine Water Quality Phys-Chem and Chlorophyll α : Sample Frequencies, Means, Medians, and WQOs

Table 95. Number of samples, mean, median, and water quality objective values for physical-chemical properties and Chlorophyll α indicators in the Townsville Dry Tropics Inshore Marine Environment.

Area	Turbidity (NTU)				TSS (mg/L)				Secchi (m) ¹⁰				Chlorophyll α			
	N. Samples	N. Months	Median	WQO	N. Samples	N. Months	Mean	WQO	N. Samples	N. Months	Mean	WQO	N. Samples	N. Months	Mean	WQO
E.C.IPZ	12	4	7.100	4.9	12	4	14.167	22	12	4	0.989	1	ND	ND	ND	ND
E.C.OPZ	24	11	13.950	4.9	25	11	29.840	15	3	3	1.053	1	21	11	1.531	2.6
O.C.IPZ	4	4	4.450	4.9	4	4	26.500	22	4	4	1.219	1	ND	ND	ND	ND
O.C.OPZ	312	12	4.257	3	8	4	19.187	10	7	4	1.109	3	ND	ND	ND	ND
Mag. Is.	387	10	1.640	2.7	9	7	1.471	3.7	9	7	4.600	3	295	11	0.559	0.84
E.C.W	20	10	3.702	6	24	12	9.146	15	ND	ND	ND	ND	24	12	0.646	2
O.C.W	352	12	1.019	1.5	9	7	1.271	2	9	7	5.722	10	361	12	0.450	0.45
Mid	305	12	0.567	1.5	9	7	0.777	2	9	7	7.956	10	314	12	0.551	0.45

Key: = Mean/Median is lower than the guideline value | = Mean/Median is higher than the guideline value | ND = No Data | NA = Not Applicable (data available but not usable).

¹⁰ The secchi depth indicator operates inversely to all other indicators. I.e., a “good” value is one that is above the guideline value, as this shows greater water clarity.

Appendix YY. Inshore Marine Water Quality Physical-Chemical Properties and Chlorophyll *a* Historic Comparison

Table 96. Townsville Dry Tropics inshore marine environment historic physical-chemical and Chlorophyll *a* indicator scores.

Zone	Sub Zone	Area	Turbidity				TSS				Secchi				Chlorophyll <i>a</i>			
			22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20
Cleveland Bay	Enclosed Coastal	E.C.IPZ	28	100	89	74	85	100	85	100	60	92	93	78	ND	ND	ND	ND
		E.C.OPZ	0	0	0	0	0	3	20	14	63	83	100	78	90	81	63	100
			14	50	44	37	43	51	52	57	62	87	96	78	90	81	63	100
	Open Coastal	O.C.IPZ	66	100	100	100	44	100	98	100	72	100	100	100	ND	ND	ND	ND
		O.C.OPZ	30	38	15	63	3	54	76	81	0	39	56	47	ND	ND	ND	ND
			48	69	57	81	24	77	87	90	36	69	78	73	ND	ND	ND	ND
	Magnetic Island	Mag. Is.	89	77	73	78	100	85	85	100	85	80	83	77	84	83	83	80
			42	65	58	63	46	71	73	79	56	78	86	76	87	82	73	90
Halifax Bay	Enclosed Coastal	E.C.W	88	58	100	ND	88	74	84	ND	ND	ND	ND	ND	100	100	100	ND
	Open Coastal	O.C.W	82	77	73	89	86	72	63	92	11	6	29	6	61	74	69	66
	Midshelf	Midshelf	100	100	93	100	100	77	92	100	41	30	21	1	43	53	60	69
			90	78	88	94	91	74	80	96	26	18	25	3	68	76	76	68

Standardised scoring range: ■ Very Poor (E) = 0 to <21 | ■ Poor (D) = 21 to <41 | ■ Moderate (C) = 41 to <61 | ■ Good (B) = 61 to <81 | ■ Very Good (A) = 81 – 100 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

Appendix ZZ. Inshore Marine Water Quality Sub Basin Historic Scores

Table 97. A comparison of nutrient and physical chemical properties indicator category scores, and the water quality index scores, for inshore sub zones between years.

Sub Zone	Nutrients				Phys-Chem				Chla				Water Quality			
	22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20	22-23	21-22	20-21	19-20
CB.Enclosed Coastal	100	100	77	77	39	63	64	57	90	81	64	100	76	81	68	78
CB.Open Coastal	100	100	100	100	36	72	74	82	ND	ND	ND	ND	68	86	87	91
Magnetic Island	22	20	26	16	91	79	80	85	84	83	83	80	66	61	63	60
HB.Enclosed Coastal	100	100	100	34	88	65	92	62	100	100	100	67	96	88	97	54
HB.Open Coastal	65	64	49	28	60	49	55	67	61	75	69	69	62	62	58	54
Midshelf	65	56	65	77	80	61	68	57	43	53	61	100	63	57	64	78

Appendix AAA. Inshore Marine Water Quality 2021–2022 Boxplots

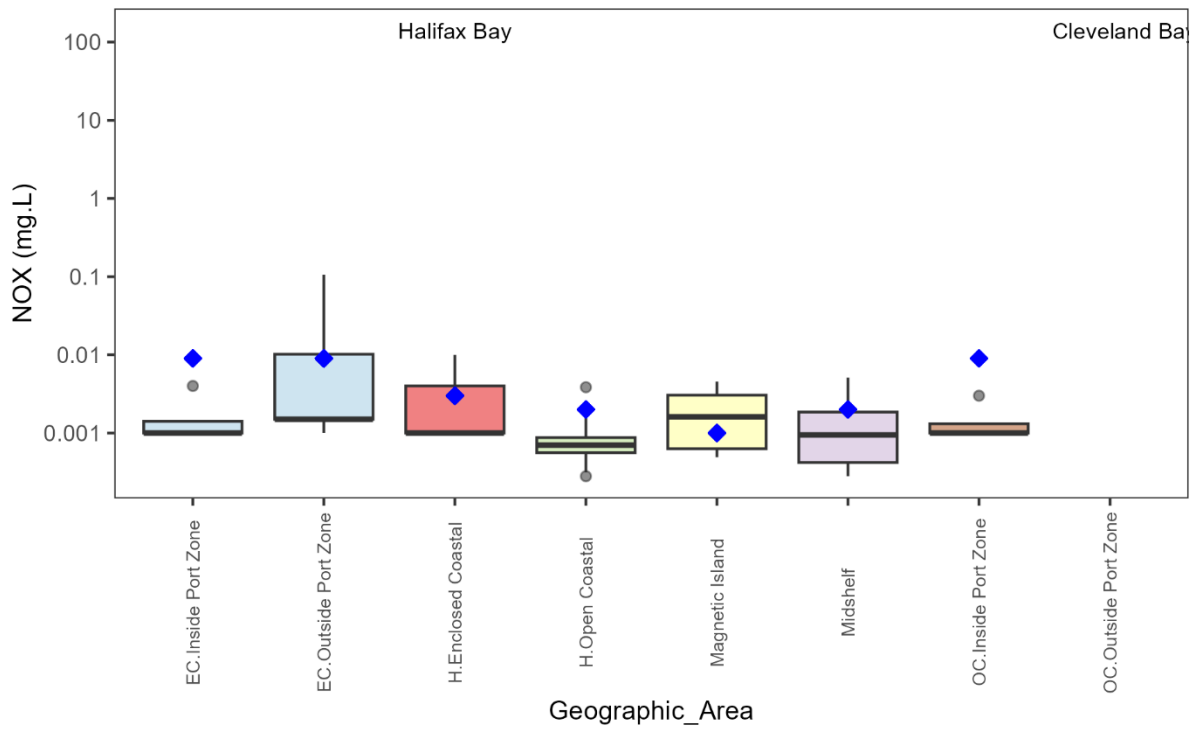


Figure 79. Nitrogen Oxides (NOX) (mg/L) Boxplot: blue diamonds indicate the water quality objective.

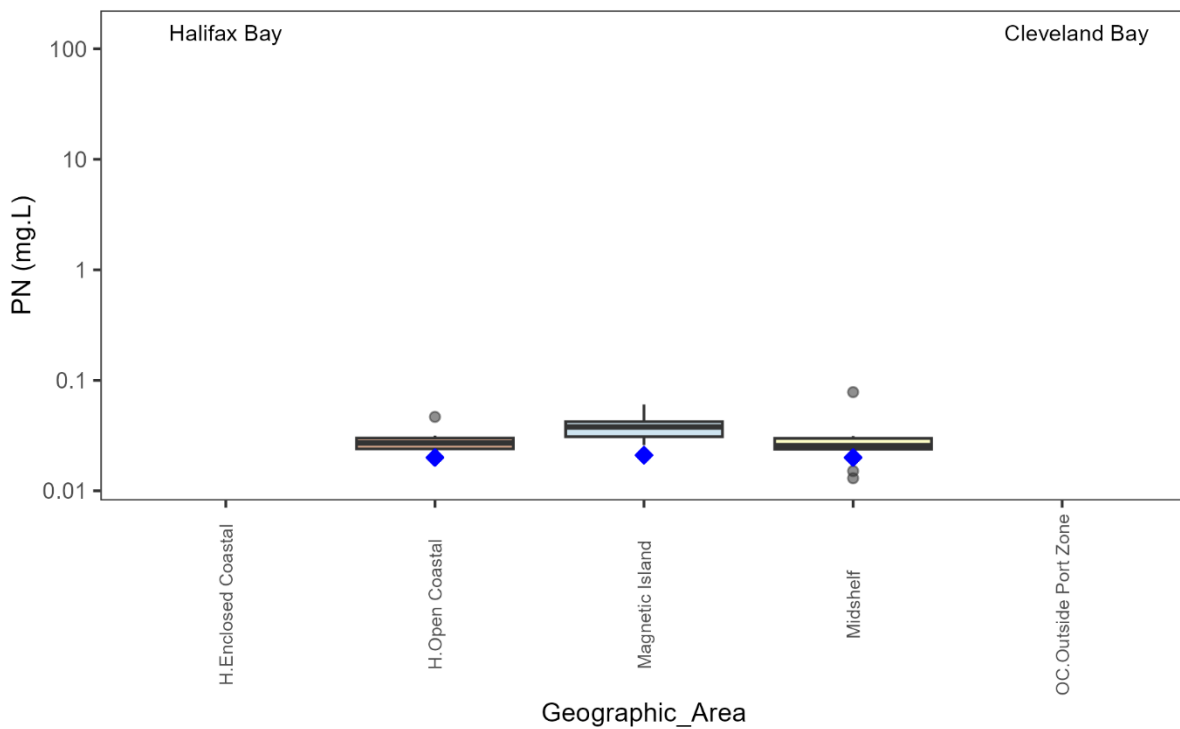


Figure 78. Particulate Nitrogen (PN) (mg/L) Boxplot: blue diamonds indicate the water quality objective.

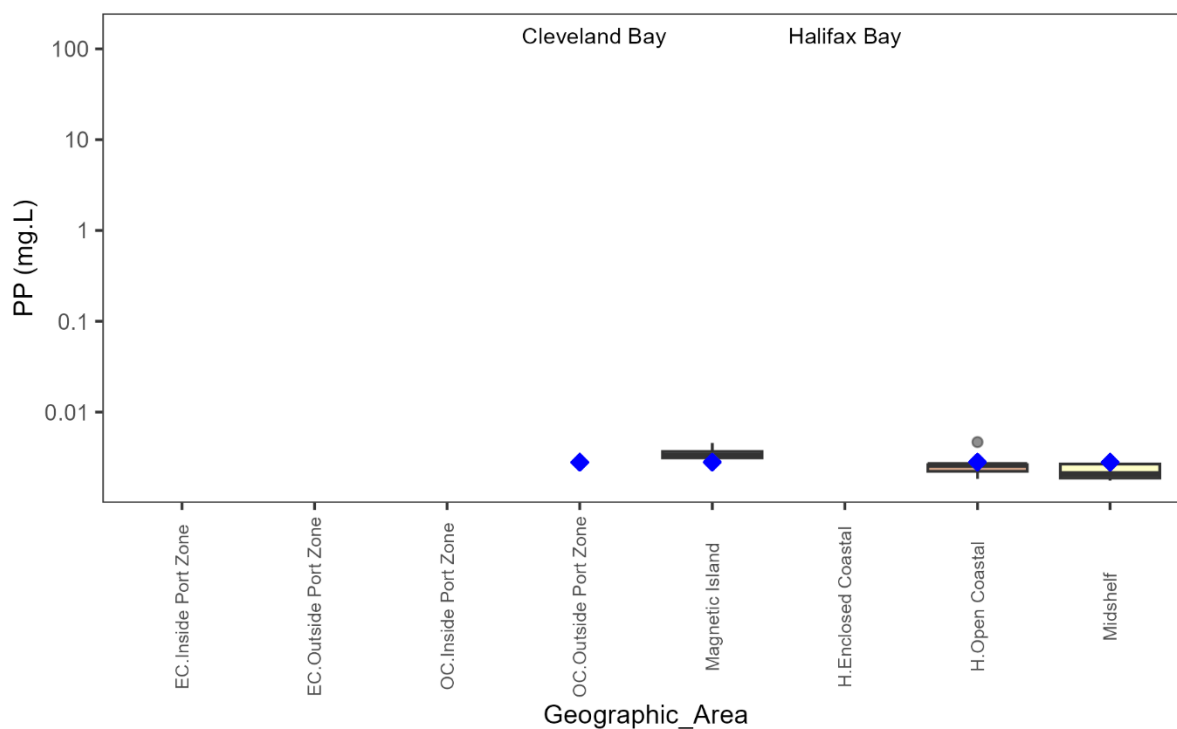


Figure 80. Particulate Phosphorus (PP) (mg/L) Boxplot: blue diamonds indicate the water quality objective.

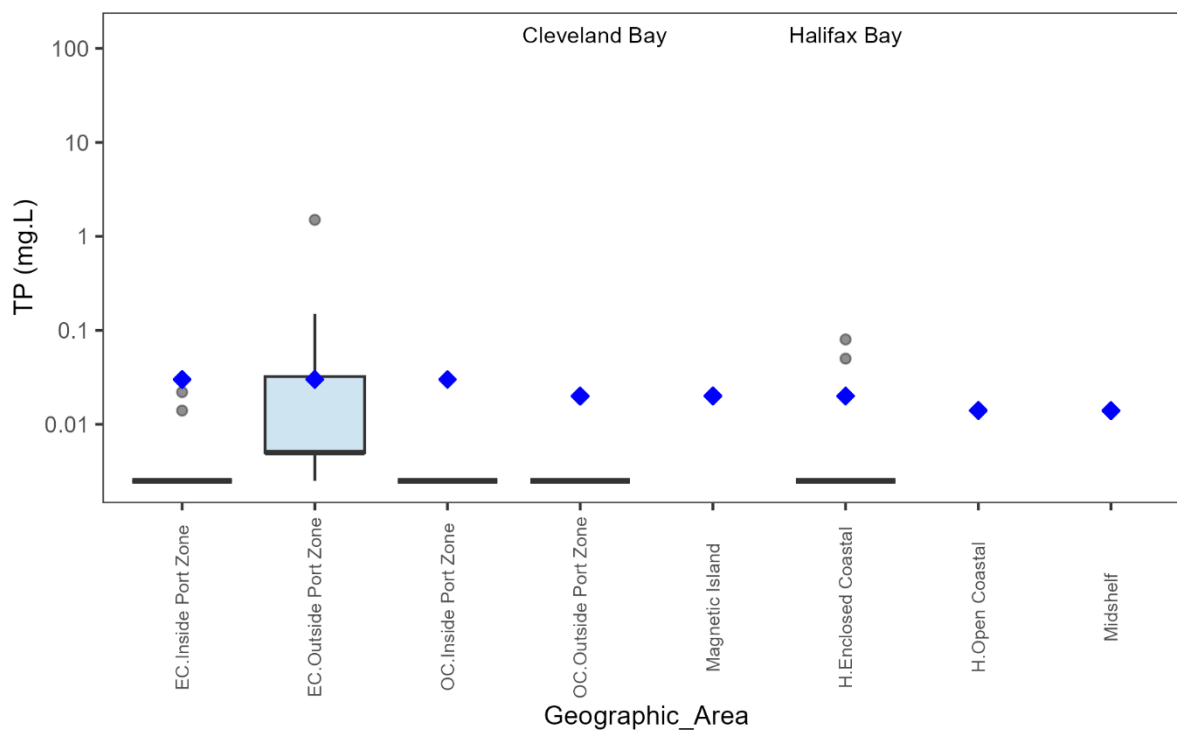


Figure 81. Total Phosphorus (TP) (mg/L) Boxplot: blue diamonds indicate the water quality objective.

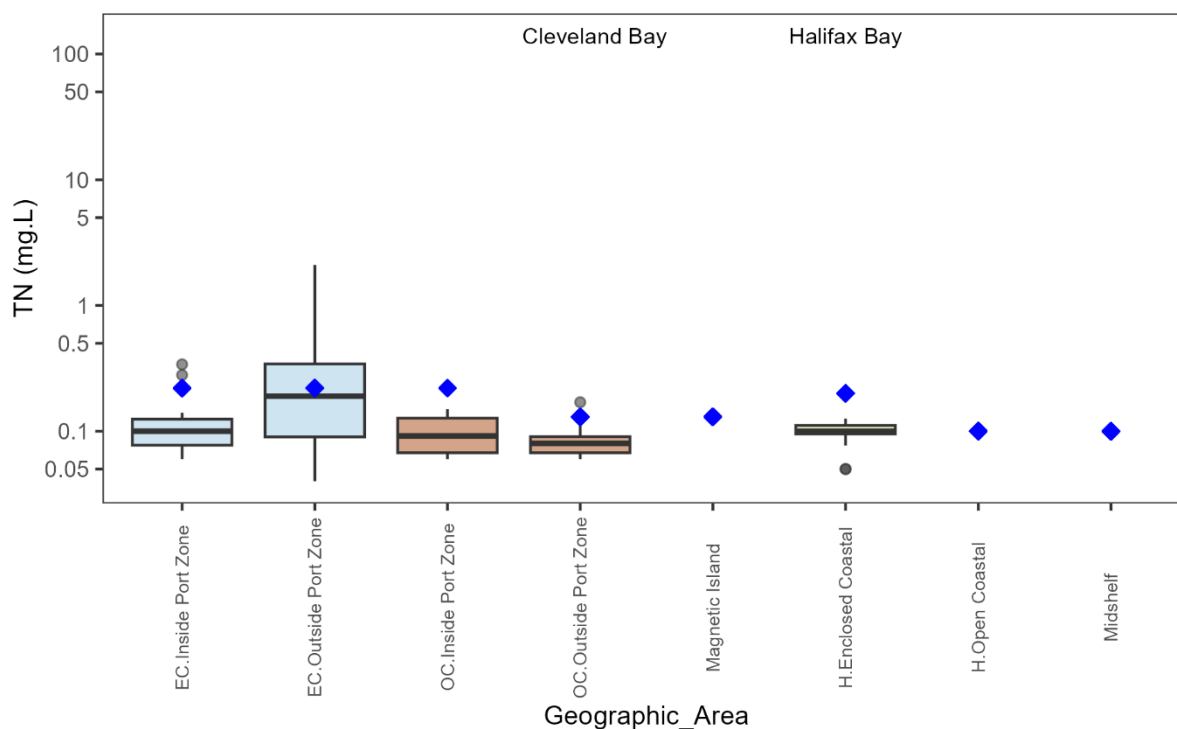


Figure 83. Total Nitrogen (TN) (mg/L) Boxplot: blue diamonds indicate the water quality objective.

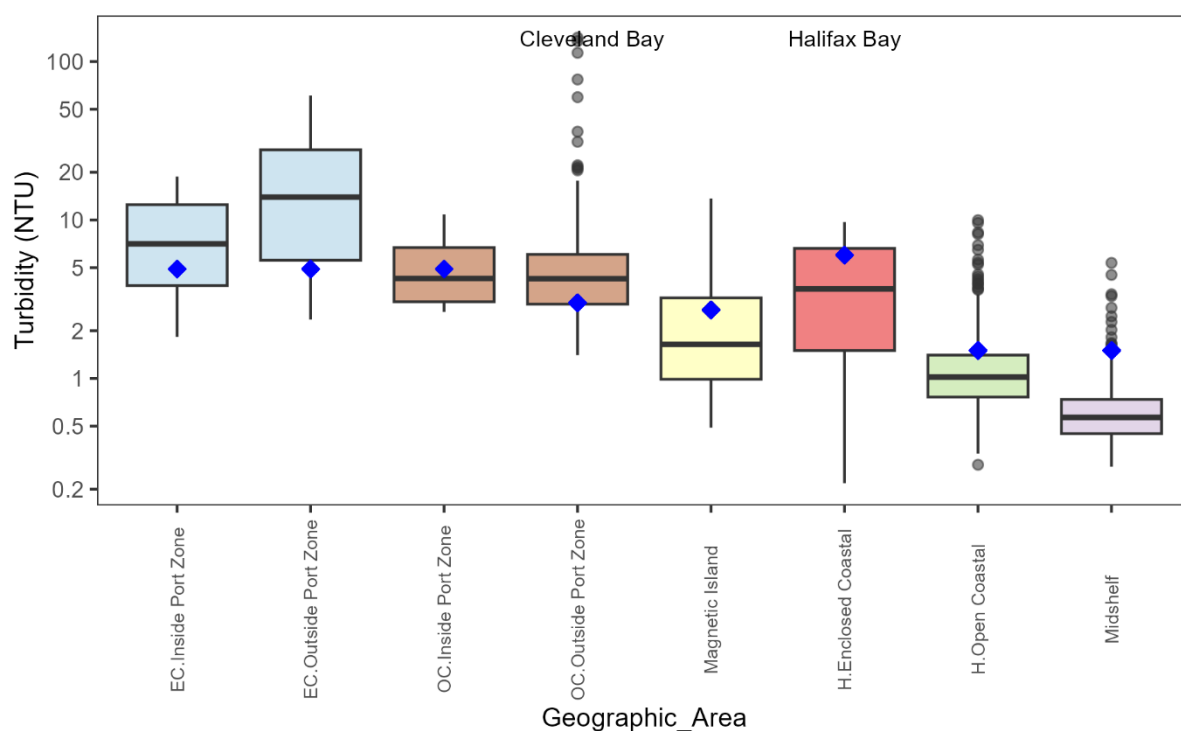


Figure 82. Turbidity (NTU) Boxplot: blue diamonds indicate the water quality objective.

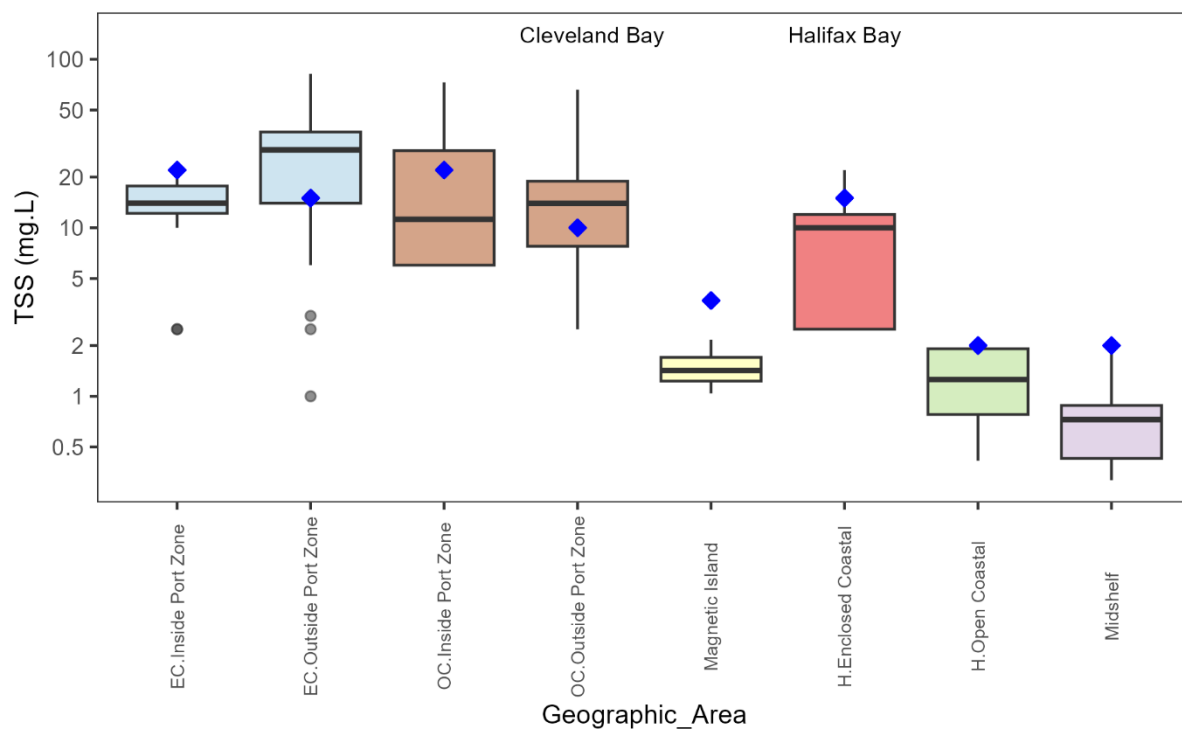


Figure 85. Total Suspended Solids (TSS) (mg/L) Boxplot: blue diamonds indicate the water quality objective.

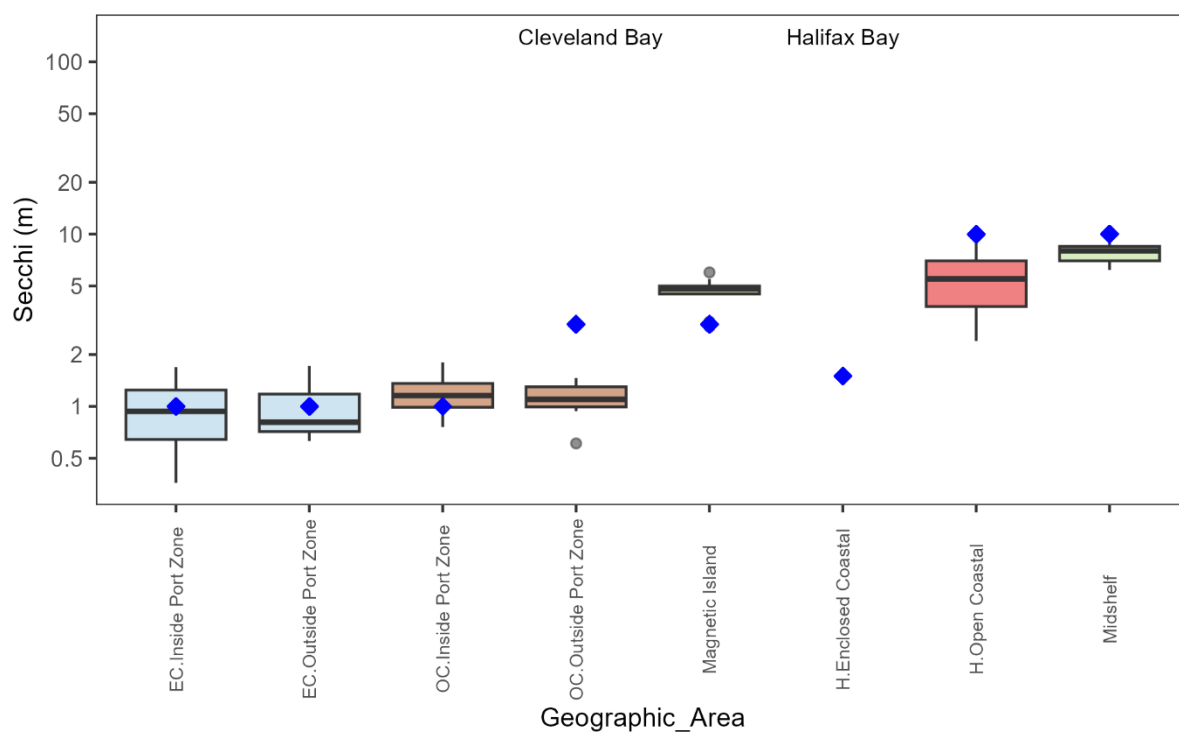


Figure 84. Secchi Depth (m) Boxplot: blue diamonds indicate the water quality objective.

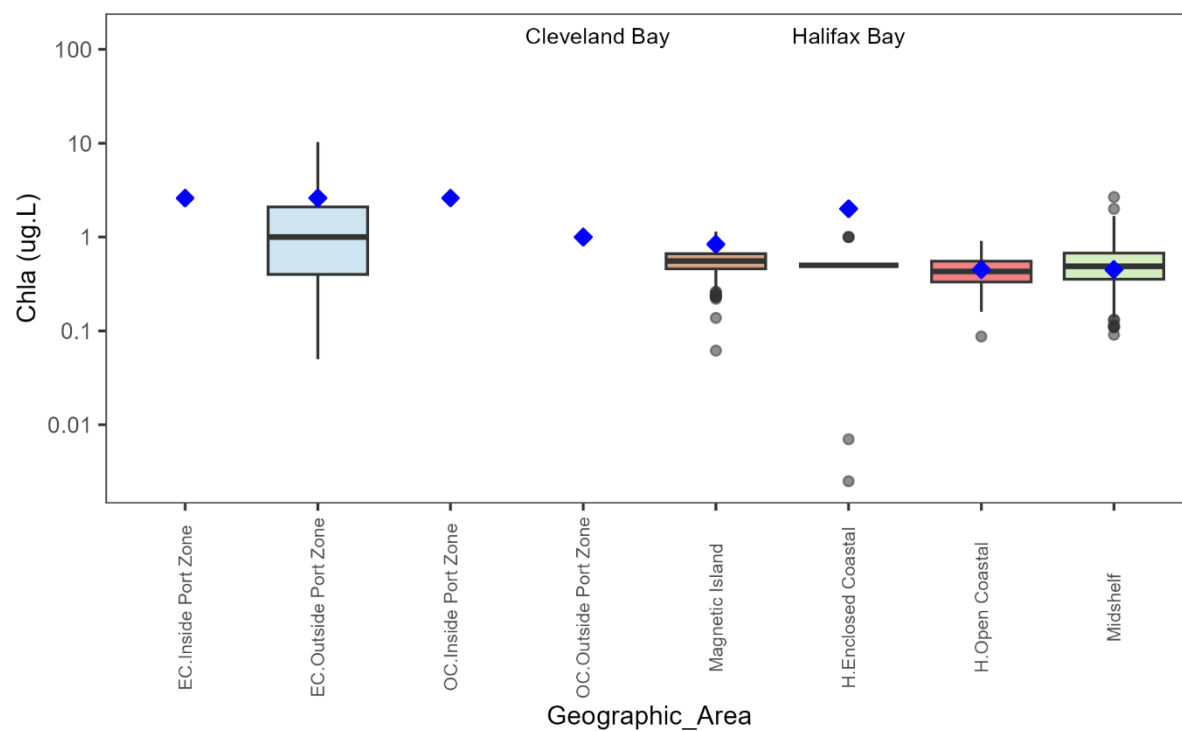


Figure 86. Chlorophyll a) Boxplot: blue diamonds indicate the water quality objective.

Appendix BBB. Inshore Marine Water Quality Line Plots

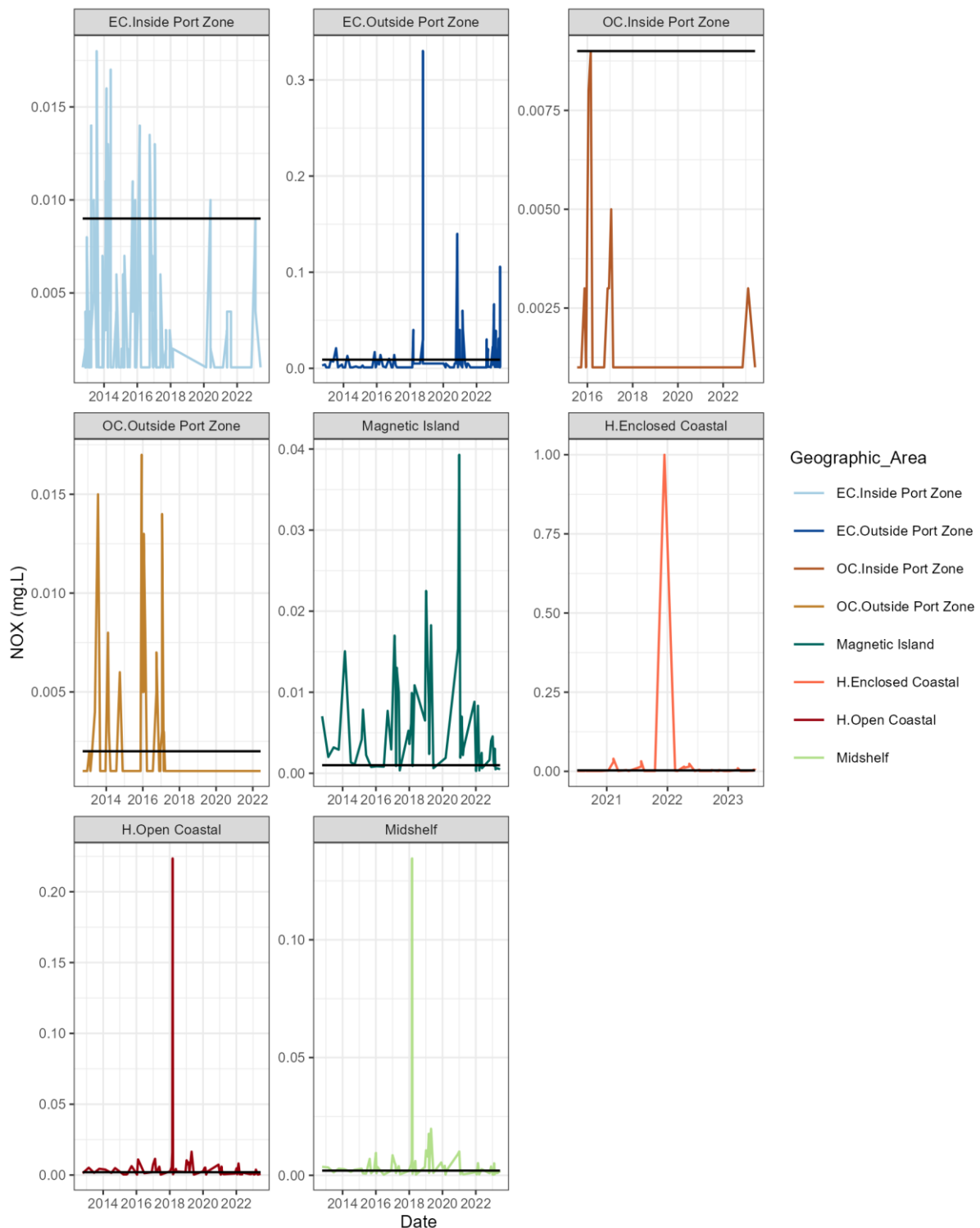


Figure 87. Dry Tropics inshore marine water quality line plots: NOx. The black line indicates water quality guidelines.

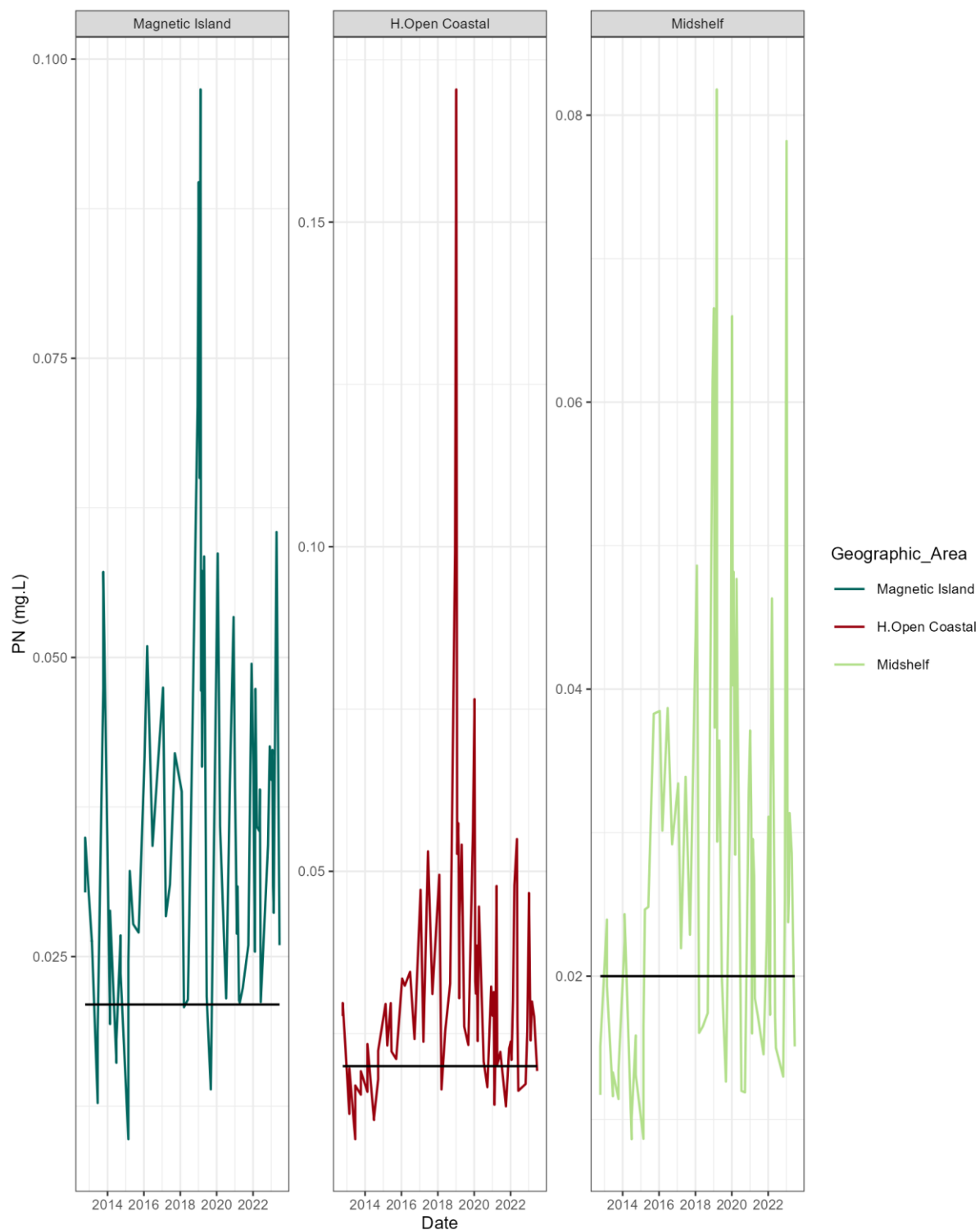


Figure 88. Dry Tropics inshore marine water quality line plots: PN. The black line indicates water quality guidelines.

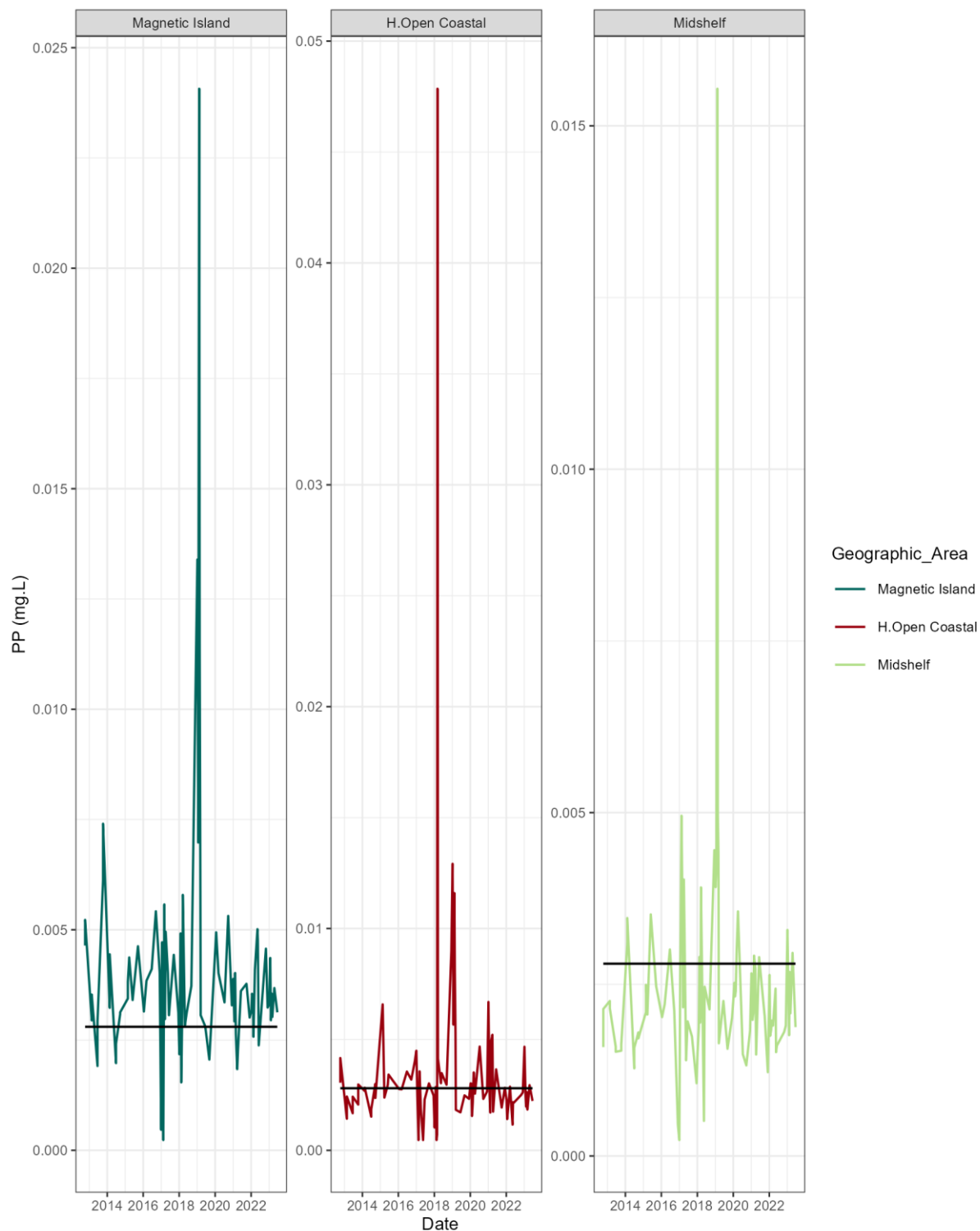


Figure 89. Dry Tropics inshore marine water quality line plots: PP. The black line indicates water quality guidelines.

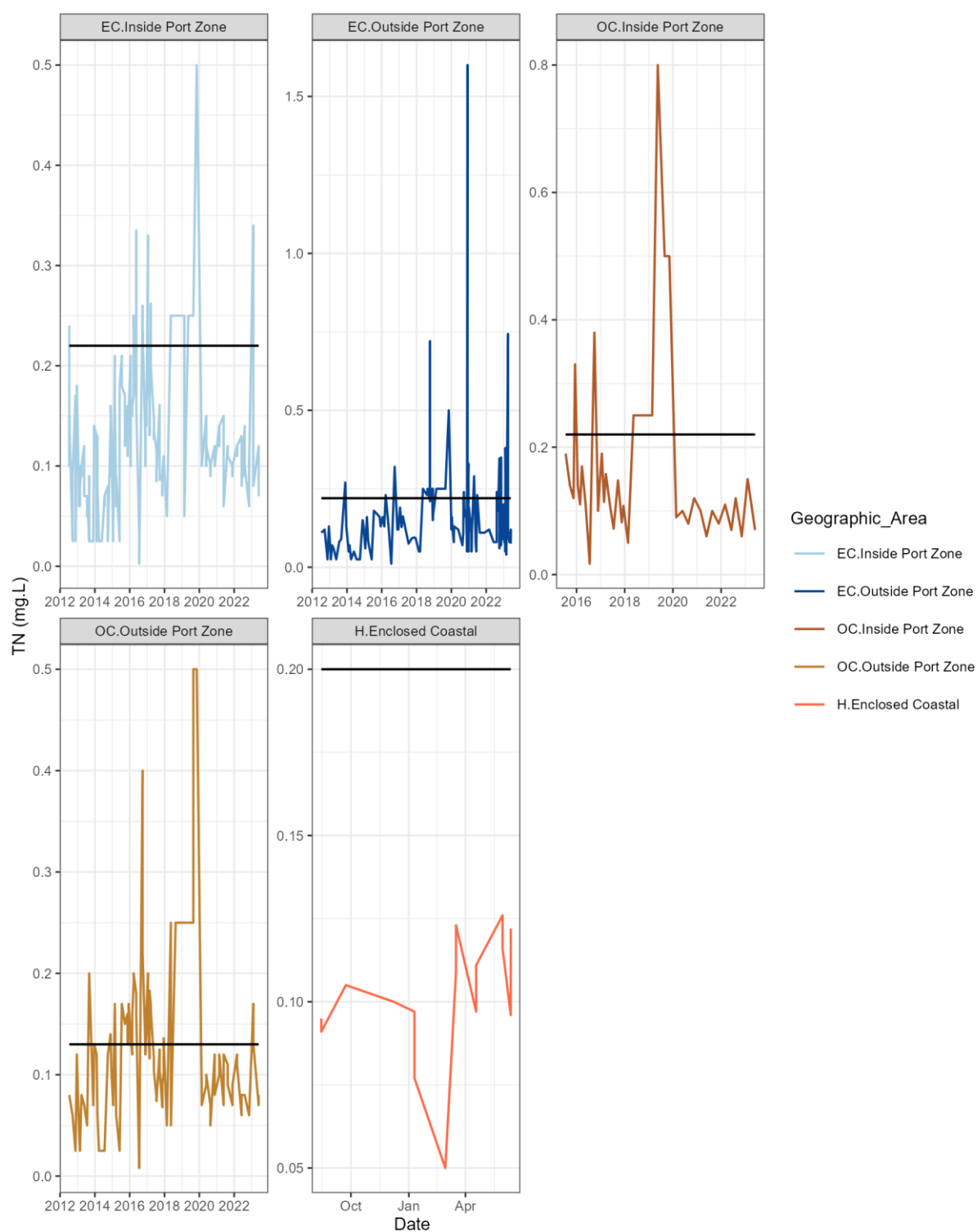


Figure 90. Dry Tropics inshore marine water quality line plots: TN. The black line indicates water quality guidelines.

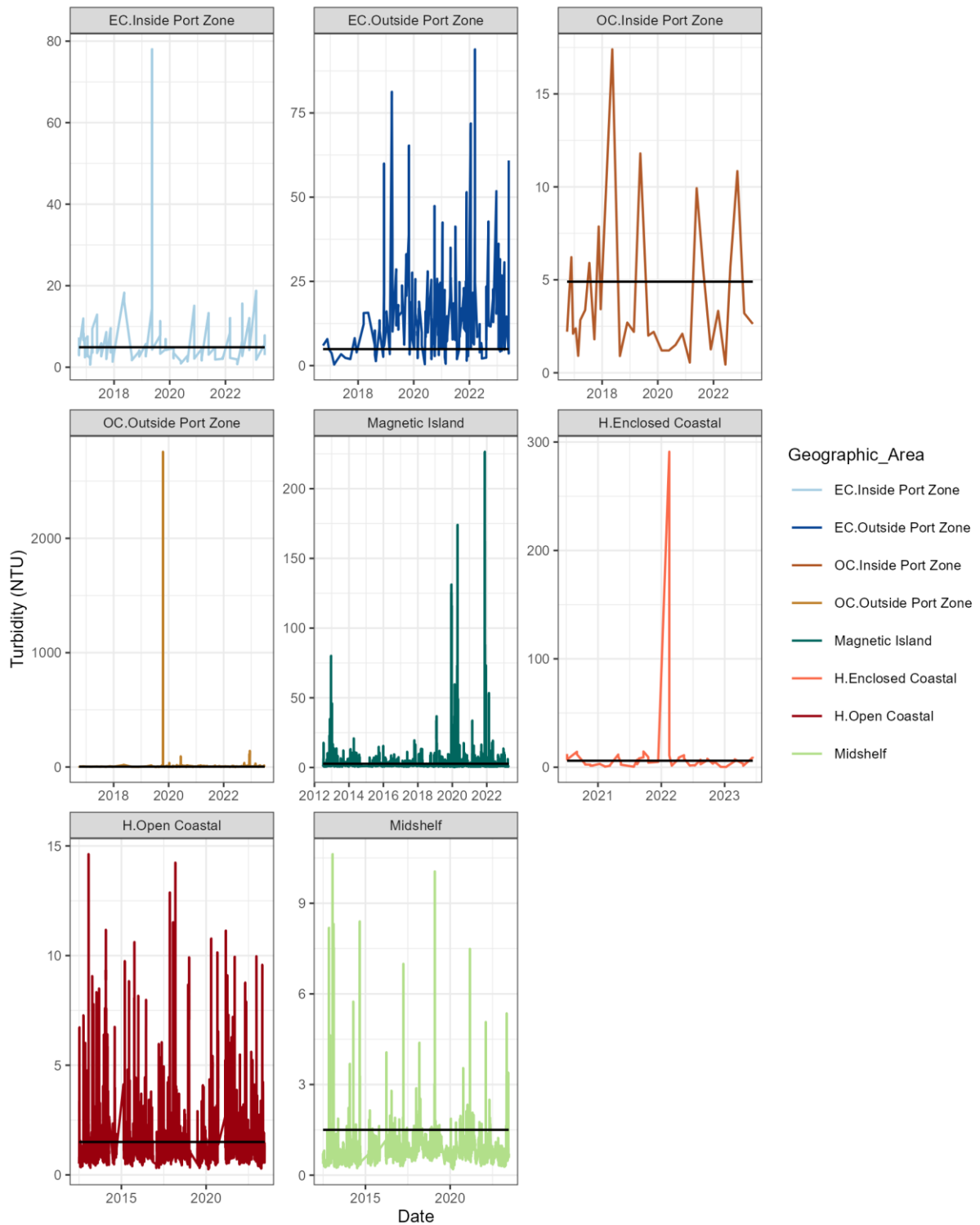


Figure 91. Dry Tropics inshore marine water quality line plots: NTU. The black line indicates water quality guidelines.

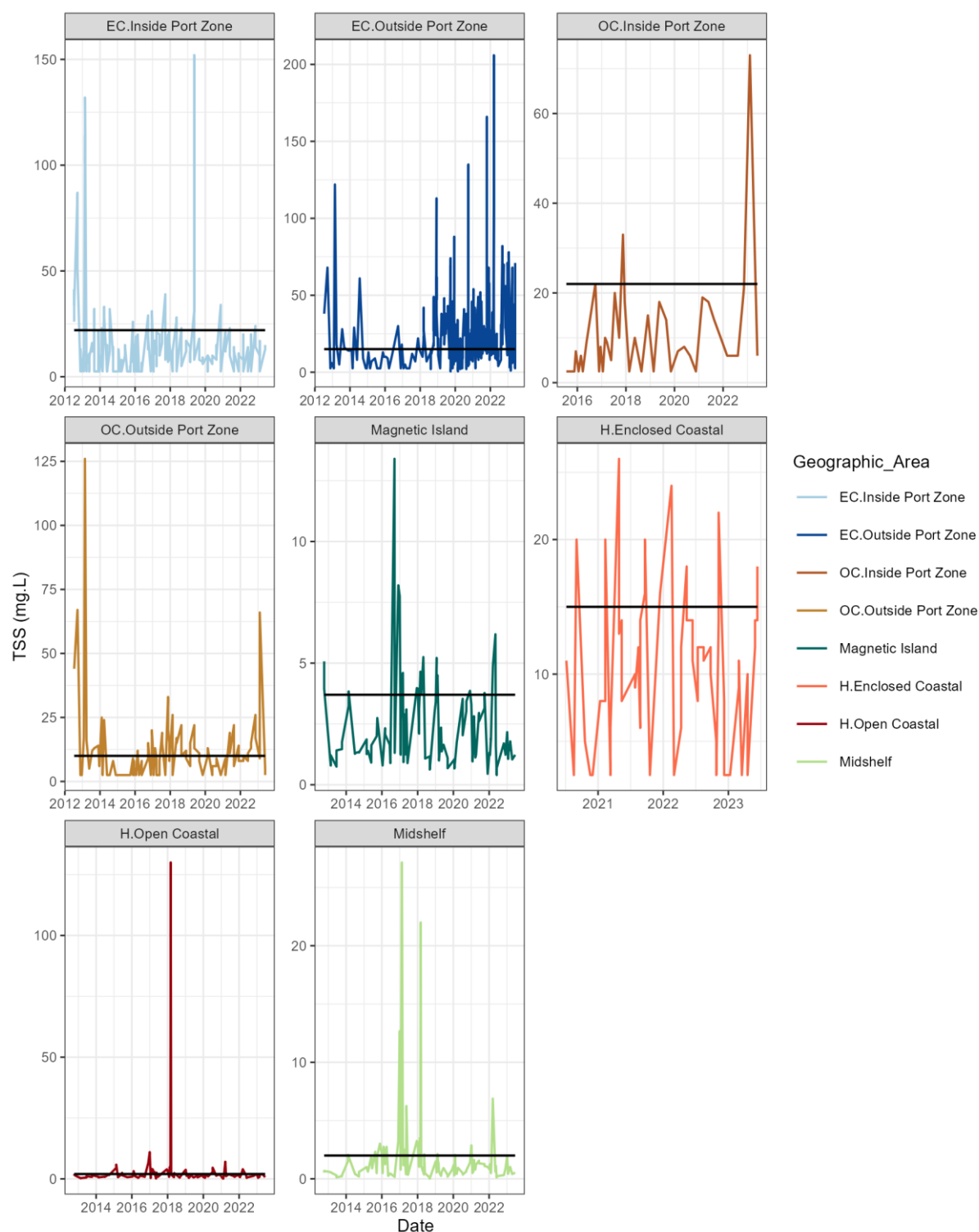


Figure 92. Dry Tropics inshore marine water quality line plots: TSS. The black line indicates water quality guidelines.

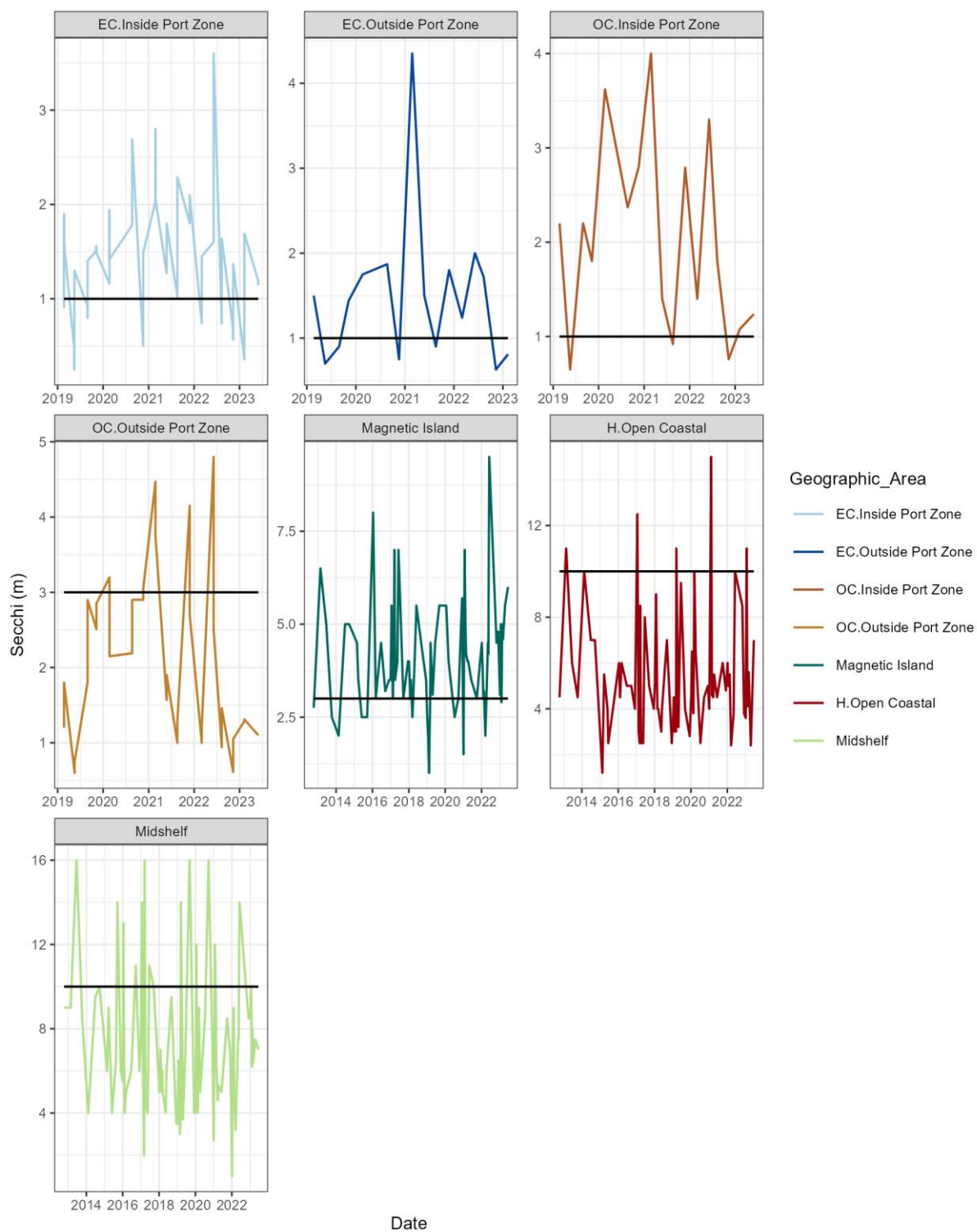


Figure 93. Dry Tropics inshore marine water quality line plots: Secchi. The black line indicates water quality guidelines.

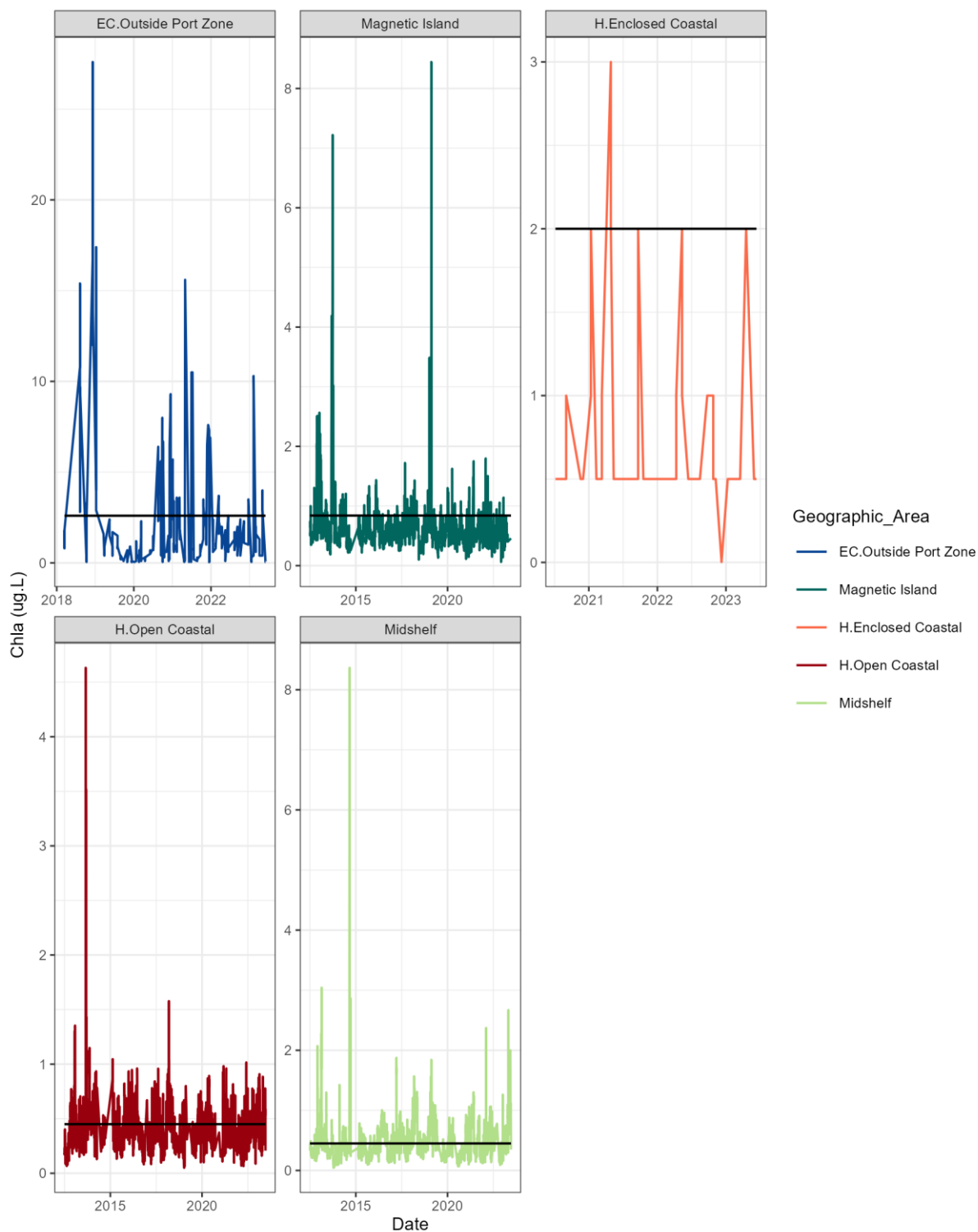


Figure 94. Dry Tropics inshore marine water quality line plots: Chl a. The black line indicates water quality guidelines.

Appendix CCC. Overlap of Dry Tropics and Wet Tropics Sampling Sites

Table 98. Comparison between the Dry Tropics and Wet Tropics inshore marine water quality (nutrient indicator category) scores .

Region	Zone	Sub Zone	Area	NOx	PN	PP	TP	Nutrients	Zone Nutrients
Dry Tropics	Halifax Bay	Enclosed Coastal	Enclosed Coastal	100	ND	ND	100	100	77
		Open Coastal	Open Coastal	100	32	63	ND	65	
		Midshelf	Midshelf	100	25	71	ND	65	
				100	29	67	100	77	
Wet Tropics	Palm Island	NA	NA	84	29	67	ND	63	63

Table 99 Comparison between the Dry Tropics and Wet Tropics inshore marine water quality (physical-chemical properties indicator category) scores.

Region	Zone	Sub Zone	Area	Turbidity	TSS	Secchi	Phys Chem	Zone Phys Chem
Dry Tropics	Halifax Bay	Enclosed Coastal	Enclosed Coastal	88	88	ND	88	76
		Open Coastal	Open Coastal	82	86	11	60	
		Midshelf	Midshelf	100	100	41	80	
				90	91	26	76	
Wet Tropics	Palm Island	NA	NA	83	93	ND	87	87

Appendix DDD. Report Change Log

The table below lists section number, page and paragraph number, and summary of updates for the 2022–2023 technical report to assist reviewers.

The theme of this years change log is refinement and efficiency.

Section	Page Number	Details
Header	NA	Logo changed from old Dry Tropics Partnership for Healthy Waters (DTPHW) logo to new Healthy Waters Partnership for the Dry Tropics (HWP) logo.
Footer	NA	Dates. Name changed from “Dry Tropics Partnership for Healthy Waters” to “Healthy Waters Partnership for the Dry Tropics”
Throughout Doc	NA	Change log key table added (temporary – removed for final publication). “Dry Tropics” changed to “Townsville Dry Tropics” to clarify the region in which the report is focused.
Front Cover	i	Dates. Reporting capitalised. Logo changed to new (HWP) logo.
1. General	ii	NA
1.1 Authorship Statement	ii	Dates. Partnership name changed.
1.2 Current DTPHW Members	ii	Update member details: Cinzia Cattaneo (MWI), Martine Newman (WT) , Reiner Mann (DESI), Travis Sydes (FNQROC), Nicole Flint (CQU), Tyson Schmid (TCC) added. Carl Mitchell (DESI), Michael Newham (DESI), Elaine Glen (POTL), Adam King (TCC) removed. All DES acronyms changed to DESI.
1.3 Acknowledgements	iii.	NA
2. Executive Summary	iv	Mention of dates removed (generalise sentence). “Climate” changed to “climate and land use”. Specification of environments removed (rather than listing all environments one by one, just state “each environment”).
2.1 The Dry Tropics Partnership	iv-v	Dates. Change “Management Response” to “Stewardship”. Table updated to include new year.
2.2 Climate and Land use in the Dry Tropics Region	vi	The sentence that summarised the key dot points that followed was removed. Dates. Values (e.g., mm of rainfall, degrees). LTM calculation (more detail in climate section).

Section	Page Number	Details
2.3 State and Condition of the Environment	vi-vii	Table updated with latest year of data.
2.3.1 Freshwater Environment	vii-xi	Tables updated with 2022-2023 results. Key Messages added for all indices. Pesticides added for the first time.
2.3.2 Estuarine Environment	ix-x	Tables updated with 2022-2023 results. Key Messages added for all indices.
2.3.3 Inshore Marine Environment	x-xi	Tables updated with 2022-2023 results. Key Messages added for all indices.
2.3.4 Offshore Marine Environment	xi	Tables updated with 2022-2023 results. Key Messages added for all indices.
2.3.5 Litter	xi-xiii	Tables updated with 2022-2023 results. Key Messages added for the index.
Table of Contents	xiv-xv	NA
4. Glossary of Terms	xvi-xx	NA
5. Table of Tables	xxi-xxiv	NA
6. Table of Figures	xxv-xxx	NA
7. Introduction	1	NA
7.1 Overview	1	Dates. Change “Management Response” to “Stewardship”. Table updated to include new year.
7.2 Report Card Zones	1-3	Dates. New Digital Elevation Model added (figure 3).
7.3 Purpose of This Document	3	Dates.
7.4 Report Card History	3	Removed. Sentence directing the reader to the Methods document to find the removed material.
8. Methods	3	Dates.
8.1 Terminology and Aggregation	3-5	Paragraph simplified. Table expanded to include all indicators.
8.2 Scoring	5	NA
8.3 Presentation	5-6	NA
8.4 Confidence Measure	6	Paragraph simplified.
8.5 Objectives/Measures/Baselines for Scoring Data	NA	Section removed. Reasoning: it is not necessary to understand the technical report. Further, the type of objective is clarified within each section.
Environmental Stressors Page divider	7	Dates. Names.

Section	Page Number	Details
9. Environmental Stressors in the Townsville Dry Tropics Region	8	Dates. Values/descriptions of stressors.
9.1 Land Use	9-10	Table 16 simplified to only show current year. Additional land use types provided (e.g., mining separated from urban use) for Table 16 and Figure 5. Link to data source removed (this detail is in the methods).
9.2 Climate	11	Dates. The sentence that summarised the key dot points that followed was removed.
9.2.1 Rainfall	11-14	Link to data source removed (this is in the methods). Values (e.g., mm of rainfall). Figures divided into separate basins (previous was the Dry Tropics overall). LTM now based on 1991-2020 data. Monthly line plots added.
9.2.2 Air Temperature	15-18	Link to data source removed (this is in the methods). Values (e.g., degrees). Figures divided into separate basins (previous was the Dry Tropics overall). LTM now based on 1911-1940 data. Monthly line plots added.
9.2.3 Sea Surface Temperature	19-20	Link to data source removed (this is in the methods). Values (e.g., degrees). LTM now based on 1991-2020 data. Monthly line plots added.
9.2.4 Degree Heating Weeks (Coral Bleaching)	21	Link to data source removed (this is in the methods). Values (e.g., DHWs). Section name changed from “Coral Bleaching (Degree Heating Weeks)” to “Degree Heating Weeks (Coral Bleaching)”
9.3 Climate Summary	NA	Section removed from here and added to section “9 Climate and Land Use in the Townsville Dry Tropics Region”.
Freshwater Page divider	22	Dates. Names.
10 Freshwater Environment	23	Text updated to include pesticides.

Section	Page Number	Details
10.1 Water Quality	23	Update year on methods doc reference
10.1.1 Monitoring Sites	23-25	Update number of sites (although no new sites were added, the wrong number of sites were written in the text last year). Updated table formatting and included missing sites (codes).
10.1.2 Overall Summary: Freshwater Quality	25-26	Text updated. Table updated with new results. Key messages updated.
10.1.3 Nutrients	26-27	Comparison of FRP removed, and instead simply note that the comparison of FRP is ongoing. Results text updated. Table updated with new results.
10.1.4 Physical-Chemical Properties	28-29	Results text updated. Table updated with new results.
10.1.5 Confidence Scores	30	NA
10.2 Pesticides	31	Entirely new section, all subsequent components new.
10.2.1 Monitoring Sites	31	New
10.2.2 Overall Summary: Pesticides	31	New
10.2.3 Results: Pesticides	32	New
10.2.4 Confidence Scores	33	New
10.3 Habitat and Hydrology	34	Link to data source removed (this is in the methods). Description simplified.
10.3.1 Overall Summary: Freshwater Habitat and Hydrology	34	Dates. Values (scores, grades). Key messages.
10.3.2 Freshwater Riparian Extent	34	Acknowledge latest update of data. Acknowledge subbasin calculations.
10.3.2.1 Monitoring Sites	35	New maps created. Link to data source, and description of data removed (this is in the methods).
10.3.2.2 Results: Freshwater Riparian Extent	35-36	Mention of method of score calculation removed (is in methods). Dates. Text that simply repeats information in table significantly cut down.
10.3.3 Freshwater Wetland Extent	36	Acknowledge subbasin calculations.

Section	Page Number	Details
10.3.3.1 Monitoring Sites.	36	New maps created. Link to data source, and description of data removed (this is in the methods).
10.3.3.2 Results: Freshwater Wetland Extent	36-37	Mention of method of score calculation removed (is in methods). Dates. Text that simply repeats information in table significantly cut down.
10.3.3.3 Updated Wetlands Dataset	38	Entirely new section. Appendix items are new as well.
10.3.4 Artificial Barriers	38	Shorten. Question regarding next update for fish barriers.
10.3.4.1 Monitoring Sites.	38	New maps created. Link to data source, and description of data removed (this is in the methods).
10.3.4.1 Results: Artificial Barriers	38	Moved to the start of the section rather than the end. Descriptive text shortened.
10.3.4.2 Results: Freshwater Impoundment Length	38	Text that simply repeats information in table significantly cut down.
10.3.4.3 Results: Freshwater Fish Barriers	39	Definition of barriers removed (already in methods). Description of methodology removed. Scoring ranges for sub indicators removed (already present in methods, and sub indicator scores are not shown in the tech report).
10.3.5 Confidence Scores	40	Text shortened.
10.4 Fish	41	Dates.
10.4.1 Monitoring Sites	41	New Maps created. Description of site selection removed (is in methods).
10.4.2 Overall Summary: Freshwater Fish	41	New Summary Table added (now that we have two sets of data). Text shortened. Dates. Values (e.g., number of fish). Key Messages Updated. Remove species classification definitions as this can be found in the methods.
10.4.3 Proportion of Indigenous Species Expected	42	New section, separating the previous results into individual indicator categories.
10.4.3.1 Results: POISE	42	New section, allows for more clarity on indicator category results and meaning.

Section	Page Number	Details
10.4.4 Proportion of Non-Indigenous Species Expected	42	New section, separating the previous results into individual indicator categories.
10.4.4.1 Results: PONISE	43	New section, allows for more clarity on indicator category results and meaning.
10.4.5 Confidence Scores	43	NA
Estuarine Page divider	44	Dates. Names.
11 Estuarine Environment	45	Add new maps detailed sub basins like in WQ maps.
11.1 Water Quality	45	Dates.
11.1.1 Monitoring Sites	45—47	Dates.
11.1.2 Overall Summary: Estuarine Water Quality	47-48	Text and table updated with newest results.
11.1.3 Nutrients	48-49	Table updated with newest results. Results text updated with newest results.
11.1.4 Physical Chemical Properties	50-51	Table updated with newest results. Results text updated with newest results.
11.1.5 Confidence Scores	52	NA
11.2 Habitat	53	Dates. Link to data source, and description of data removed (this is in the methods).
11.2.1 Overall Summary: Estuarine Habitat	53	Dates. Values (scores, grades). Key Messages.
11.2.2 Mangrove and Saltmarsh Extent	53-54	Description of vegetation types removed (in methods).
11.2.2.1 Monitoring Sites	54	Text shortened. New maps (in appendix).
11.2.2.2 Results: Estuarine Mangroves and Saltmarsh	54-56	Text shortened. Dates. Values (e.g., ha of vegetation). New Table with sub basins included. New appendix tables with historic data.
11.2.3 Estuarine Riparian Extent	56	Clarification on methods source.
11.2.3.1 Monitoring Sites	56	Text shortened. New maps (in appendix).
11.2.3.2 Results: Estuarine Riparian Extent	56-57	Text shortened. Values (scores, grades). Tables re-ordered to save a page.
11.2.5 Confidence Scores	57	NA

Section	Page Number	Details
Inshore Page divider	58	Dates. Names.
12 Inshore Environment	59	NA
12.1 Water Quality	59	Dates.
12.1.1 Monitoring Sites	59-60	New Maps (figure 22).
12.1.2 Overall Summary: Estuarine Water Quality	61	Text and score updates. Table updated with latest year of data. Scores back calculated (see "Updated Methodology").
12.1.3 Updated Methodology	61	Entirely new section
12.1.4 Nutrients	61-63	Scores and text updated. Tables updated with latest year of data. Historic data (in appendix updated).
12.1.5 Physical Chemical Properties	64-65	Scores and text updated. Tables updated with latest year of data. Historic data (in appendix updated).
12.1.6 Chlorophyll a	66	Scores and text updated. Tables updated with latest year of data. Historic data (in appendix updated).
12.1.7 Overlap with the Wet Tropics Technical Report	66	NA (appendix updated).
12.1.8 Confidence Scores	67	NA
12.2 Habitat	68	NA
12.2.1 Overall Summary: Inshore Habitat	68	Text and scores updated. Tables updated with latest results. Key Messages updated with greater detail.
12.2.2 Coral	69	Text shortened. Outline of methods removed (this is in methods doc and in the original source material).
12.2.2.1 Monitoring Sites	69-71	Text shortened. Maps updated with new outline for "Palms West 1" reef – moved closer to actual location.
12.2.2.2 Results: Inshore Coral	71-72	Link to data removed (in methods).
12.2.3 Seagrass	72	Outline of sampling time removed (this is in methods doc and in the original source material).
12.2.3.1 Monitoring Sites	72-73	Description shortened. Maps updated with newest seagrass boundaries
12.2.3.2 Results	73-75	All text cut down to essentials (this text is already in the main seagrass report).
12.2.4 Confidence Scores	75	Text shortened.

Section	Page Number	Details
Offshore Page divider	76	Dates. Names.
13 Offshore Marine Environment	77	Add new maps detailing area.
13.1 Water Quality	77-78	Dates. Table updated.
13.1.1 Data Source	78	Entirely new section. Provided detailed explanation of the source/problems with data.
13.2 Habitat	78	Dates.
13.2.1 Overall Summary: Offshore Habitat	78	Text shortened. Values (Score), table updated. Key messages updated.
13.2.2 Coral	79	Dates of sampling updated.
13.2.2.1 Monitoring Sites	79	Text shortened.
13.2.2.2 Results: Offshore Coral	79-80	Text clarified, cleaned up, and references added. Values (scores and grades).
13.2.3 Confidence Scores	80	Text shortened.
Litter Page divider	81	Dates. Names.
14 Litter	82	text updated
14.1 Monitoring Sites	83	Text updated.
14.2 Comparison with previous years	83-85	Table and text updated
14.3 Key Messages	85	Text updated
14.4 Results	85-86	Table and text updated
14.5 Confidence Scores	86-87	No change
15. References	88	Removed references that are no longer used.
Appendices page divider	90	Dates. Names.
16. Appendices	91-167	NA
Appendix A. to G.		New climate graphs/maps
Appendix H.		Table updated with summary stats for latest year.
Appendix I.		2022-2023 DIN and TP scores added.
Appendix J.		Table updated with summary stats for latest year.
Appendix K.		2022-2023 Turbidity and High/Low DO scores added.
Appendix L. and M.		New freshwater box and line plots for latest results added.
Appendix N.		New pesticides sampling locations maps.

Section	Page Number	Details
Appendix O. to R.		New freshwater riparian maps/graphs
Appendix S. to V.		New freshwater wetlands maps/graphs
Appendix W.		New table showing effect of updated wetland data.
Appendix X. and Y.		NA
Appendix Z.		New fish sampling locations
Appendix AA. to CC.		New fish sampling data and plots
Appendix DD.		Summary stats tables updated with latest data
Appendix EE.		Historical results table updated with latest data
Appendix FF.		Summary stats tables updated with latest data
Appendix GG.		Historical results table updated with latest data
Appendix HH. and II.		New estuarine box and line plots with latest data.
Appendix JJ. to MM.		New estuarine mangrove and saltmarsh maps/graphs
Appendix NN. to QQ.		New estuarine riparian maps and graphs
Appendix RR.		Summary stats tables updated with latest data
Appendix SS.		Historical results table updated with latest data
Appendix TT.		Summary stats tables updated with latest data
Appendix UU.		Historical results table updated with latest data
Appendix VV. and WW.		New inshore box and line plots with latest data.
Appendix XX.		Values for DT and WT updated.
Appendix YY.		New table.