dry tropics partnership
for healthy waters

Dry Tropics Partnership for Healthy Waters
Waterways Report Card 2023

TECHNICAL REPORT
PART 3: Freshwater Results

Reporting on data collected 2021 - 2022

10 Freshwater Environment

Within the freshwater environment, water quality, habitat and hydrology, and fish are the three indices scored. Each of these indices are made up of indicator categories and indicators which are updated on varying time scales from annually to every three to four years. All indicator categories use data provided by multiple partners of the DTPHW team. In the Dry Tropics region, the water quality index is updated annually, with the most recent data from the 2021–2022 financial year.

Index scores are calculated for the Ross Freshwater Basin and the Black Freshwater Basin. The extent of each basin is shown in Figure 9, and the results are presented below.
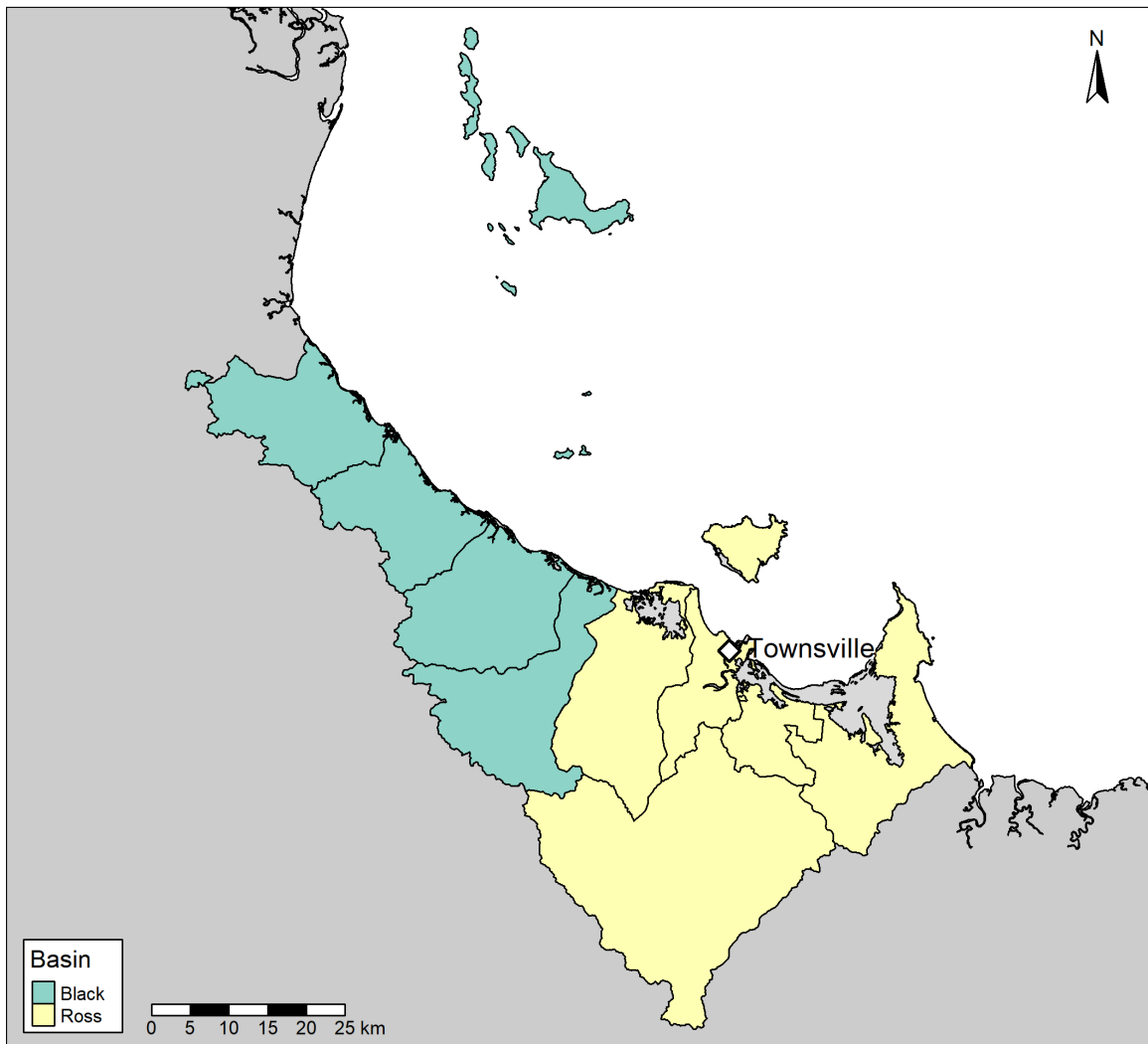

Figure 9. Freshwater Basins and delineation of Sub Basins

10.1 Water Quality

The water quality index for the freshwater environment of the Dry Tropics regions consists of two indicator categories: Nutrients, and Physical-Chemical Properties. These are divided into five indicators and for each indicator the parameters used to calculate the scores were the:

- Water Quality Objectives (WQOs);
- Scaling factors (SF);
- Annual medians, calculated from the monthly medians; and
- 80th percentile (and 20th percentile for dissolved oxygen), calculated from the monthly medians.

The Methods Document (2023) provides definition of the WQO and SF for each watercourse and the conversion of the raw data to a standardised score using the annual medians and percentile fractions. The annual medians and percentile fractions are calculated from the monthly medians to remove the skewing associated with a greater number of samples collected during the wet season. Some sites become dry during the dry season and are unable to be sampled.

Weighted scores are calculated using the proportion of the total basin area for each sub basin. The weighted score for the basin is the sum of the average of the products of the sub basin proportion and their respective indicator scores[9].

The nutrients indicator category is comprised of two indicators, Dissolved Inorganic Nitrogen (DIN), and Total Phosphorus (TP) and the scores for nutrients are averaged from the scores of the two indicators. The physical-chemical properties indicator category is comprised of three indicators, Turbidity, High DO, and Low DO. The score is calculated as the average of Turbidity and the minimum score from High DO and Low DO.

10.1.1 Monitoring Sites

Data for the two freshwater indicator categories are collected from the same sites. There are 22 sites spread across the two basins, divided into eight (8) sub basins in line with the WQIP (Townsville City Council, Queensland Government, Australian Government 2010) (Table 23 and Appendix I).

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[9] $Weighted\ Basin\ Score = \sum_i^n \left(\frac{1}{m} \sum_j^m \left(Indicator_j * weight_i \right) \right)$

Where i is the Sub basin, j is the indicator, n is the number of sub basins, and m is the number of indicators

Table 23. Dry Tropics freshwater water quality site summary.

Basin	Sub Basin	Water Course	Site
Ross	Bohle River	Bohle River	BOH22.3
			BOH18.1
	Lower Ross	Lower Ross River	Aplin's Weir
			Blacks Weir
			Gleesons Weir
	Upper Ross	Ross Lake	RLS1
			RLS2
			RLS3
			RLS4
			RLS5
			RLS6
			RLS7
Black	Black River	Black River	BR6.8
	Bluewater Creek	Althaus Creek	AltC7.0
		Bluewater Creek	BWC6.1
		Sleeper Log Creek	SLC5.2
	Rollingstone Creek	Leichhardt Creek	LC4.5
		Saltwater Creek	SC2.7
		Rollingstone Creek	RC5.5
	Crystal Creek	Ollera Creek	OC3.7
		Crystal Creek	CryC7.1
		Paluma Lake	Paluma Lake Site 1

10.1.2 Overall Summary: Freshwater Water Quality

The overall water quality has remained a grade of 'good' for both the Ross Freshwater Basin and Black Freshwater Basin, with a slight decrease in score for the Ross Freshwater Basin Table 24. This decrease is associated with a decrease in nutrient scores in the Ross Lake and Bohle Rivers as well as low, low dissolved oxygen scores across the basin.

Table 24: Freshwater Quality Index Scores and Grades with comparison to previous years.

Basin	Nutrients	Phys-Chem Properties	Water Quality			
			2021–2022	2020–2021	2019–2020	2018–2019
Ross	71	68	70	73	70	66
Black	73	64	68	68	67	62

Standardised scoring range: ■ = Very Poor: 0 to <21 | ■ = Poor: 21 to <41 | ■ = Moderate: 41 to <61 | ■ = Good: 61 to <81 | ■ = Very Good: 81 to 100.

10.1.2.1 *Key Messages*

- The Ross Freshwater Basin saw a decrease in score from 73 to 70 within the same grade of 'good' with the decline associated with a decrease in the score for TP in Ross Lake and a decrease in the score for DIN in the Bohle River.
- The Black Freshwater Basin score and grade have remained stable across the reporting years 2019–2022.
- The Bohle River TP grade remains 'very poor' and the DIN scores have decreased with the grade decreased from 'moderate' to 'poor' compared with 2020–2021.
- There was an increase in the number of watercourses with 'very poor' or 'poor' scores associated with low dissolved oxygen % saturation in both the Ross and Black freshwater basins in the 2021–2022 year.

10.1.3 Nutrients

As there have been continuous gaps in the data for TP, investigation is continuing into the potential to include Filterable Reactive Phosphorus (FRP) in the analysis. Data source investigations have provided the comparison presented in Appendix J.

10.1.3.1 *Results: Freshwater Nutrients*

The scores and grades for the Ross and Black freshwater basins, and their associated sub basins are presented in Table 25 and the annual medians, total number of samples collected, the number of months in which sampling occurred, WQO and SF are presented in Appendix J.

The nutrient indicator category for the Ross Freshwater Basin was graded as 'good' with a weighted score of 71. The Upper Ross and Lower Ross sub basins were graded as 'good', whilst the Bohle River was graded as 'poor' for nutrients. However, it is noted that this does not include a score for TP for two of the three sites within the Lower Ross as data is not available. Comparison of the available FRP data for these sites (Appendix J) with the available WQO suggests that these sites would receive a score of 90 for FRP. In this scenario, the nutrient grade for the Lower Ross would increase (~79) as the sub basin score is the average of the nutrient scores for the watercourses. Whilst the DIN scores for Aplin's Weir and Blacks Weir are lower than for Gleesons Weir, they are relatively stable when considering historical data (Appendix K).

The Bohle River TP grade remains 'very poor' and the DIN scores have decreased from 54 to 48 with the grade remaining 'moderate' compared with 2020–2021. The source of nutrient inputs to the Bohle River continue to require investigation, so that management can be implemented to improve the water quality.

The nutrient indicator category for the Black Freshwater Basin was graded as 'good' with a weighted score of 73. Each of the sub basins achieved this grade, except Rollingstone Creek, which achieved a grade of 'very good'. Althaus Creek had a decrease in grade for TP from 2020–2021 to 'moderate'. Whilst data was available for DIN for Paluma Lake, it was not included in the report as the ammonium component had a higher limit of reporting than its water quality objective.

Table 25. Unweighted and weighted standardised scores and grades for the nutrient indicators and indicator category in the Dry Tropics Freshwater Basins.

Basin	Sub Basin	Watercourse	Unweighted Score and Grade DIN	TP	Nutrients[10]	Weighting (%)	Area (km2)	Weighted Score and Grade Sub Basin	Basin
Ross	Upper Ross	Ross Lake	90	61	75	0.32	458	24.2	71
	Lower Ross	Aplins Weir	61	NA	61	-	-	-	
		Gleesons Weir	90	NA	90	-	-	-	
		Blacks Weir	59	90	74	-	-	-	
			70	90	75	0.56	786	44.8	
	Bohle River	Bohle Mid-Field	36	0	18	-	-	-	
		Bohle Far-Field	60	0	30	-	-	-	
			48	0	24	0.12	169	2.9	
			66	37	58	1	1413		
Black	Black River	Black River	63	61	62	0.37	250	23.1	73
	Bluewater Creek	Althaus Ck	90	48	69	-	-	-	
		Bluewater Ck	66	90	78	-	-	-	
		SleeperLog Ck	71	90	80	-	-	-	
			75	76	76	0.24	162	18.3	
	Rollingstone Creek	Leichhardt Ck	90	90	90	-	-	-	
		Saltwater Ck	90	90	90	-	-	-	
		Rollingstone Ck	62	90	76	-	-	-	
			80	90	85	0.21	145	18.3	
	Crystal Creek	Ollera Ck	71	90	80	-	-	-	
		Crystal Ck	69	90	79	-	-	-	
			70	90	80	0.17	116	13.8	
	Paluma Lake	Paluma Lake	NA	90	90	0	2	0.3	
			74	82	79	1	675		

Standardised scoring range: ■ = Very Poor: 0 to <21 | ■ = Poor: 21 to <41 | ■ = Moderate: 41 to <61 | ■ = Good: 61 to <81 | ■ = Very Good: 81 to 90. (Scores are capped at 90).

[10] Sites indicators are average within each indicator to calculate watercourse indicators which are averaged to calculate sub basin indicators. Watercourse indicators are averaged between each indicator to calculate watercourse indicator categories, which are averaged to calculate sub basin indicator categories.

10.1.4 Physical-Chemical Properties

10.1.4.1 *Results: Freshwater Physical-Chemical Properties*

The scores and grades for the Ross and Black freshwater basins, and their associated sub basins are presented in Table 26 and the annual medians, total number of samples collected, the number of months in which sampling occurred, WQO and SF are presented in Appendix L.

The physical-chemical indicator category for the Ross Freshwater Basin was graded as 'good' with a weighted score of 68. The Lower Ross and Bohle River sub basins both received a grade of 'moderate' for the physical-chemical indicator category due to low scores for low dissolved oxygen. Unusually low dissolved oxygen % saturation was observed at Blacks Weir from December 2021 to June 2022, at Gleesons Weir from January to June 2022, and at Aplin's Weir from February to May 2022. The Bohle also had some sporadically low dissolved oxygen % saturation (~ 30% saturation) at varying times throughout the reporting year. Further, higher turbidity readings were observed in the Bohle during the wet season and may be associated with rainfall events.

The Black Freshwater Basin received a grade of 'good' with a weighted score of 64 for the physical-chemical indicator category. Of the sub basins, Paluma Lake, Crystal Creek, Rollingstone Creek, and Black River received a grade of 'good'. Low dissolved oxygen contributed to a lower score at Sleeper Log Creek (very poor), Rollingstone Creek (poor), Ollera Creek (very poor), and Paluma Lake (moderate). The consistency of the lower low dissolved oxygen scores across both the Ross and Black freshwater basins during the year suggests that there may have been some environmental influence contributing to this. Althaus Creek continued to have 'very poor' turbidity and Sleeper Log Creek turbidity score decreased to a grade of 'very poor'.

Table 26. Unweighted and weighted standardised scores and grades for the physical-chemical properties indicators and indicator category in the Dry Tropics Freshwater Basins.

Basin	Sub Basin	Watercourse	Unweighted Score and Grade				Weighting (%)	Area (km2)	Weighted Score and Grade	
			Turbidity	High DO	Low DO	PhysChem			Sub Basin	Basin
Ross	Upper Ross	Ross Lake	90	90	90	90	0.32	458	28.8	68
	Lower Ross	Aplin's Weir	90	80	55	72	-	-	-	
		Gleesons Weir	90	90	11	50	-	-	-	
		Blacks Weir	90	90	19	54	-	-	-	
			90	86	28	59	0.56	786	33.3	
	Bohle River	Bohle Mid-Field	67	90	26	46	-	-	-	
		Bohle Far-Field	66	90	40	53	-	-	-	
			66	90	33	50	0.12	169	6	
			82	88	40	61	1	1413		
Black	Black River	Black River	90	47	90	68	0.37	250	25.5	64
	Bluewater Creek	Althaus Ck	0	90	90	45	-	-	-	
		Bluewater Ck	90	79	66	78	-	-	-	
		Sleeper Log Ck	0	90	20	10	-	-	-	
			30	86	59	44	0.24	162	10.7	
	Rollingstone Creek	Leichhardt Ck	90	90	61	75	-	-	-	
		Saltwater Ck	75	90	90	82	-	-	-	
		Rollingstone Ck	90	90	40	65	-	-	-	
			85	90	63	74	0.2148	145	16	
	Crystal Creek	Ollera Ck	90	90	0	45	-	-	-	
		Crystal Ck	90	90	90	90	-	-	-	
			90	90	45	67	0.1719	116	11.6	
	Paluma Lake	Paluma Lake	90	90	55	72	0.003	2	0.2	
			70	84	60	63	1	675	64	

Standardised scoring range: ■ = Very Poor: 0 to <21 | ■ = Poor: 21 to <41 | ■ = Moderate: 41 to <61 | ■ = Good: 61 to <81 | ■ = Very Good: 81 to 90.
(Scores are capped at 90).

10.1.5 Confidence Scores

There was low confidence in the water quality scores for the Ross Freshwater Basin due to limited spatial sampling in the basin, with only two rivers and Ross Lake sampled. There was moderate confidence in the water quality scores for the Black Freshwater Basin, with most major watercourses sampled. The score for each criterion is shown in Table 27 .

Table 27. Confidence scores for the freshwater water quality indicator categories.

Basin	Indicator category	Maturity of method (*0.36)	Validation (*0.71)	Representativeness (*2)	Directness (*0.71)	Measured error (*0.71)	Final Score	Rank
Ross	Nutrients	2	3	1	3	1	7.6	Low (2)
	Phys-chem	2	3	1	3	1	7.6	Low (2)
	Water quality index						7.6	Low (2)
Black	Nutrients	2	3	1.5	3	1	8.6	Mod (3)
	Phys-chem	2	3	1.5	3	1	8.6	Mod (3)
	Water quality index						8.6	Mod (3)

Rank based on final score: Very low (1): 4.5 – 6.3; Low (2): >6.3 – 8.1; Moderate (3): >8.1 – 9.9; High (4): >9.9 – 11.7; Very high (5): >11.7 – 13.5.

Confidence criteria were scored 1–3 and weighted by the value identified in parenthesis. Weighted scores were summed to produce a final score (4.5 – 13.5). Final scores were ranked from 1 to 5 (very low to very high).

10.2 Habitat and Hydrology

The habitat and hydrology index for the freshwater basins of the Dry Tropic region consists of two habitat specific indicator categories and one hydrology specific indicator category. The habitat indicator categories are Freshwater Riparian Extent and Freshwater Wetland Extent. Both indicator categories source methodology from the Reef Water Quality Report Card[11]. The data used in the Reef Water Quality Report Card is updated approximately every four years with the next expected updated in 2023. The hydrology specific indicator category is Artificial Barriers and consists of two indicators: Impoundment Length and Fish Barriers. Results for these indicators are provided by a combination of partners of the DTPHW team. This data is updated approximately every four years.

10.2.1 Overall Summary: Freshwater Habitat and Hydrology

For the 2021-2022 reporting period the standardised scores for the habitat and hydrology index remained the same in both freshwater basins. The Ross Freshwater Basin received a score of 51 (moderate), and the Black Freshwater Basin received a score of 71 (good). Changes to the assessed area for the Wetland Extent indicator, and changes to the method of aggregation of the indicator categories did change scores. However, these updates have been incorporated and back calculated into the historic results presented below (Table 28).

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[11] All results are downloaded from the Reef 2050 Water Quality Improvement Plan's [Reef Water Quality Report Card] (Australian Government 2023).

Table 28. Standardised scores for the habitat and hydrology indicator categories and index in the Ross Freshwater Basin and Black Freshwater Basin.

Basin	Riparian Extent	Wetland Extent	Artificial Barriers	Habitat and Hydrology Index		
				2021–2022	2020–2021	2019–2020
Ross freshwater	44	60	49	51	51	5
Black freshwater	56	57	100	71	71	71

Standardised scoring range: ■ = Very Poor: 0 to <21 | ■ = Poor: 21 to <41 | ■ = Moderate: 41 to <61 | ■ = Good: 61 to <81 | ■ = Very Good: 81 to 100

10.2.1.1 *Key Messages*

- The method of aggregation was updated for the 2021–2022 technical report. Historic scores have been back calculated to include this update (Appendix U).
- The area assessed for the wetland extent indicator category was updated for the 2021–2022 report. Historic scores have been back calculated to include this update (Appendix T).
- There was no change to the habitat and hydrology index scores for the 2021–2022 report.

10.2.2 Freshwater Riparian Extent

Currently the Dry Tropics Partnership uses the results published by the Reef Plan Great Barrier Reef Report Card with no changes, edits, or updates. The most recently published results are from 2017 and are included in this report.

10.2.2.1 *Monitoring Sites*

The area assessed for the freshwater riparian extent indicator category includes all mapped waterway lines in the Ross Freshwater Basin and Black Freshwater Basin as per the Regulated Vegetation Management Category R data[12], and the Watercourse Lines datasets[13]. However, this currently does not include Ross Lake or waterways on any islands within the Dry Tropics reporting region (e.g., Magnetic Island), a map of the area is provided in Appendix M.

10.2.2.2 *Results: Freshwater Riparian Extent*

The standardised score and grade for the freshwater riparian extent indicator category is calculated as a percentage lost/gained in 2017 compared to the amount of vegetation present during the 2013 assessment. Preclear estimates[14] of vegetation extent are presented to provide a broader overview of general vegetation trends.

For the 2021–2022 reporting period the total area of freshwater riparian extent[14] was approximately 25,365ha in the Ross Freshwater Basin, and 23,448ha in the Black Freshwater Basin (based on 2017 vegetation) which represents loss in both basins since 2013. From 2013 to 2017, Ross Freshwater Basin has lost 135ha (0.45%) of its freshwater riparian vegetation, and from preclearing estimates

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[12] The Regulated Vegetation Management Category R data is available for download from QSpatial's [Catalogue] (Queensland Government 2023).

[13] The Watercourse Lines dataset is available for download from QSpatial's [Catalogue] (Queensland Government 2023).

[14] Total areas are estimates only as the exact pre-clear estimates used by the Reef 2050 plan is not provided.

has lost approximately 4,635ha (15.45%) in total, assuming the pre-cleared extent was 100% vegetated. In the Black Freshwater Basin, 0.52ha (0.20%) of riparian vegetation has been lost from 2013 to 2017, and approximately 2,552ha (9.81%) in total has been lost from preclearing estimates (Table 30).

Table 29. Riparian Extent in the freshwater basin of the Dry Tropics.

Basin	Freshwater Riparian Extent		
	2017 (ha)[14]	2013 (ha)[14]	Pre-clear (ha)[14]
Ross freshwater	~25,365	~25,500	~30,000
Black freshwater	~23,448	~23,500	~26,000

In the Ross Freshwater Basin, the final standardised score was 44 (moderate) with an area loss of 135ha and percent loss of 0.45%, and in the Black Freshwater Basin the final standardised score was 56 (moderate) with an area loss of 0.52ha and percent loss of 0.20% (Table 30).

Table 30. Riparian Extent loss and standardised score in the freshwater basin of the Dry Tropics.

Basin	Freshwater Riparian Extent		
	Extent loss 2013–2017		Standardised Score
	km²	%	
Ross freshwater	-135[15]	-0.45	44
Black freshwater	-52	-0.20	56

Riparian extent scoring range: ■ = Very Poor: >1% loss | ■ = Poor: 0.51 to 1% loss | ■ = Moderate: 0.11 to 0.5% loss | ■ = Good: 0 to 0.1% loss| ■ = Very Good: increase in vegetation.

Standardised scoring range: ■ = Very Poor: 0 to <21 | ■ = Poor: 21 to <41 | ■ = Moderate: 41 to <61 | ■ = Good: 61 to <81 | ■ = Very Good: 81 to 100

10.2.3 Freshwater Wetland Extent

The Dry Tropics Partnership uses the same methods, data, and analysis as published by the Reef Plan Great Barrier Reef Report Card, with minor changes to the assessed area: including Magnetic Island and the Palm Island group in the analysis of wetland extent. This update has been back calculated and incorporated into all historic freshwater habitat and hydrology results presented in this report. Results prior to back calculation are provided in Appendix T.

10.2.3.1 *Monitoring Sites*

The area assessed for the freshwater wetland extent indicator category covers the entire Ross and Black freshwater basins, as well as all islands within the Dry Tropics region. Maps of the wetlands within this area that area assessed are provided in Appendix Q.

10.2.3.2 *Results: Freshwater Wetland Extent*

The standardised score and grade for the wetland extent indicator category is calculated as a percentage lost/gained in 2017 compared to the amount of vegetation present during the 2013

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[15] Exact area changes are provided by the Reef 2050 Report and are known to this precision.

assessment. Vegetation extents from earlier years are presented to provide a broader overview of general vegetation trends.

For the 2021–2022 reporting period the total area of wetland riparian extent was 667.69ha in the Ross Freshwater Basin, and 440.47ha in the Black Freshwater Basin (based on 2017 vegetation) which represents loss in both basins since 2013. From 2013 to 2017, Ross Freshwater Basin has lost 0.78ha (0.11%) of its freshwater wetland vegetation, and from 2009 estimates has lost 3.62ha (0.54%). In the Black Freshwater Basin, 0.80ha (0.18%) of wetland vegetation has been lost from 2013 to 2017, and 2.57ha (0.58%) has been lost from 2009 (Table 31).

Table 31. Wetland Extent in the freshwater basin of the Dry Tropics.

Basin	Freshwater Wetland Extent		
	2017 (ha)	2013 (ha)	2009 (ha)
Ross freshwater	667.69	668.47	671.31
Black freshwater	440.47	441.27	443.04

In the Ross Freshwater Basin, the final standardised score was 60 (moderate) with an area loss of 0.72ha and percent loss of 0.11%, and in the Black Freshwater Basin the final standardised score was 57 (moderate) with an area loss of 0.80ha and percent loss of 0.18% (Table 32).

Table 32. Wetland Extent loss and standardised score in the freshwater basin of the Dry Tropics.

Basin	Freshwater Wetland Extent		
	Extent loss 2013–2017		Standardised Score (Grade)
	ha	%	
Ross freshwater	-0.72	-0.11	60
Black freshwater	-0.80	-0.18	57

Wetland extent scoring range: ■ = Very Poor: >3% loss | ■ = Poor: 0.51 to 3% loss | ■ = Moderate: 0.11 to 0.5% loss | ■ = Good: 0 to 0.1% loss | ■ = Very Good: increase in vegetation.

Standardised scoring range: ■ = Very Poor: 0 to <21 | ■ = Poor: 21 to <41 | ■ = Moderate: 41 to <61 | ■ = Good: 61 to <81 | ■ = Very Good: 81 to 100

10.2.3.3 *Change to Assessed Area*

The update to the assessed area increased the score in the Ross Freshwater Basin from 59 to 60 and increased the score in the Black Freshwater Basin from 55 to 57 (Appendix T).

10.2.4 Artificial Barriers

Artificial in-stream barriers, such as weirs and dams are often built for flood mitigation purposes, water storage, drinking water supply, hydropower, or even to stop saltwater ingress (WaterNSW 2022, City of Townsville 2022). Although useful, these barriers often have a profound impact upon stream ecology, connectivity (e.g., fish migration), and natural water flow (Faulks 2011). The artificial barriers indicator category is comprised of two indicators: impoundment length and fish barriers. Both indicators are updated approximately every four years, with impoundment length updated in 2022 (results presented in this report) and fish barriers scheduled to be updated in 2023.

10.2.4.1 Monitoring Sites

Both indicators define assessable waterways using the Waterways for Waterway Barrier Works data[16]. All waterways that were classified as "major" or "high" importance for fish movement and fish communities based on the Strahler stream order system were selected.

The assessed area for the impoundment length indicator has been updated to include all islands within the Dry Tropics region (e.g., Magnetic Island), although this had no impact on the standardised score for the indicator. Streams used, and their classification as either impounded or not impounded, are presented in Appendix R. There has been no change to the assessed area for the fish barriers indicator, the streams used, and the location of passable and impassable barriers is presented in Appendix S.

10.2.4.2 Results: Freshwater Impoundment length

Total impoundment length in the Dry Tropics region has remained relatively consistent between reporting periods. In the Black Freshwater Basin, of the 659km of assessed waterways no impoundments were recorded. The Black Freshwater Basin received a very good score of 100, with no impounded waterways. In the Ross Freshwater Basin, the total amount of assessed waterways increased by 7km from 888km during the 2020–2021 reporting period, to 895km during this reporting period. This was due to the inclusion of Magnetic Island waterways; however, this had no impact on the final standardised score of 34. Throughout the Ross Freshwater Basin, no new impoundments were recorded, and the basin received a poor score, with 8.0% impoundment. This was due to the presence of the Ross River Dam, and three weirs (Black, Gleeson and Aplin's) on the Ross River.

Table 33. Natural and Impounded stream length and standardised score in the freshwater basin of the Dry Tropics.

Basin	Waterway				Standardised Score (Grade)
	Natural	Impounded	Total	% Impounded	
Ross freshwater	824km	72km	895km	8.0%	34
Black freshwater	659km	0km	659km	0.0%	100

Standardised scoring range: ■ = Very Poor: ≥10% impoundment ■ = Poor: 7 to <10% ■ = Moderate: 4 to <7% ■ = Good: 1 to <4% ■ = Very Good: <1% impoundment.

10.2.4.3 Results: Freshwater Fish Barriers

The fish barriers indicator category measures the frequency, location, and total number of barriers such in the waterway. All barriers were classified as either passable (a physical barrier that does not prevent fish movement) or impassable (a physical barrier that does prevent fish movement). There is no change to the results for the fish barriers indicator in the 2021–2022 technical report.

In the Ross Freshwater Basin, there were 12 barriers identified across five measured waterways. Of these four were classified as impassable, and all were located on the Ross River. Five of the remaining passable barriers were located on Stuart Creek, two on Bohle River, and one on Alligator Creek. Of the 357km of waterways assessed in the Ross Freshwater Basin, the average waterway length was 71.4km, and had an average of 1.6 passable and 0.8 impassable barriers. In the Black

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[16] Data is available from the QSpatial [Catalogue]. Note that the currently available dataset is an updated (changed) version of the dataset used in this report.

Freshwater Basin 92km of the Black River was assessed, and no fish barriers, passable or impassable, were identified (Table 34).

Table 34. Waterway characteristics and fish barriers in the Ross Freshwater Basin and Black Freshwater Basin.

Basin	Waterway Name	length	Number of Barriers: Passable	Impassable	Length to first barrier: Passable	Impassable
Ross freshwater	Ross River	263.6km	0	4	1.0km	1.0km
	Bohle River	51.1km	2	0	7.2km	51.1km
	Stuart Creek	17.5km	5	0	11.9km	17.5km
	Alligator Creek	13.7km	1	0	0.7km	13.7km
	Whites Creek	11.1km	0	0	11.1km	11.1km
Ross Average		71.4km	1.6	0.8	6.4km	18.9km
Black freshwater	Black River	92.0km	0	0	0.0km	92.0km

For each waterway assessed in the Dry Tropics reporting region calculations of barrier density, percentage of stream to first passable barrier, and percentage of stream to first impassable barrier were conducted. In the Ross Freshwater Basin, barrier density ranged from 3.5km of waterway per barrier, to 65.9km per barrier, and percentage of passable and impassable waterway length ranged from 0.4% to 100%. In the Black Freshwater Basin, no barriers were recorded, thus barrier density was not applicable and percentage of stream to first barrier was 100% (Table 35). The fish barrier indicator received a standardised score of 65 (good) in the Ross Freshwater Basin, and 100 (very good) in the Black Freshwater Basin (Table 35).

Table 35. Standardised scores for the components of the fish barrier's indicator.

Waterway	Barrier density (km/barrier)	Percentage of stream to first barrier: Passable	Impassable	Standardised Score (Grade)
Ross River	65.9km	0.4%	0.4%	40
Bohle River	25.5km	14.1%	100%	61
Stuart Ck	3.5km	68.2%	100%	60
Alligator Ck	13.7km	5.2%	100%	60
Whites Ck	NA	100%	100%	100
Ross Total	27.2km	37.6%	80.1%	65
Black River	NA	100%	100%	100

Barrier density scoring range: ■ = Very Poor: 0 to 2km | ■ = Poor: >2 to 4km | ■ = Moderate: >4 to 8km | ■ = Good: >8 to 16km | ■ = >16km.

Percentage of stream to first passable barrier scoring range: ■ = Very Poor: 0 to <40% | ■ = Poor: 40 to <60% | ■ = Moderate: 60 to <80% | ■ = Good: 80 to <100% | ■ = 100%.

Percentage of stream to first impassable barrier scoring range: ■ = Very Poor: 0 to 60% | ■ = Poor: >60 to 80% | ■ = Moderate: >80 to 90% | ■ = Good: >80 to 100% | ■ = 100%.

Standardised scoring range: ■ = Very Poor: 0 to <21 | ■ = Poor: 21 to <41 | ■ = Moderate: 41 to <61 | ■ = Good: 61 to <81 | ■ = Very Good: 81 to 100.

10.2.4.4 *Results: Freshwater Artificial Barriers*

Despite updates to the assessed area for impoundment length, the freshwater artificial barriers indicator category did not change during the 2021–2022 reporting period. Further, the fish barriers indicator has not been updated and thus all results for the artificial barriers indicator category remain unchanged. The Black Freshwater Basin received a standardised score of 100 (very good) due to the lack of artificial barriers, and the Ross Freshwater Basin received a standardised score of 49 (moderate) due to the high frequency of barriers, and their proximity to the downstream limit of the water way, particularly in the Ross River (Table 36).

Table 36. Standardised scores for the artificial barrier's indicator category in the Ross Freshwater Basin and Black Freshwater Basin.

Basin	Impoundment Length	Fish Barriers	Artificial Barriers
Ross freshwater	34	65	49
Black freshwater	100	100	100

Standardised scoring range: ■ = Very Poor: 0 to <21 | ■ = Poor: 21 to <41 | ■ = Moderate: 41 to <61 | ■ = Good: 61 to <81 | ■ = Very Good: 81 to 100

10.2.4.5 *Change to Aggregation and Wetland Extent Indicator*

The method of aggregation of the riparian, wetland extent, and artificial barriers indicator categories has been updated to provide equal weighting to each indicator category, this change moves the Dry Tropics 2021–2022 technical report to be in line with the reporting structure of the Reef 2050 report card. The area assessed for the wetland extent indicator category has been updated to include all islands in the Dry Tropics region. Results with these updates are presented in Table 28. Results before these updates are presented in Appendix U. In combination these changes changed the index score from 77 to 71 in the Black Freshwater Basin and from 50 to 51 in the Ross Freshwater Basin.

10.2.5 Confidence Scores

Confidence in the riparian extent, wetland extent, and artificial barriers indicator categories was low or very low with a rank of 1, 1, and 2 out of 5 respectively. All indicator categories received; a maturity score of 2, as the methodology has been peer-reviewed, but not yet published; a directness scored of 2 as the data has a quantifiable relationship with estuarine habitat condition; and a measured error score of 1 as many components of the underlying dataset do not have their error quantified. The riparian extent and wetland extent indicator categories received a validation score of 2 as regular ground truthing does occur, however the artificial barriers indicator category only received a validation score of 1 as large amounts of data are based on remote sensing or regional expert opinion only. Finally, the representativeness of the two extent indicator categories received a score of 1 due to their sample size, while artificial barriers received a 2 due to its large sample size (relative to the population).

Table 37. Confidence scores for the mangrove and saltmarsh extent and riparian extent indicator categories.

Indicator Category	Maturity (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured error (x0.71)	Score (Rank)
R. Extent	2	2	1	2	1	6.3 (1)
W. Extent	2	2	1	2	1	6.3 (1)
A. Barriers	2	1	2	2	1	7.6 (2)

Rank based on score: 1 (very low) = 4.5 to 6.3; | 2 (low) = >6.3 to 8.1; | 3 (moderate) = >8.1 to 9.9; | 4 (high) = >9.9 to 11.7; | 5 (very high) = >11.7 to 13.5.

10.3 Fish

The Fish index for the freshwater basin of the Dry Tropics regions consists of two indicator categories, the Proportion of Indigenous Species Expected, and the Proportion of Non-Indigenous Species Expected. The Fish index is designed to provide a basic description of how similar regional fish communities are to the best available estimate of their natural state. Condition ratings are based on the median result across multiple sites within each basin, with each site generally being assessed on a single occasion. Non-indigenous fish affect aquatic plants and animals by competing for food and space, preying on native species, introducing exotic diseases and parasites, and driving habitat changes and therefore it is important to assess them within the environment (Department of Climate Change, Energy, the Environmental and Water 2023). Results for this index are provided by partners of the DTPHW team and are updated every three years. The existing data is for the 2018-2019 period with the next update scheduled for the 2022–2023 technical report.

10.3.1 Proportion of Indigenous Species Expected and Proportion of Non-Indigenous Species Expected

Both the Proportion of Indigenous Species Expected (POISE) and Proportion of Non-Indigenous Species Expected (PONISE) indicator categories are the measure of observed verse expected species, they compare the richness of species captured during the sampling year against the predicted number of species calculated by a pre-disturbance model. The POISE indicator category compares the species richness of indigenous species, while the PONISE indicator category compares the species richness of translocated and alien species. PONISE is further broken into two indicators, the Proportion of Translocated Fish, and the Proportion of Alien Fish. The classification of fish as indigenous, translocated or alien is shown below (Table 38).

Table 38. The distinction between indigenous, translocated, and alien fish species.

Native to Australia?	Native to Waterway?	Classification
Yes	Yes	Indigenous
Yes	No	Translocated
No	No	Alien

10.3.1.1 *Monitoring Sites*

24 sites had been sampled across the Dry Tropics region for the 2021–2022 report (2019 data). Sites were selected using an objective randomised design however five site locations had to adjusted. Four sites in the upper Ross River catchment (upstream of the Ross River Dam) could not be sampled due

to access constraints, and one site within the Black Weir pool could not be sampled due to resource constraints. These sites were moved elsewhere in accordance with the site selection method. A lack of sampling within the upper catchment and weir pool may have influenced results, however the current result is still considered reasonable in relation to other basins. In the Ross Freshwater Basin 11 sites were sampled across 9 unique waterways, with Alligator Creek assessed three times. In the Black Freshwater Basin 13 sites were sampled across 11 unique waterways, with Alice River and Crystal Creek both assessed twice (Appendix V).

10.3.1.2 Results

A total of 7,741 fish were caught during sampling across the Dry Tropics region of which 110 were retained for laboratory confirmation of identification, 968 were introduced species that were euthanised, and the remainder were released unharmed. 33 unique species were caught during sampling with 26 species recorded in the Ross Freshwater Basin, and 23 species recorded in the Black Freshwater Basin (Appendix V). The basins shared 16 species and recorded the presence of both indigenous and alien species. Translocated species were only found in the Ross Freshwater Basin. Of the 26 species recorded in the Ross 22 were indigenous, three were alien, and one was translocated. Three indigenous species were recorded for the first time (Giant Mottled Eel, Bunaka and Scaleless Goby) (Appendix X). Of the 23 species recorded in the Black Freshwater Basin, 20 were indigenous and three were alien, all three alien species were found in both basins (Gambusia, Guppy and Mozambique tilapia) (Appendix Y).

The POISE indicator category was measured to be 0.62 in the Ross Freshwater Basin and 0.70 in the Black Freshwater Basin, showing that despite the large number of indigenous species, presence is still lower than the pre-disturbance model. Within the PONISE the translocated species indicator was measured to be 0.0 in both the Ross Freshwater Basin and Black Freshwater Basin, due to the very low presence of translocated species. Similarly, although some alien species were recorded, presence was low and the alien species indicator was measured to be 0.037 in the Ross Freshwater Basin, and 0.012 in the Black Freshwater Basin (Table 39).

Table 39. Raw scores for the Proportion of Indigenous Species Expected, and Proportion of Non-Indigenous Species Expected indicator categories in the Dry Tropics region.

Basin	Proportion of Indigenous species Expected	Proportion of:		Non-Indigenous Species Expected
		Translocated Species	Alien Species	
Ross freshwater	0.62	0.0	0.037	0.051
Black freshwater	0.70	0.0	0.012	0.012

Scoring range (POISE): ■ = Very Poor: 0 to <0.40 | ■ = Poor: 0.40 to <0.53 | ■ = Moderate: 0.53 to <0.67 | ■ = Good: 0.67 to <0.80 | ■ = 0.80 to 1.

Scoring range (PONISE): ■ = Very Poor: >0.2 to 1 | ■ = Poor: >0.1 to 0.2 | ■ = Moderate: >0.05 to 0.1 | ■ = Good: >0.03 to 0.05 | ■ = 0 to 0.3.

10.3.1.3 Final Result: Freshwater Fish

In the Ross Freshwater Basin, the POISE indicator category received a standardised score of 54, and the PONISE indicator category received a standardised score of 60 for a fish index score of 57. In the Black Freshwater Basin, the POISE indicator category received a standardised score of 66, and the PONISE indicator category received a standardised score of 91 for a fish index score of 78. Overall, the fish index, and thus fish communities, were in a moderate condition within the Ross Freshwater

Basin and good condition within the Black Freshwater Basin (Table 40). Raw results and boxplots for the POISE and PONISE indicator categories are provided in Appendix X, Appendix Y, and Appendix Z.

Table 40. Standardised score and grade for the Proportion of Indigenous Species Expected, and Proportion of Non-Indigenous Species Expected indicator categories, and Fish Index in the Dry Tropics region.

| Basin | Proportion of: | | Fish |
	Indigenous Species Expected	Non-Indigenous Species Expected	
Ross freshwater	54	60	57
Black freshwater	66	91	78

Standardised scoring range: ■ = Very Poor: 0 to <21 | ■ = Poor: 21 to <41 | ■ = Moderate: 41 to <61 | ■ = Good: 61 to <81 | ■ = Very Good: 81 to 100

10.3.1.4 *Key Messages*

- 7,741 fish of 33 unique species were caught during sampling across the Dry Tropics region, 6,773 fish from 29 unique species were indigenous, and 968 fish from four unique species were non-indigenous.
- Of the 26 species recorded in the Ross Freshwater Basin, 22 were indigenous, 3 were alien, and 1 was translocated. Of the 23 species recorded in the Black Freshwater Basin, 20 were indigenous and 3 were alien.
- 3 indigenous species were recorded for the first time in the Ross Freshwater Basin (Giant Mottled Eel, Bunaka and Scaleless Goby).

10.3.2 Confidence Scores

Confidence in the fish index was moderate with a rank of 3 out of 5. The fish index received a maturity score of 2, as the methodology has been peer-reviewed, but not yet published. A validation score of 2 as frequent in-field observations were conducted, however a level of modelling was required to calculate pre-disturbance populations. A representativeness of 2 due to a limited sample size and number sampling locations relative to the population. A directness of 3 as the fish species were measured directly, and a measured error of 1 as the final scores are reliant on modelled populations (Table 41).

Table 41. Confidence scores for the fish index in the freshwater basin of the Dry Tropics.

Index	Maturity (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured error (x0.71)	Score (Rank)
Fish	2	2	2	3	1	9 (3)

Rank based on score: 1 (very low) = 4.5 to 6.3; | 2 (low) = >6.3 to 8.1; | 3 (moderate) = >8.1 to 9.9; | 4 (high) = >9.9 to 11.7; | 5 (very high) = >11.7 to 13.5.