HEALTHY WATERS PARTNERSHIP dry tropics

Townsville Dry Tropics
Waterways Report Card 2025

TECHNICAL REPORT

Complete Report

Reporting on data collected 2023 - 2024

JULY 2025 | Healthy Waters Partnership for the Dry Tropics (HWP)

General

Authorship Statement

This technical report presents the results of the Townsville Dry Tropics 2023–2024 Report Card (released in July 2025) and was prepared by the Partnership's Technical Officer (TO), Adam Shand, with support and review from the Partnership's Senior Technical Officer (STO), Dinny Taylor. Significant support and review were received from the Regional Report Cards Technical Working Group (TWG) members, and the Wet Tropics Waterways Partnership and the Healthy Rivers to Reef Partnership. This report is endorsed by the Healthy Waters Partnership for the Dry Tropics (HWP).

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Current Townsville Dry Tropics TWG Members and their Respective Organisations

Table 1. Current HWP TWG members and respective organizations.

Member	Organisation
Diane Tarte	TWG: Chair (Independent)
Dinny Taylor	HWP: STO
Adam Shand	HWP: TO
Andrew Moss/Katie Hillyer	Department of Environment, Tourism, Science, and Innovation (DETSI)
Glynis Orr	DETSI
Reiner Mann	DETSI
Angus Thompson	AIMS
Michael Rasheed	James Cook University (JCU)
Alex Carter	JCU
Travis Sydes	Far North Qld Regional Organisation of Councils (FNQROC)
Nicole Flint	Central Queensland University (CQU)
Paula Cartwright	JCU
Jamie Corfield	DETSI
David Moffatt	DETSI
Stephen Lewis	JCU
Tyson Schmid	Townsville City Council (TCC)

Acknowledgements

We thank partners who kindly contributed their data, members of the Healthy Waters Partnership for the Dry Tropics (HWP) Management Committee, and members of the Technical Working Group (TWG) who provided feedback on the document. Partners providing data include Townsville City Council (Townsville Water & Waste), Port of Townsville, Australian Institute of Marine Science, Department of Environment, Tourism, Science, and Innovation, Queensland Herbarium (through the Department of Environment, Tourism, Science, and Innovation), James Cook University (TropWater), Ornatas, and Reef Check Australia. Creative Commons (Receiving Environment Monitoring Program, Sewage Treatment Plant data) by Townsville City Council is licensed under CC BY 4.0/Adapted Material. The Partnership acknowledges the Australian Marine Debris Initiative, Tangaroa Blue

Foundation, the community organisations, and individuals involved in the collection and the provision of data used in this report.

Members of the Reef Independent Science Panel are acknowledged for their advice and review of the document. The Partnership would like to acknowledge the assistance provided by Dr Bill Venables in the development of the litter model.

Executive Summary

This executive summary includes three summary sections covering:

- The Healthy Waters Partnership for the Dry Tropics,
- Climate and land use in the Townsville Dry Tropics region,
- The state and condition of the environment, including scores and grades for each index for each environment, and site-specific scores and grades for litter.

The Healthy Waters Partnership for the Dry Tropics

The Healthy Waters Partnership for the Dry Tropics (referred to as "the Partnership" or "HWP") was launched in January 2019, with a focus on producing an annual Report Card. The pilot annual Report Card was released in May 2019 and reports on data mainly from the 2017–2018 year. Following this pilot, each year an annual report card has been produced, with the current Report Card using data from the 2023–2024 year. Where a seasonal monitoring program extends outside of the year period, such as inshore coral, data from the whole monitoring period are included. For monitoring programs that collect data less frequently than annually (for example, wetland and riparian extent) then the most recent data set is included. In June 2021, the Partnership also began releasing annual Stewardship Reports, highlighting the management actions of partners (Table 2). In 2023 this evolved into the Stories of Stewardship presented as a series of web articles.

Table 2. Timeline of key HWP publications.

Released:	**2025**	**2024**	**2023**	**2022**	**2021**	**2020**	**2019**
Reporting period:	**23-24**	**22-23**	**21–22**	**20–21**	**19–20**	**18–19**	**17–18**
Report Card	✓ (current)	✓	✓	✓	✓	✓	✓ (pilot)
Stories of Stewardship	✓ (current)	✓	✓	✓	✓		

The key deliverable for the Report Card is an assessment of the state of the environment. The Report Card focuses on three indices that are directly dependent on waterway health: Water Quality, Habitat and Hydrology, and Fish. Indices are scored and graded for the freshwater, estuarine, inshore marine, and offshore marine environments within the Townsville Dry Tropics region. However, not all indices are scored and graded for each environment (for example, fish is only scored within the freshwater environment (Table 4).

The results presented in the 2023–2024 Report Card cover all areas of the Townsville Dry Tropics reporting region. On land, the Partnership region extends from the Crystal Creek catchment in the north, to the Ross River (lower) and Alligator Creek catchments in the south. In the marine environment the Partnership region extends from the coastline to the outer edge of the Great Barrier Reef (GBR) Marine Park. The reporting region for the Partnership incorporates all islands within this area, including Magnetic Island and the Palm Island group.

The Townsville Dry Tropics reporting region is divided into seven unique areas based on the environment type (freshwater, estuarine, inshore marine, and offshore marine), and riverine basin (Basin) (Black and Ross) or Bay (Zone) (Cleveland Bay and Halifax Bay) (Figure 1, Table 3). If required, Basins/Zones are divided into sub-basins/sub-zones based on the geographical definition and constructed boundaries (ports, weirs) provided by the Queensland water quality objectives (Department of Environment and Science 2018).

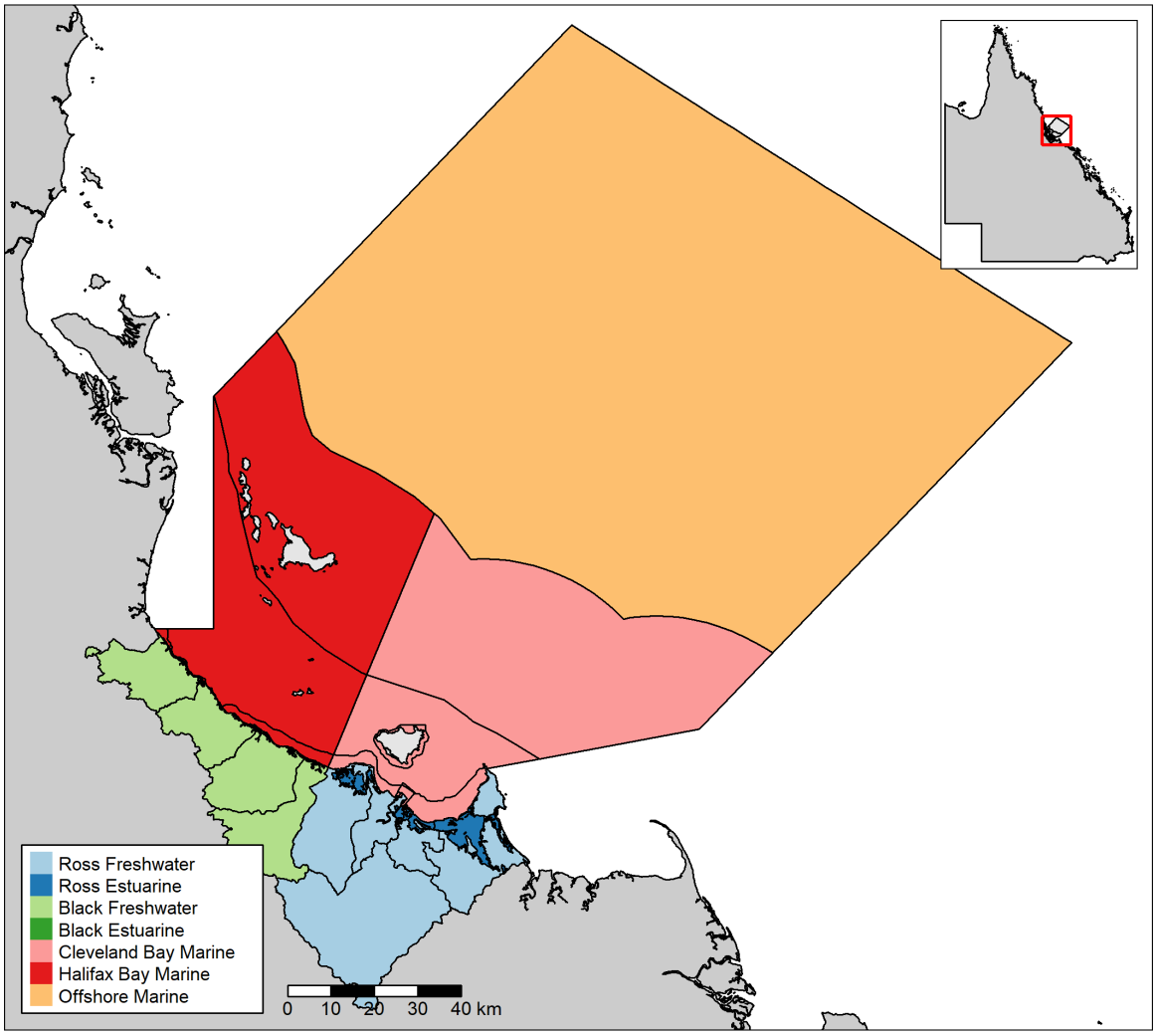

Figure 1. Geographic boundary of the HWP reporting region, divided into seven areas based on the environment type (freshwater, estuarine, inshore marine, and offshore marine), and riverine basin (Basin) (Black and Ross) or Bay (Zone) (Cleveland Bay and Halifax Bay). Each area is further divided into additional areas depending on water type, water quality objectives, and water dynamics (e.g. flow).

Table 3. The seven reporting areas in the Townsville Dry Tropics region.

Basin/Zone	Waterway
Ross Freshwater	Freshwater
Black Freshwater	Freshwater
Ross Estuarine	Estuarine
Black Estuarine	Estuarine
Cleveland Bay	Inshore Marine
Halifax Bay	Inshore Marine
Offshore Marine	Offshore Marine

This document is a detailed technical report that provides context and insight into the annual Report Card. It is intended to be read in conjunction with the "Townsville Dry Tropics Program Design" (Healthy Waters Partnership for the Dry Tropics 2024) and "Methods for Townsville Dry Tropics 2023–2024 Report Card (released in 2025)" (Healthy Waters Partnership for the Dry Tropics 2025). A table of every indicator measured is presented in 2.1 Terminology and Data Aggregation. An example of the coasters used for reporting results in the final Report Card is presented in 2.3 Presentation.

Climate and Land Use in the Townsville Dry Tropics Region

Between 1st July 2023 and 30th June 2024, the Townsville Dry Tropics region experienced one cyclone, Severe Tropical Cyclone Kirrily (approx. 50km away), and entered a neutral El Niño–Southern Oscillation (ENSO) (Bureau of Meterology 2025). Key influences for the 2023–2024 reporting period are summarised below.

- Grazing and conservation remain the two largest land use types by area. (Ross: 30.6% Conservation, 45.3% Grazing. Black: 43.0% Conservation, 39.9% Grazing).
    - Land use data has not been updated since the previous technical report (data for 2021, released 2023). The next update (2025 data) is expected to be released in 2027.
- Total rainfall was 930mm in the Ross Basin, and 1343mm in the Black Basin. Annual rainfall in both basins was classified in the "average" category, however, was less than the long-term mean (calculated from the most recent 30-year block of data: 1991 to 2020) of 1061mm and 1420mm respectively. Compared to the previous year, rainfall was much lower in the Ross Basin (1239mm to 930mm), and slightly lower in the Black Basin (1425mm to 1343mm).
    - Monthly rainfall was largely average throughout the year, ranging from the "below average" category to the "above average" category for 11 months of the year. In comparison, the previous year experienced notable peaks and troughs of rainfall.
- The annual average air temperature was 24.9°C in the Ross Basin, and 24.4°C in the Black Basin and was classified in the "very much above average" category in both basins. No month of the year recorded less than the long-term average temperature. Compared to the previous year, air temperatures were slightly higher (24.8°C to 24.9°C in the Ross Basin, 24.2°C to 24.4°C in the Black Basin).
    - Annual mean temperatures exceeded the long-term mean (calculated from the oldest 30-year block of data available in the dataset (from 1911 to 1940) by 1.2°C in the Ross Basin and 1.3°C in the Black Basin.
- The annual average sea surface temperature was 26.8°C, which was 0.6°C above the long-term average of 26.2°C. Compared to the previous year, sea surface temperature was slightly lower (27.1°C down to 26.8°C).
    - For 9 months of the year monthly sea surface temperatures ranged from the "above average" category to the "highest 1%" on record category, with only October, November, and December temperatures falling into the "average" category.
    - The proxy for risk of coral bleaching ranged from "low risk" to "very high risk", with most of the marine zone experiencing between 4 and 8+ Degree Heating Weeks.
    - These high temperatures (as noted by annual SST, and DHW) contributed to the 5th mass coral bleaching event for the Great Barrier Reef since 2016.

State and Condition of the Environment

The results presented in this document describe the state and condition of the waterways and environment in the seven reporting areas of the Townsville Dry Tropics region (Figure 1, Table 3). Within each area standardised scores and grades are produced for environmental indicators, indicator categories, and indices. Results from multiple indicators are aggregated into results for indicator categories, which are aggregated into results for indices (see Page 4). Indicators, and thus the indices reported for each area vary (Table 4). Confidence levels based on how the data were collected and analysed are also reported.

Table 4. Indices measured in each area of the Townsville Dry Tropics region.

Basin/Zone	Water Quality (WQ)	Latest update	Habitat and Hydrology (HH)	Latest update	Fish (F)	Latest update
Black Freshwater	✓	23–24	✓	22–23	✓	22-23
Black Estuarine	✓	23–24	✓ (Only Habitat)	22–23		
Halifax Bay	✓	23–24	✓ (Only Habitat)	23–24		
Ross Freshwater	✓	23–24	✓	22–23	✓	22-23
Ross Estuarine	✓	23–24	✓ (Only Habitat)	22–23		
Cleveland Bay	✓	23–24	✓ (Only Habitat)	23–24		
Offshore Marine	✓	19–20	✓ (Only Habitat)	23–24		

The index and standardised scores of each area for the 2023–2024 reporting period are presented below for quick reference. Selected key messages for results of particular interest are provided and refer to indicators which are presented in detail within the results sections.

Freshwater Environment

Table 5. Comparison of 2023–2024 weighted scores for Water Quality (WQ), Habitat and Hydrology (HH), Fish (F), and Pesticides (P) indices in the Ross Freshwater Basin and the Black Freshwater Basin against previous years.

Basin	2023-2024				2022-2023				2021–2022				2020–2021				2019–2020			
	WQ	HH	F	P[1]	WQ	HH	F	P[1]	WQ	HH	F	P[1]	WQ	HH	F	P[1]	WQ	HH	F	P[1]
Ross	67	X	X	75	67	61	49	81	70	X	X	89	73	X	X	94	70	X	57	89
Black	71	X	X	84	66	79	55	82	68	X	X	91	68	X	X	92	67	X	78	89

Standardised scoring range (WQ, HH, F): ■ 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.

Standardised scoring range (P): ■ = Very High Risk: 0 to <21 | ■ = High Risk: 21 to <41 | ■ = Moderate Risk: 41 to <61 | ■ = Low Risk: 61 to <81 | ■ = Very Low Risk: 81 to 100 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

Key Messages

Water Quality

- The Ross Freshwater Basin grade remained “good” with no change in overall water quality score.
    - However, the nutrients grade and score did increase in the Ross Basin (from “moderate” (60) to “good” (72), while the physical chemical properties score decreased from 74 to 63.
    - In both instances these changes were predominantly driven by changes in the Lower Ross Sub Basin, with greatly improved DIN scores and reduced Low DO scores. For both indicators, no strong temporal trends are yet apparent.

[1] Pesticide results are not representative of the Ross and Black Basins, but rather of the specific pesticide sampling sites within the Ross and Black Basins. Pesticides were first added to the 2022-2023 Technical Report, previous scores have been added post-publication.

  - The Bohle River Total Phosphorus (TP) grade remained "very poor" for the sixth[2] year in a row, and the DIN grade remained "very poor" although increased its score slightly compared with 2022-2023.
  - DIN values in the Upper Ross and Paluma Lake sub basins remain "NA" due to the Water Quality Objective values (WQOs) being equal to or less than the Limit of Reporting values (LOR).
- The Black Freshwater Basin score increased from 66 to 71 within the same grade of "good".
  - This improvement was largely driven by an improvement in the physical-chemical indicator category from 63 to 74. Specifically, the turbidity indicator in the Bluewater Creek Sub Basin improved notably from "poor" (28) to "moderate" (59). This increase is after several years of lower scores and will need to be monitored for consistency.
  - Althaus Creek shows ongoing low scores and grades for the TP and Turbidity indicators (42 and 58, "moderate"), and further investigation would be required to isolate specific drivers. An increase in grade has been noted, however this may be driven by the limited number of samples collected (Appendix J), continued improvement is needed particularly in years with a greater number of samples.

Habitat and Hydrology

- There is no new data available for the freshwater habitat and hydrology section, thus scores have not changed since the previous report. Historic key messages are presented below:
  - Standardised scores for the habitat and hydrology index increased in both freshwater basins.
    - The riparian extent indicator category improved in both basins, with the Black Freshwater Basin recording its first increase in freshwater riparian vegetation score since the beginning of the HWP Technical Report.
  - Sub basin scores have been calculated and presented for the first time. This allowed for several new observations such as:
    - Identifying the Stuart Creek sub basin as the location with the greatest loss of riparian vegetation extent between 2019 and 2021.
    - Identifying the Bluewater and Rollingstone Creek sub basins as the locations with the greatest loss of wetland extent between 2019 and 2021.
    - Identifying several sub basins with the Black Freshwater Basins that have gained riparian vegetation extent between 2019 and 2021.

Fish

- There is no new data available for the freshwater fish section, thus scores have not changed since the previous report. Historic key messages are presented below:
  - This is the second time the fish index has been measured and scores for the fish index declined in both basins.
    - The primary driver was the PONIS indicator category in the Ross Basin (decreased from 60 to 41), and the POISE indicator category in the Black basin (decreased from 66 to 25).

[2] Note that only five years of historical data are shown in each technical report. However full historical scores are available upon request.

- Within the Ross Basin, 4011 fish from 29 species were caught during sampling.
  - 86% (3447) were indigenous and were released after identification.
  - 14% (564) were non-indigenous and were euthanised.
    - 529 fish were alien, 35 were translocated.
  - Scores indicate that most waterways were graded as “moderate”.
- Within the Black Basin, 2217 fish from 25 species were caught during sampling.
  - 83% (1830) were indigenous and were released after identification.
  - 17% (387) were non-indigenous and were euthanised.
    - All non-indigenous species were alien.
  - Scores indicate that some waterways were graded “very good’ whilst others were “very poor”.
  - The large decrease in the POISE indicator category score is most likely connected to heavy rainfall before sampling dispersing the fish populations.

Pesticides

- This is the second year in which pesticides data have been reported in the Townsville Dry Tropics Technical Report.
- Pesticide results and scores are not representative of the entire basin, as pesticides were only monitored at two sites (one in Ross River and one in Black River).
- The pesticides index is a risk metric, even if scores are “very low risk”, this does not indicate the absence of pesticides completely.
- The score for the Black Basin sample site increased from 82 to 84 although did not change grade.
- Notably, both the score and grade decreased for the Ross River sample site, from “very low risk” (81) to “low risk” (75).
  - Two new pesticides were detected (Hexazinone (PSII) and Metsulfuron-methyl (non-PSII)), for the first time in more than 5 years, while one pesticide was not detected from the previous year (Triclopyr (non-PSII)).
  - In particular, even a single detection of Metsulfuron-methyl for a single day can result in a notable contribution to the annual wet season Pesticide Risk Metric (PRM) due to its high toxicity and very low guideline value. Continued monitoring is required to understand if this sharp decrease in scores continues.

Estuarine Environment

Table 6. Comparison of 2023–2024 weighted scores for Water Quality and Habitat indices in the Ross Estuarine Basin and Black Estuarine Basin against previous years.

Basin	2023-2024		2022-2023		2021–2022		2020–2021		2019–2020		2018–2019	
	WQ	H	WQ	H	WQ	H	WQ	H	WQ	H	WQ	H
Ross	69 (B)	X	79 (B)	74 (B)	83 (A)	X	88 (A)	X	88 (A)	X	39 (D)	73 (B)
Black	61 (B)	X	68 (B)	50 (C)	64 (B)	X	66 (B)	X	47 (C)	X	52 (C)	71 (B)

■ 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.

Key Messages

Water Quality

- The Ross Estuarine Basin overall water quality grade remained “good”, however the score decreased from 79 to 69.
    - Most influential was the decline in the score for DIN in the Louisa Creek watercourse, which saw a decrease in grade from “good” (67) to “very poor" (0). This decline is the first notable decrease in DIN scores in five years of reporting. The cause(s) of this decline have not been determined, however could have results from increasing land use impacts, weather conditions and/or the sample timing in relation to environmental events. Additional, years of sampling are required to establish trends.
    - Louisa Creek showed ongoing low scores and grades for the Low DO and Nutrients indicators, along with recent low scores for the DIN indicator. Further investigation would be required to isolate specific drivers.
- The Black Estuarine Basin overall water quality grade remained “good”, however the score decreased from 68 to 61.
    - Most influential was the decrease in score for the Low DO indicator in Camp Oven Creek (42 to 2), Turbidity in Bluewater Creek (63 to 28) and Sleeper Log Creek (59 to 35), and DIN in Bluewater Creek (65 to 50). However, minor improvements that occurred across several indicators in several watercourses “muted” the effect of this decline on the overall basin grade.
    - Althaus Creek showed ongoing low scores and grades for the turbidity indicator, and further investigation would be required to isolate specific drivers. An increase in grade has been noted, however continued improvement is needed.
    - Over several years Sleeper Log Creek has shown a consistent decline in Turbidity for both score and grade. It is recommended that further investigation is conducted to isolate specific drivers.
    - Scores and grades decreased in Crystal Creek for DIN, TP, and Turbidity. Ongoing monitoring is essential to determine if this continues.
- Across all estuaries in the Dry Tropics Region, 10 of 13 watercourses received a grade of “good” or “very good” for nutrients, and 8 of 13 received a grade of "good” or “very good” for physical-chemical properties.

Habitat

- There is no new data available for the estuarine habitat section, thus scores have not changed since the previous report. Historic key messages are presented below:
  - Sub Basins scores have been calculated and presented for the first time. This allowed for several new observations such as:
    - Identifying the Bohle River and Crystal Creek sub basins as the main areas of mangrove and saltmarsh loss and all other sub basins either undergoing no change or receiving small increases in mangrove and saltmarsh vegetation.
    - Identifying the Black River, Bluewater Creek and Rollingstone Creek sub basins as key drivers of riparian vegetation loss and several sub basins as the main areas of gain of riparian vegetation.
  - The Black Estuarine Basin recorded its first increase (11.7ha) in mangrove and saltmarsh vegetation since the beginning of the Dry Tropics Technical Report.
  - The Black Estuarine Basin also recorded its first ever loss in riparian vegetation (-9.8ha) since the beginning of the Dry Tropics Technical Report.
    - This may be connected to the ongoing urban development throughout the basin.
  - In the Ross Estuarine Basin mangrove and saltmarshes decreased (-8.5ha) and riparian vegetation increased (0.2ha).

Inshore Marine Environment

Table 7. Comparison of 2023–2024 weighted scores for Water Quality and Habitat in Cleveland Bay and Halifax Bay against previous years.

Zone	2023-2024		2022-2023		2021–2022		2020–2021		2019–2020	
	WQ	H	WQ	H	WQ	H	WQ	H	WQ	H
Cleveland Bay	76 (B)	37 (D)	73 (B)	53 (C)	78 (B)	57 (C)	73 (B)	54 (C)	79 (B)	48 (C)
Halifax Bay	65 (B)	44 (C)	73 (B)	47 (C)	69 (B)	45 (C)	73 (B)	49 (C)	54 (C)	52 (C)

■ 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.

Key Messages

Water Quality

- The Cleveland Bay inshore marine zone overall water quality grade remained “good” and the score increased from 73 to 76.
  - Grades for indicators with the nutrient indicator category continue to remain moderate to “very poor” within the Magnetic Island Sub Zone. These scores are the result of high concentrations of nutrients, stringent water quality objectives, and proximity to a range of anthropogenic activities.
  - Grades for Turbidity and TSS remained “very poor” in the Enclosed Coastal Outside Port Zone area. This location has had several years of low results, and it is recommended that further investigation is conducted to determine the cause of the decline.
- The Halifax Bay inshore marine zone overall water quality grade remained “good” however declined from 73 to 65.

- Most influential was the Chlorophyll a indicator in the Open Coastal and Midshelf Sub Zones.
- Chlorophyll a decline from “good” (61) to “poor” (40) in the Open Coastal and Sub Zone and decline from “moderate” (43) to “poor” (36) in the Midshelf Sub Zone. Continued sampling is required to monitor for trends.

Habitat

- The Cleveland Bay inshore marine zone grade declined from moderate to poor, and also showed a large score decrease (53 to 37).
  - The seagrass grade within Cleveland Bay declined from good to poor, while the score decreased from 68 to 37.
    - The biomass condition indicator is the primary driver of decline scores, with several meadows exhibiting losses of meadow “hotspots”. However, the area and composition condition indicators largely remain stable for all meadows, indicating the potential for recovery.
    - Biomass losses are driven primarily by system-wide pressures such as TC Kirrily, as well as periods of high cloud cover, high winds, elevated wave heights and rainfall that are resulting in extended periods of low light.
    - Successive environmental conditions that are not favourable for seagrass growth and persistence, during and over multiple years are likely to have caused the seagrass condition loss recorded in the Townsville region.
  - The coral grade within Cleveland Bay remained “poor”, however the score decreased slightly from 39 to 37. Scores and grades from coral in Cleveland Bay have fluctuated within this range for the past four years due to exposure to several pressures including cyclones, and increased water temperatures leading to bleaching.
  - Low scores are primarily driven by the Juvenile and macroalgae indicators, suggesting limited coral recruitment and a high density of macroalgae competing for available space.
- The Halifax Bay inshore marine zone grade remained “moderate” although the score decreased slightly from 47 to 44.
  - The coral grade with Halifax Bay was 44 (moderate), the lowest score received in the past five years (by 1).
  - There remains a notable amount of macroalgae recorded at three of six sites.

Offshore Marine Environment

Table 8. Comparison of 2023–2024 weighted scores for Habitat in the Offshore Marine Environment against previous years.

Zone	2023-2024		2022-2023		2021–2022		2020–2021		2019–2020	
	WQ	H	WQ	H	WQ	H	WQ	H	WQ	H
Offshore	ND	64 (B)	ND	63 (B)	ND	64 (B)	ND	62 (B)	100 (A)	56 (C)

■ 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.

Key Messages

Water Quality

- No data were available for the 2023–2024 Townsville Dry Tropics Technical Report.

Habitat

- The Offshore Marine Zone coral grade remained “good”, with minimal changes to the previous Technical Report.
    - Juvenile density was graded as “very good” at 7 of 9 reefs surveyed.
    - All coral reefs had an overall grade of “moderate” or “good”.
    - John Brewer Reef shows signs of recovering from a recent crown-of-thorns starfish outbreak.
    - TC Kirrily had a limited impact on total coral cover at survey sites; however, the positioning of some sites (e.g. leeward) may have provided protection.

Litter

Litter was first included in the 2019–2020 report card. The data used to derive the scores and grades for the litter index is from Tangaroa Blue Foundation's (TBF) Australian Marine Debris Initiative Database (AMDI). The data is collected by volunteers, and partners through the Reef Clean program which is funded through the Australian Government's Reef Trust.

The methodology has been updated from the initial year of data collection, and data collected from new sites. Zone scores are not comparable as the sites litter is collected from each year in each Zone varies, thus only site-specific scores and grades are presented (Table 9).

Table 9. Comparison of 2022–2023 standardised scores and grades for Litter in the Townsville Dry Tropics region against previous years.

Zone	Site	Scores and Grades				
		2023-2024	2022-2023	2021-2022	2020-2021	2019-2020
Halifax Bay	North West Beach, Pelorus Island	ND	ND	ND	ND	95 (VLP)
	West Beach, Pelorus Island	ND	ND	ND	ND	80 (VLP)
	North Beach, Orpheus Island	ND	ND	ND	ND	4 (VHP)
	Little Pioneer Bay, Orpheus Island. underwater	ND	91 (VLP)	ND	ND	ND
	Rocky Beach, Orpheus Island	39 (HP)	ND	ND	ND	ND
	Fig Tree Bay, Orpheus Island	ND	28 (HP)	ND	ND	ND
	Big Rock Bay, Orpheus Island	ND	7 (VHP)	7 (VHP)	7 (VHP)	21 (HP)
	Fig Tree Beach, Orpheus Island	41 (MP)	ND	19 (VHP)	16 (VHP)	ND
	Pioneer Bay, Orpheus Island	ND	84 (VLP)	ND	ND	ND
	Picnic Bay, Orpheus Island	ND	5 (VHP)	2 (VHP)	11 (VHP)	0 (VHP)
	Boulder Beach North, Orpheus Island	ND	ND	14 (VHP)	ND	ND
	Yanks Jetty, Orpheus Island	ND	ND	ND	76 (LP)	74 (LP)
	Boulder Beach, Orpheus Island	ND	ND	1 (VHP)	ND	ND
	South Beach, Orpheus Island	ND	ND	10 (VHP)	ND	42 (MP)
	Fantome Island, Northern End	ND	57 (MP)	36 (HP)	12 (VHP)	ND
	North West Beach, Fantome Island	ND	61 (LP)	ND	ND	ND
	Ollera Beach	ND	ND	ND	ND	39 (HP)
	Rollingstone Beach	ND	ND	ND	ND	50 (MP)
	Toomulla Beach	ND	ND	ND	ND	53 (MP)
	Toomulla main beach	ND	ND	83 (VLP)	ND	ND
	Saunders Beach	ND	ND	ND	ND	71 (LP)
Cleveland Bay	Bushland Beach, Townsville	ND	55 (MP)	ND	62 (LP)	ND
	Myrmidon Reef underwater	ND	ND	ND	98 (VLP)	ND
	Radical Bay, Magnetic Island	ND	96 (VLP)	ND	ND	ND
	Horseshoe Bay, Magnetic Island	91 (VLP)	83 (VLP)	34 (HP)	ND	ND
	Florence Bay, Magnetic Island	ND	51 (MP)	ND	ND	ND
	Arthur Bay, Magnetic Island	ND	ND	ND	43 (MP)	ND
	Alma Bay, Magnetic Island	33 (HP)	60 (LP)	71 (LP)	63 (LP)	45 (MP)
	Alma Bay, Magnetic Island underwater	98 (VLP)	100 (VLP)	ND	98 (VLP)	97 (VLP)
	Geoffrey Bay, Magnetic Island	ND	ND	ND	80 (VLP)	ND
	Geoffrey Bay Reef, Magnetic Island underwater	ND	ND	ND	ND	93 (VLP)
	Nelly Bay Beach, Magnetic Island	73 (LP)	77 (LP)	73 (LP)	77 (LP)	53 (MP)
	Nelly Bay, Magnetic Island underwater	ND	99 (VLP)	99 (VLP)	99 (VLP)	100 (VLP)
	Shelly Beach, Pallarenda	ND	44 (MP)	ND	29 (HP)	63 (LP)
	Shelly Cove, Cape Pallarenda Conservation Park	98 (VLP)	92 (VLP)	91 (VLP)	70 (LP)	67 (LP)

Zone	Site	Scores and Grades				
		2023-2024	2022-2023	2021-2022	2020-2021	2019-2020
	Cape Pallarenda Old Jetty Area	56 (MP)				
	Pallarenda Beach	85 (VLP)	84 (VLP)	72 (LP)	ND	ND
	Rowes Bay	64 (LP)	89 (VLP)	87 (VLP)	75 (LP)	75 (LP)
	Kissing Point, Townsville	ND	ND	ND	79 (LP)	ND
	Strand Park, Townsville	80 (VLP)	ND	ND	74 (LP)	62 (LP)
	Strand Waterpark Beach	83 (VLP)	ND	ND	86 (VLP)	ND
	Secret Beach, Ross River, Townsville,	91 (VLP)	81 (VLP)	ND	ND	ND
Ross	Three Mile Creek, Pallarenda	ND	ND	ND	37 (HP)	ND
	Strand Rock Pool, Townsville	ND	74 (LP)	ND	47 (MP)	ND
	Jezzine Barracks Townsville Heritage Precinct	ND	63 (LP)	ND	ND	ND
	West End, Townsville	ND	66 (LP)	ND	ND	ND
	Ross Creek, Townsville	ND	59 (MP)	46 (MP)	ND	ND
	Queensland Country Bank Stadium	ND	ND	21 (HP)	23 (HP)	ND
	South Townsville Recreational Boat Park	ND	ND	ND	33 (HP)	ND
	Anderson Park, Townsville	ND	ND	91 (VLP)	ND	ND
	Sherriff Park Townsville	ND	ND	73 (LP)	ND	ND
	Aplins Weir Rotary Park	ND	74 (LP)	69 (LP)	35 (HP)	41 (MP)
	Lake Idalia Wetland Foreshore	ND	45 (MP)	ND	ND	ND
	Riverside Gardens Community Centre, Ross River, Douglas	48 (MP)	ND	ND	ND	ND
	Apex Park, Condon	ND	ND	62 (LP)	ND	ND

Standardised scoring range: ■ Very High Pressure (VHP) = 0 to <20 | ■ High Pressure (HP) = 20 to <40 | ■ Moderate Pressure (MP) = 40 to <60 | ■ Low Pressure (LP) = 60 to <80 | ■ Very Low Pressure (VLP) = 80 to 100 | NA = No data available

Sites where litter has been collected underwater are indicated. Where there are two sites with the same location name, for example, Alma Bay, Magnetic Island is the beach area above the low tide mark and Alma Bay, Magnetic Island underwater is collected by diving out from the beach. If a site is not designated as underwater and is on the coast, it is above the low tide mark.

Key Messages

- Alma Bay beach at Magnetic Island had the highest litter pressure in the region.
- The litter pressure on the east coast of Orpheus Island appears to be decreasing which may be associated with regular collection as well as local factors.
- The most amount of litter pressure on the mainland was at Cape Pallarenda Old Jetty area with moderate litter pressure and Shelly Cove, Cape Pallarenda Conservation park had the least with very low litter pressure on the mainland for Cleveland Bay.
- The only site within the Ross Basin, the Riverside Gardens Community Centre had a moderate litter pressure.

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Glossary of Terms

Table 10. Glossary of terms used in the Townsville Dry Tropics Report Card Results 2025 Technical Report.

AIMS	Australian Institute of Marine Science
Alien species	Species that are not native to any part of Australia
AMDI	Australian Marine Debris Initiative
Artificial barriers	Any barrier that prevents or delays connectivity between key habitats. Potentially impacting migratory fish populations, reducing diversity of aquatic species and the condition of aquatic ecosystems (Moore 2016)
Basin	Area of land where surface water runs to smaller creeks or rivers discharging into a common point, may include many sub-basins or sub-catchments
BOM	Bureau of Meteorology
Catchment area	Area of land from which rainfall flows into a river, lake or reservoir and discharges into a common point
Chlorophyll-*a*	An indicator of phytoplankton biomass, widely considered a useful proxy of nutrient availability and system productivity
Climate	Refers to both natural climate variability and climate change
CVA	Conservation Volunteers Australia
DETSI	Department of Environment, Tourism, Science and Innovation of the Queensland Government
DHW	An accumulated measurement of sea surface temperature (SST) that assesses the instantaneous bleaching heat stress during the prior 12-week period. (Significant coral bleaching usually occurs when the DHW value reaches 4 °C-weeks. By the time the DHW value reaches 8 °C-weeks, severe, widespread bleaching and significant mortality are likely)
DIN	Dissolved Inorganic Nitrogen. Comprised of nitrate, nitrite, and ammonium
DO	Dissolved Oxygen
HWP	Healthy Waters Partnership for the Dry Tropics
Ecosystem	A dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit
Ecosystem Health	An ecological system is healthy and free from 'distress syndrome' if it is stable and sustainable. That is, if it is active and maintains its organization and autonomy over time and is resilient to stress. Ecosystem health is thus closely

	linked to the idea of sustainability, which is seen to be a comprehensive, multiscale, dynamic measure of system resilience, organization, and vigour.
Enclosed Coastal (EC)	A partially smooth, semi protected water body including shallow, enclosed waters near an estuary mouth and generally considered the interface between coastal and inland waters. Its boundaries depend on the local or regional authorities.
Environmental values (EV)	Characteristics or qualities of a natural system that supports viable natural communities and human uses
eReefs	Integrated modelling system to visualise, communicate and report reef information for the GBR
Floor rounding	Rounding decimal places down to the nearest integer. (for example, 60.9 = 60)
Flow (as an indicator)	The degree that the natural river currents or stream flows have been modified, influencing waterways and ecosystem health
FRP	Filterable Reactive Phosphorus
GBR	Great Barrier Reef
GBR Report Card	GBR Report Card under the Reef Water Quality Protection Plan (2013)
GBRMPA	Great Barrier Reef Marine Park Authority
GBRMP	Great Barrier Reef Marine Park
High DO	High Dissolved Oxygen. Can be a sign of algae growth and poor water quality
Impoundment length	An indicator used in the 'in-stream habitat modification' indicator for freshwater basins in the region. The proportion (%) of the linear length of the main river channel when at the full capacity of artificial in-stream structures, such as dams and weirs.
Index	The aggregation of indicator categories. For example, the water quality index is an aggregation of nutrient, phys-chem, and Chlorophyll *a* indicator categories.
Indicator	A measure of one component of an environment. For example, the total amount of phosphorus (TP) present in the water.
Indicator category	The aggregation of indicators. For example, the nutrient indicator category is an aggregation of TP and DIN indicators.
Inshore Marine environment	Includes Enclosed Coastal (EC), Open Coastal (OC) and Midshelf (MS) waters, extending east to the boundary with the offshore waters (Department of Environment and Science 2018, Great Barrier Reef Marine Park Authority 2010).

Inshore Marine Zone	Inshore Marine Zone is a reporting zone in the Townsville Dry Tropics Report Card that includes Inshore Marine environments
ISP	Independent Science Panel
Invasive species	Invasive species include both alien and translocated species
JCU	James Cook University
Litter	Any type of waste material that is less than 200 litres in volume and that has been deposited unlawfully
Low DO	Low Dissolved Oxygen. Can result in anoxic waterways (depletion of oxygen) and poor water quality.
LTMP	Long Term Monitoring Program of GBR Midshelf and offshore reef communities
Macroalgae (cover)	Indicator used to assess coral health. Macroalgae includes seaweed and other visible benthic (attached to the bottom) marine algae.
Marine Debris	Also called marine litter. Defined as any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment.
MD	Moderate disturbed waters
Midshelf Waters	Midshelf Waters lie offshore of the open coastal waters and extend from 12 to 48 km offshore in the Burdekin region (waters south of approximately Pelorus Island) and 6 to 24 km offshore in the Wet Tropics region (waters north of Pelorus Island) (Great Barrier Reef Marine Park Authority 2010).
MMP	Marine Monitoring Program of the inshore reef communities along Wet Tropics, Burdekin, Mackay, Whitsunday, and Fitzroy regions of the GBR
Modified Wetland	Modified wetlands are existing wetlands which were also former natural wetlands, where activities that modify wetland hydrology and/or structures associated with these activities have been observed from aerial or satellite imagery or from field survey data (Queensland Wetlands Program 2023).
MSL	Mean Sea Level
Non-indigenous species	See Invasive species
NOx	Generic term for nitrogen oxides such as mixtures of nitrites and nitrates
NRM	Natural resource management
NTU	Nephelometric Turbidity Unit. The units that turbidity is measured in.

OGBRWH	Office of the Great Barrier Reef and World Heritage, Queensland Government
Offshore waters	Offshore waters lie offshore of midshelf waters and extend 48 to 180 km from the coast in the Burdekin region (waters south of approximately Pelorus Island) and 24 to 170 km offshore in the Wet Tropics region (waters north of Pelorus Island) (Great Barrier Reef Marine Park Authority 2010)
Offshore Marine	Offshore is a reporting zone in the Townsville Dry Tropics Report Card that includes offshore waters
Open Coastal (OC)	Open Coastal Waterbodies extend from the coast, or if present, the seaward edge of an enclosed coastal waterbody. The seaward limit extends 12 km offshore in the Burdekin region (waters south of approximately Pelorus Island) and 6 km offshore in the Wet Tropics region (waters north of Pelorus Island) (Great Barrier Reef Marine Park Authority 2010).
Palustrine wetlands	Vegetated, non-riverine or non-channel systems that include billabongs, swamps, bogs, springs, soaks etc and have more than 30% emergent vegetation
Physical-chemical properties	(Phys-chem properties). Indicator category that includes dissolved oxygen and turbidity.
PN	Particulate Nitrogen
POTL	Port of Townsville Limited
PP	Particulate Phosphorus
QA/QC	Quality Assurance / Quality Control
QPSMP	Queensland Ports Seagrass Monitoring Program
RE	Regional Ecosystem
Reef 2050 Plan	The overarching framework of the Australian and Queensland governments for protecting and managing the reef until 2050
REMP	Receiving Environment Monitoring Program. A REMP provides a basis for evaluating whether the discharge limits or other conditions imposed upon an activity have been successful in maintaining or protecting receiving environment values over time.
Riparian extent	Vegetation with a 50m buffer from a waterway
RIMReP	Reef 2050 Integrated Monitoring and Reporting Program
Secchi	Secchi depth. A measure used to gauge the transparency (clarity) of water.
TBF	Tangaroa Blue Foundation

TCC	Townsville City Council
Translocated species	Species that are native to Australia but not native to the specific waterway
TP	Total Phosphorus
TSS	Total Suspended Solids
Turbidity	A measure of how cloudy/opaque water is, recorded in NTU
Waterway	A land-based body of water, e.g. a creek, river, or stream
WQO	Water Quality Objectives. Defined for specific regions, these values act as a management target. They do not necessarily reflect 'natural' condition but rather a state that is considered acceptable considering environmental, social, and economic factors.
WQGV	Water Quality Guideline Values. Defined for broad scale regions, these values act as an 'earliest baseline' and ideally reflect the natural state of the environment pre-European/pre-developed settlement (or pre-land clearing). They allow managers to assess how water quality has changed from 'natural' condition.

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1 Introduction

1.1 Overview

The Healthy Waters Partnership for the Dry Tropics (referred to as "the Partnership" or "HWP") was launched in January 2019, with a focus on producing an annual Report Card. The current Report Card is for the 2023–2024 year.

Where a seasonal monitoring program extends outside of the year period, such as inshore coral, data from the whole monitoring period are included. For monitoring programs that collect data less frequently than annually (for example, wetland and riparian extent) then the most recent data set is included. In June 2021, the Partnership also began releasing annual Stewardship Reports, highlighting the actions of partners to improve waterway health (Table 11).

Table 11. Timeline of key HWP publications.

Released:	**2025**	**2024**	**2023**	**2022**	**2021**	**2020**	**2019**
Reporting period:	**23-24**	**22-23**	**21–22**	**20–21**	**19–20**	**18–19**	**17–18**
Report Card	✓ (current)	✓	✓	✓	✓	✓	✓ (pilot)
Stewardship Report	✓ (current)	✓	✓	✓	✓		

The key deliverable for the Report Card is an assessment of the state of the waterway health. The Report Card focuses on three indices for waterway health: Water Quality, Habitat and Hydrology, and Fish. Indices are scored and graded for the freshwater, estuarine, inshore marine, and offshore marine environments within the Townsville Dry Tropics region. However, not all indices are scored and graded for each environment (for example, fish is only scored within the freshwater environment). To assess trends over time, summary results from previous reports are presented alongside this year's results.

1.2 Report Card Zones

The results presented in the 2023–2024 Report Card cover all areas of the Townsville Dry Tropics reporting region. On land, the Partnership region extends from the Crystal Creek catchment in the north, west to the Ross River (upper) catchment and to the Alligator Creek catchment in the south. In the marine environment the Partnership extends from the coastline to the outer edge of the Great Barrier Reef (GBR) Marine Park. The reporting region for the partnership incorporates all islands within this area, including Magnetic Island and the Palm Island group.

The Townsville Dry Tropics reporting region is divided into seven unique areas based on the environment type (freshwater, estuarine, inshore marine, and offshore marine) and riverine basin (Basin) (Black and Ross) or Bay (Zone) (Cleveland Bay and Halifax Bay) (Table 12, Figure 2). If required, Basins/Zones are divided into sub-basins/sub-zones based geographical definition and constructed boundaries (ports, weirs) provided by the Queensland water quality objectives (Department of Environment and Science 2018). The freshwater and estuarine zones for Magnetic Island and the Palm Island group are not currently included as there is no data available.

Table 12. The seven reporting areas in the Townsville Dry Tropics region.

Basin/Zone	Waterway
Ross Freshwater	Freshwater
Black Freshwater	Freshwater
Ross Estuarine	Estuarine
Black Estuarine	Estuarine
Cleveland Bay	Inshore Marine
Halifax Bay	Inshore Marine
Offshore Marine	Offshore Marine

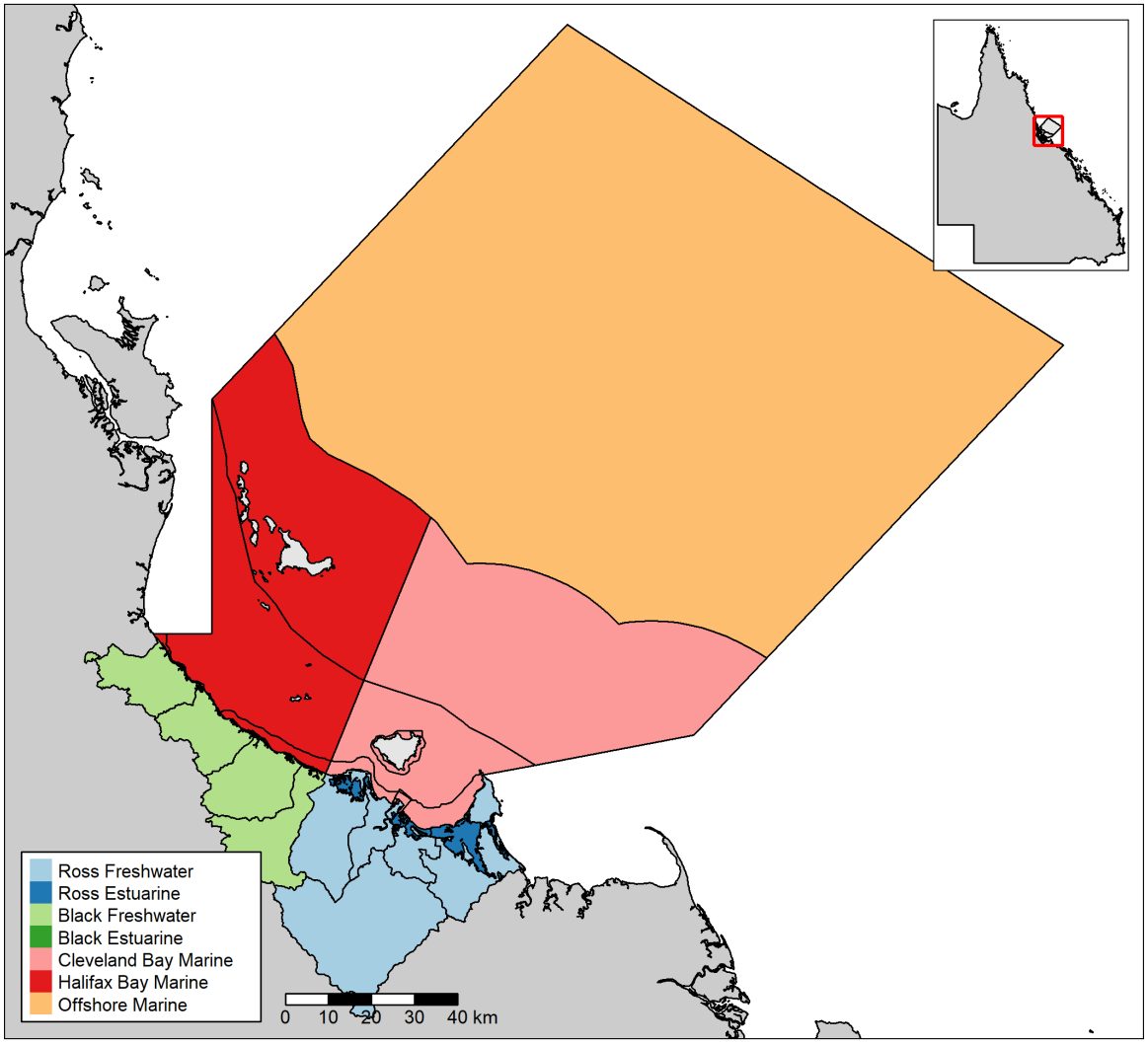

Figure 2. *Geographic boundary of the HWP reporting region, divided into seven areas based on the environment type (freshwater, estuarine, inshore marine, and offshore marine), and riverine basin (Basin) (Black and Ross) or Bay (Zone) (Cleveland Bay and Halifax Bay). Each area is further divided into additional areas depending on water type, water quality objectives, and water dynamics (e.g. flow).*

The topography of the Townsville Dry Tropics also plays a critical role in the division and understanding of the dynamics of the local environment. A digital elevation model (DEM) is

presented below that exemplifies the key mountain ranges and coastal planes that will be discussed throughout this technical report (Figure 3).

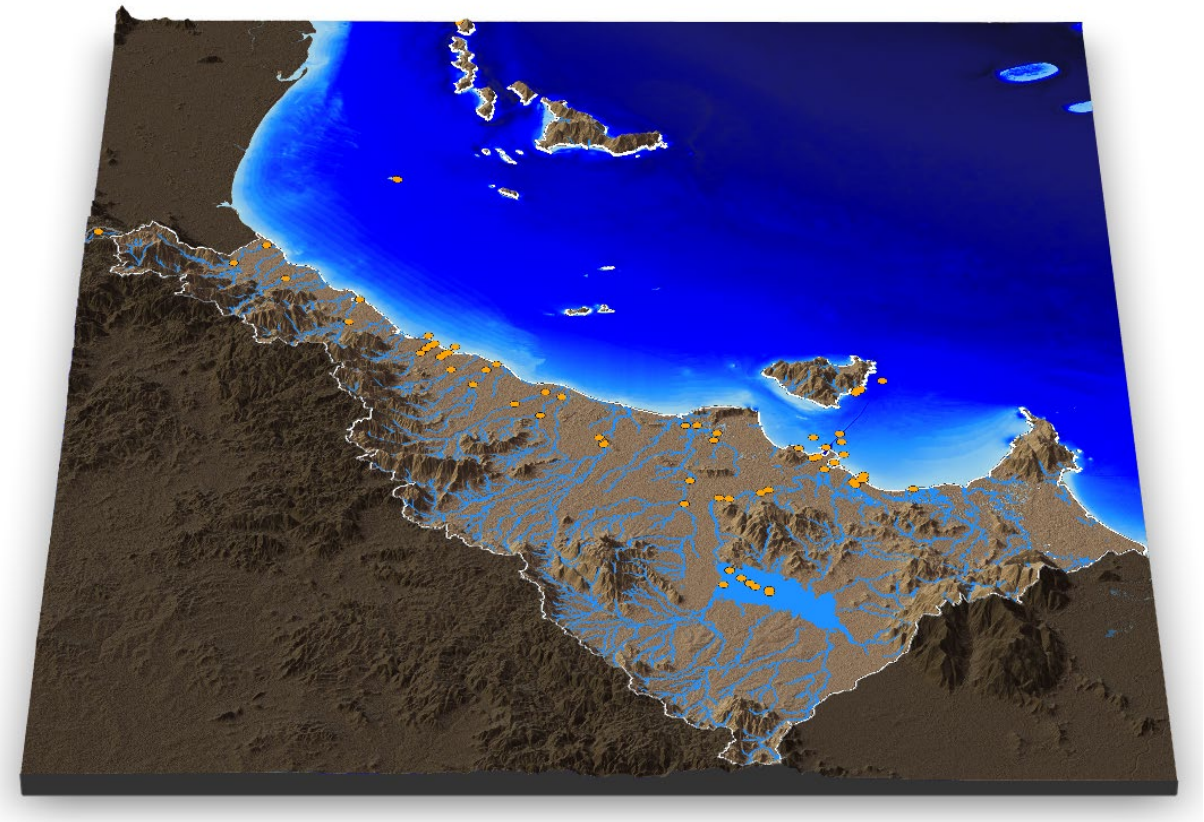

Figure 3. Digital Elevation Model (DEM) of the Townsville Dry Tropics region. Orange points symbolise water quality sampling locations. Note the high mountain ranges and low coastal planes.

1.3 Purpose of This Document

This report (hereby referred to as the Technical Report) provides insight into the results found in the 2023–2024 Report Card. Within are weighted and unweighted scores for indicators, indicator categories, and indices for all sites in the seven areas (Table 12). Key messages and confidence scores for each index are also provided. For further details on the design of the Report Card program, refer to the "Townsville Dry Tropics Program Design" and "Methods for Townsville Dry Tropics 2023–2024 Report Card (released in 2025)" (Healthy Waters Partnership for the Dry Tropics 2025).

1.4 Report Card History

A history of the Partnerships' Report Cards can be found in "Methods for Townsville Dry Tropics 2023–2024 Report Card (released in 2025)" (Healthy Waters Partnership for the Dry Tropics 2025).

2 Methods

Detailed methods can be found in "Methods for Townsville Dry Tropics 2023–2024 Report Card (released in 2025)". Key components to understand the Technical Report are presented below.

2.1 Terminology and Data Aggregation

Data is reported and aggregated at multiple levels: indicator, indicator category, and index. Results from indicators are aggregated into indicator categories, which are aggregated into indices. Results can only be aggregated if they meet the follow rules:

1. ≥50% of indicators are required to aggregate to an indicator category,
2. ≥60% of indicator categories are required to aggregate to an index.

There are three indices in the report card: Water Quality, Habitat and Hydrology, and Fish. Some indices are only measured in certain areas. A complete list can be found in Table 13.

Table 13. All indicators, indicator categories, and indices used in the 2023-2024 Technical Report and Report Card.

Environment	Index	Indicator Category	Indicator
Freshwater	Water Quality	Nutrients	Dissolved Inorganic Nitrogen
			Total Phosphorus
		Phys-Chem	Turbidity
			High/Low DO
	Habitat and Hydrology	Riparian vegetation	Change in riparian extent
		Wetlands	Change in wetland extent
		Artificial barriers	Fish barriers
			Impoundment length
	Fish	Proportion of Indigenous Species Expected	Indigenous Species
		Proportion of Non-Indigenous Species Expected	Translocated Species
			Alien Species
	Pesticides	Pesticides	Pesticides
Estuarine	Water Quality	Nutrients	Dissolved Inorganic Nitrogen
			Total Phosphorus
		Phys-Chem	Turbidity
			High/Low DO
	Habitat	Mangrove and Saltmarsh Extent	Change in mangrove and saltmarsh extent
		Riparian Vegetation	Change in riparian extent
Inshore	Water Quality	Nutrients	Total Phosphorus
			Nitrogen Oxides
			Total Nitrogen
			Filterable Reactive Nitrogen
			Particulate Nitrogen
			Particulate Phosphorus
		Phys-Chem	Total Suspended Solids

			Turbidity
			Secchi Depth
		Chlorophyll a	Chlorophyll a
	Habitat	Coral	Hard Coral Composition
			Coral Cover
			Change in coral cover
			Juvenile Density
			Macroalgae cover
		Seagrass	Biomass
			Meadow area
			Species composition
Offshore	Habitat	Coral	Change in coral cover
			Coral Cover
			Juvenile Density
All	Litter	Litter	Litter

2.2 Scoring

Data are graded using five ordinal values commonly used in Report Cards: “Very Good” (A) to “Very Poor” (E). Each indicator is scored on a scale appropriate for the variable being measured and thus some indicators have different scoring ranges. To ensure results for all indicators are comparable, all scores are converted (if required) into a standardised score between 0 and 100 (Table 14).

Table 14. Standardised scoring range and corresponding grades used in the Technical Report.

Scoring Range[3]	**Grade and Colour Code**
81 to 100	Very Good, (A), or Very Low Pressure
61 to <81	Good, (B), or Low Pressure
41 to <61	Moderate, (C), or Moderate Pressure
21 to <41	Poor, (D), or High Pressure
0 to <21	Very Poor, (E), or Very High Pressure

2.3 Presentation

The information in this technical report is summarised in an annual Report Card. The Report Card uses a stylized coaster to present the final grades for each index with their associated colours (Figure 4. B). This coaster is a slimmed down version of the aggregation used within the technical report (Figure 4. A). Coasters are created for each of the seven areas in the Townsville Dry Tropics region (Figure 2).

[3] Some indicators may have slightly different scoring ranges than demonstrated in this table.

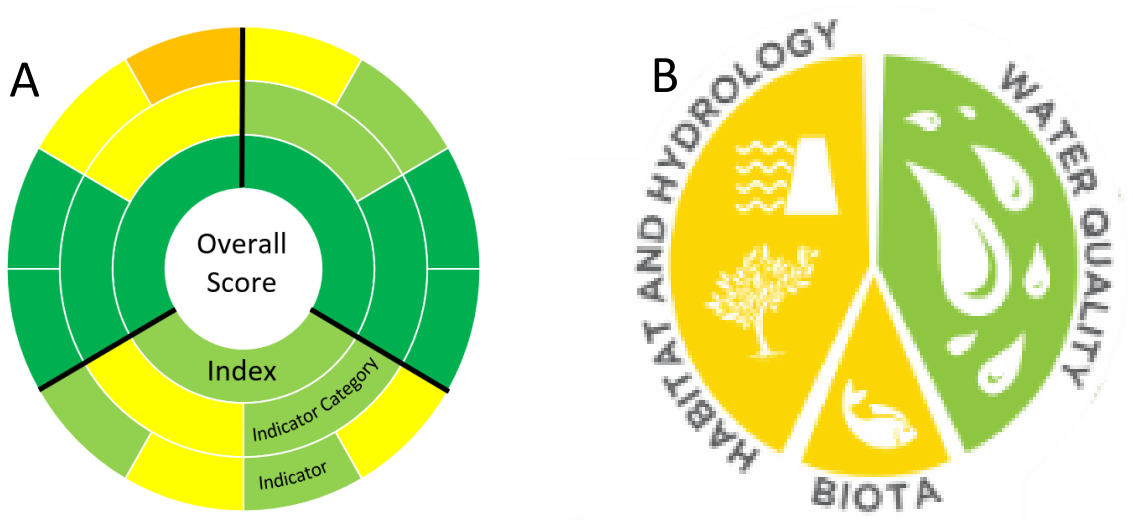

Figure 4. Coasters used within the Technical Report (A) and Report Card (B).

2.4 Confidence Measure

Results are given a qualitative confidence score based on the accuracy and appropriateness of the data used in the analysis. Scores are calculated using five criteria which are weighted to reflect their importance (Table 15). Final confidence scores range from 4.5 (very low) to 13.5 (very high).

Table 15. The criteria, score and weighting used to generate indices confidence scores.

Criteria	Score	Weighting
Maturity of Methodology	New = 1; Developed = 2; Established = 3	0.36
Validation	Limited = 1; Not comprehensive = 2; Comprehensive = 3	0.71
Representativeness	Low = 1; Moderate = 2; High = 3	2
Directness	Conceptual = 1; Indirect = 2; Direct = 3	0.71
Measured error	>25% = 1; 10% – 25% = 2; <10% = 3	0.71

Environmental Stressors

2023–2024

Written by Adam Shand

As part of the results for the Townsville Dry Tropics Report Card 2024 (Reporting on data from July 2023– June 2024)

Healthy Waters Partnership for the Dry Tropics (HWP)

July 2025

3 Environmental Stressors in The Townsville Dry Tropics Region

Environmental stressors such as extreme climate and intensive land use are influential factors for almost every indicator measured in the Technical Report. Between 1st July 2023 and 30th June 2024, the Townsville Dry Tropics region experienced two cyclones (Severe Tropical Cyclone Jasper approx. 450km away, and Severe Tropical Cyclone Kirrily approx. 50km away), weather events (wind, swell) as a result of TC Kirrily, and entered a neutral El Niño–Southern Oscillation (ENSO) (Bureau of Meterology 2025). Key influences for the 2023–2024 reporting period are summarised below.

- Grazing and conservation remain the two largest land use types by area. (Ross: 30.6% Conservation, 45.3% Grazing. Black: 43.0% Conservation, 39.9% Grazing).
    - Land use data has not been updated since the previous technical report (data for 2021, released 2023). The next update (2025 data) is expected to be released in 2027.
- Total rainfall was 930mm in the Ross Basin, and 1343mm in the Black Basin. Annual rainfall in both basins was classified in the “average” category, however, was less than the long-term mean (calculated from the most recent 30-year block of data: 1991 to 2020) of 1061mm and 1420mm respectively. Compared to the previous year, rainfall was much lower in the Ross Basin (1239mm to 930mm), and slightly lower in the Black Basin (1425mm to 1343mm).
    - Monthly rainfall was largely average throughout the year, ranging from the “below average” category to the “above average” category for 11 months of the year. In comparison, the previous year experienced large peaks and troughs of rainfall.
- The annual average air temperature was 24.9°C in the Ross Basin, and 24.4°C in the Black Basin and was classified in the “very much above average” category in both basins. No month of the year recorded less than the long-term average temperature. Compared to the previous year, air temperatures were slightly higher (24.8°C to 24.9°C in the Ross Basin, 24.2°C to 24.4°C in the Black Basin).
    - Annual mean temperatures exceeded the long-term mean (calculated from the oldest 30-year block of data available in the dataset (from 1911 to 1940) by 1.2°C in the Ross Basin and 1.3°C in the Black Basin.
- The annual average sea surface temperature was 26.8°C, which was 0.6°C above the long-term average of 26.2°C. Compared to the previous year, sea surface temperature was slightly lower (27.1°C down to 26.8°C).
    - For 9 months of the year monthly sea surface temperatures ranged from the “above average” category to the “highest 1%” on record category, with only October, November, and December temperatures falling into the “average” category.
    - The proxy for risk of coral bleaching ranged from “low risk” to “very high risk”, with most of the marine zone experiencing between 4 and 8+ Degree Heating Weeks.
    - These high temperatures (as noted by annual SST, and DHW) contributed to the 5th mass coral bleaching event for the Great Barrier Reef since 2016.

3.1 Land Use

Land use data describes what the dominant use for the land is, with nationally consistent descriptions set by the Australian Land Use and Management (ALUM) Classification system (Department of Agriculture, Fisheries and Forestry 2023). Land use in the Townsville Dry Tropics region in 2021 is summarised in Table 16, and Figure 5.

Table 16. Total area and percentage of land use classes in the Townsville Dry Tropics region in 2021.

Land Use (2021)	Ross Basin		Black Basin	
	%	km²	%	km²
Conservation	30.6	538.1	43.0	492.6
Dryland Agriculture	0.0	0.6	0.1	1.1
Forestry	2.6	45.0	6.8	78.0
Grazing	45.3	795.1	39.9	456.9
Irrigated Agriculture	0.6	10.8	1.8	20.3
Mining	0.3	5.5	0.5	5.3
Urban/Intensive	12.7	223.6	5.4	62.1
Water	7.8	137.6	2.6	29.4
Total Area	-	1756.2	-	1145.9

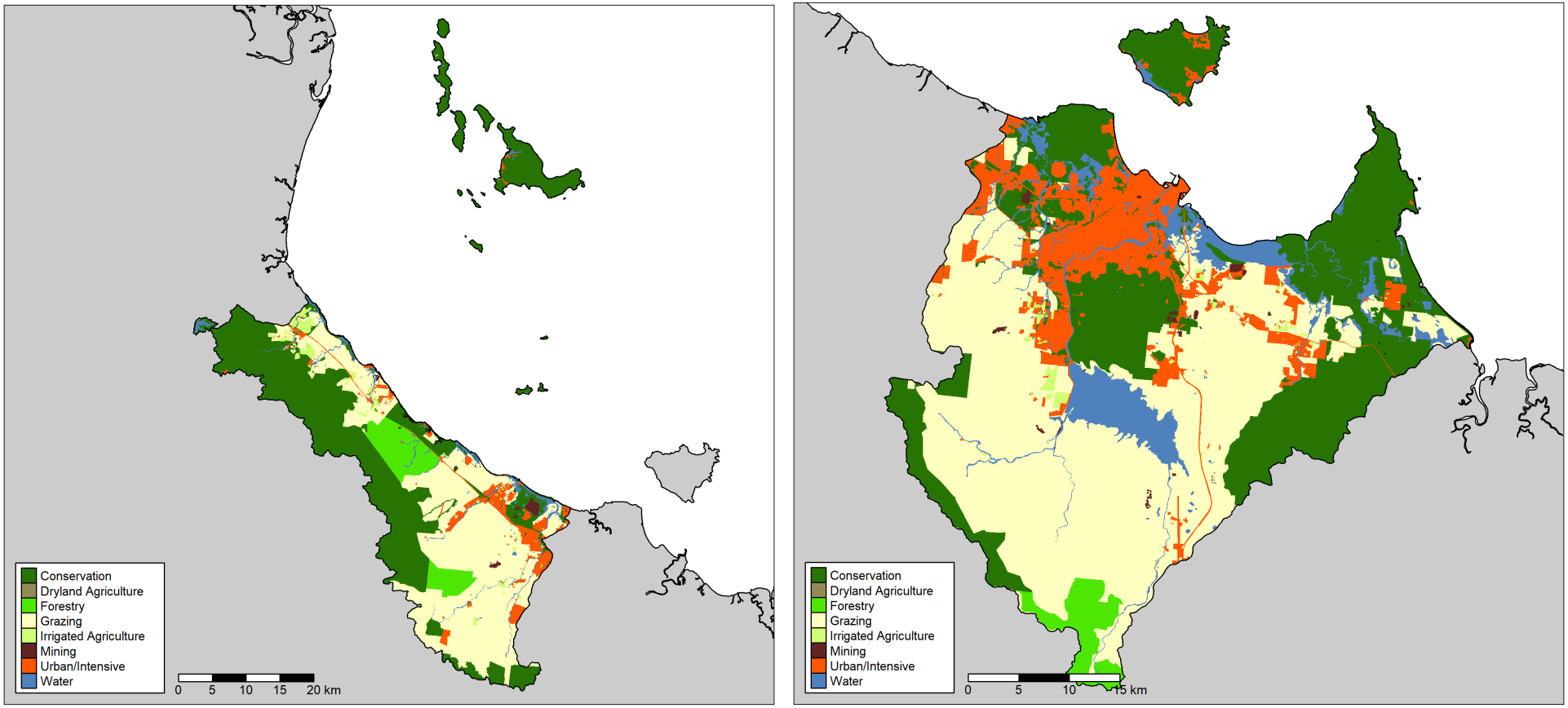

Figure 5. Land use categories in the Ross Basins and Black Basins of the Dry Tropics region in 2021.

3.2 Climate

A changing climate and extreme weather can have a major impact on the health of the environment both globally and within the Townsville Dry Tropics region. These forces directly and indirectly put pressure on local waterways and can influence the results presented in this report (IPCC 2022, United Nations 2023). Between 1st July 2023 and 30th June 2024, the Townsville Dry Tropics region experienced one cyclone, Severe Tropical Cyclone Kirrily (approx. 50km away), and entered a neutral El Niño–Southern Oscillation (ENSO) (Bureau of Meterology 2025). Key influences for the 2023–2024 reporting period are summarised below.

3.2.1 Rainfall

Monthly rainfall across the Townsville Dry Tropics region was largely average, with 11 months of rainfall in the Ross and Black basins ranging from the "below average" category (10th-30th percentile) to the "above average" category (70th-90th percentiles), and only one month of the year (July) falling in the "very much above average" category (90th - 99th percentile) of rainfall. The monthly averages are calculated from the most recent 30-year block of data: 1991 to 2020 (Table 17).

Table 17. Monthly rainfall percentiles in the Ross Basin and Black Basin grouped into seven categories.

Basin	2023						2024						Annual
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Ross													
Black													

■ = Lowest 1% | ■ = Very much below average | ■ = Below Average | ■ = Average | ■ = Above Average | ■ = Very much above average | ■ = Highest 1%

Interestingly, despite the occurrence of a severe tropical cyclone rainfall did not show any notable spikes and followed closely with season trends seen in the line plots below (Figure 7).

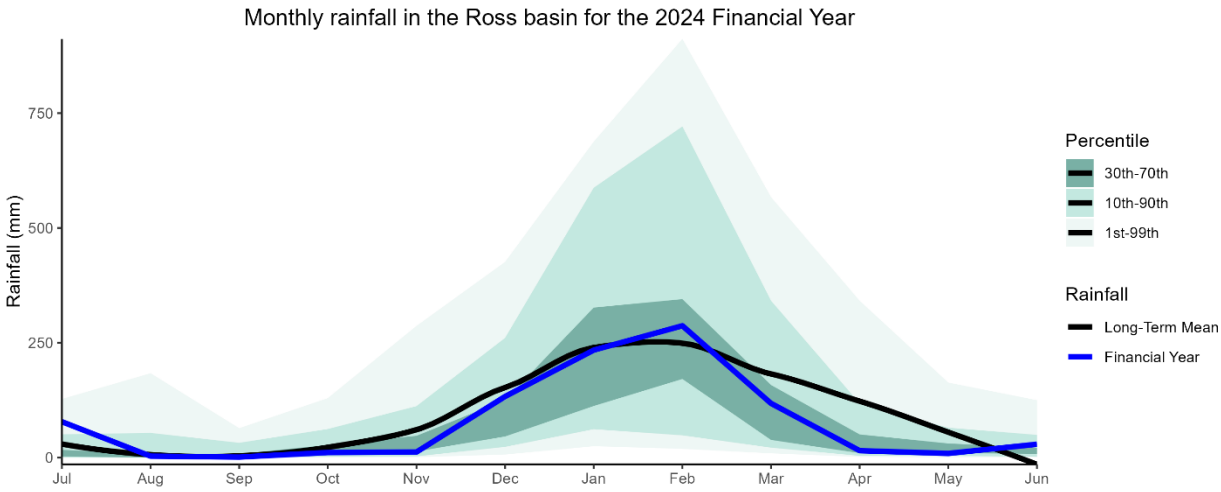

Figure 6. Monthly rainfall in the Ross Basin in comparison to the long-term mean (calculated from 1991 to 2020). The Blue line indicates rainfall for the current financial year. The black line indicates the long-term rainfall. The dark green shading represents the 30th to 70th percentiles of the long-term mean, the medium green shading represents the 10th to 90th percentiles of the long-term mean, and the light green shading represents the 1st to 99th percentiles of the long-term mean.

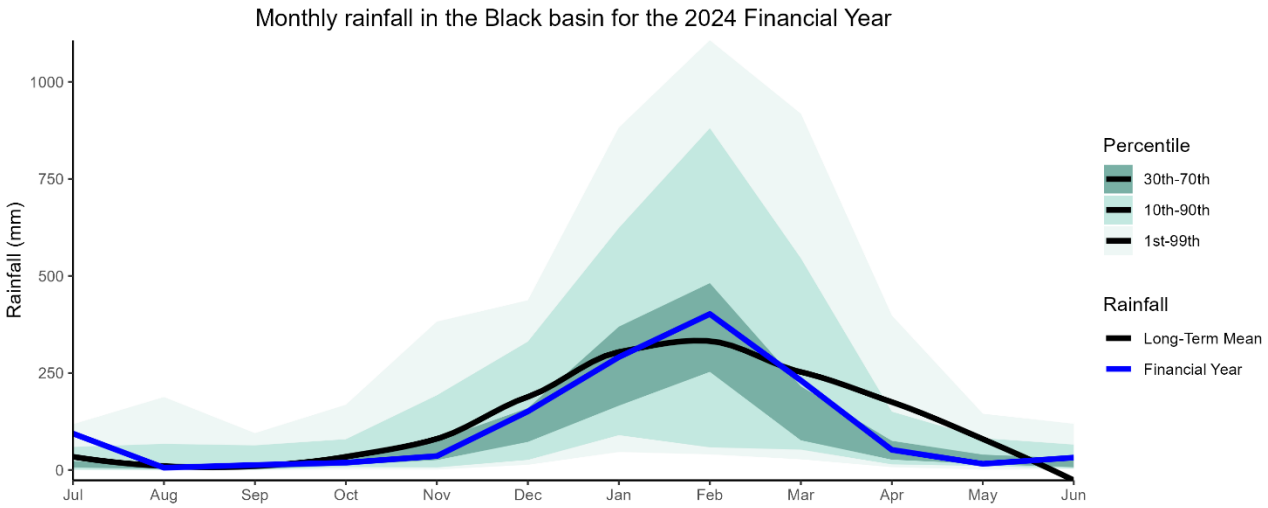

Figure 7. Monthly rainfall in the Black Basin in comparison to the long-term mean (calculated from 1991 to 2020). The Blue line indicates rainfall for the current financial year. The black line indicates the long-term rainfall. The dark green shading represents the 30th to 70th percentiles of the long-term mean, the medium green shading represents the 10th to 90th percentiles of the long-term mean, and the light green shading represents the 1st to 99th percentiles of the long-term mean.

Total annual rainfall was 930mm in the Ross Basin, and 1343mm in the Black Basin. This was less than the long-term mean (calculated from the most recent 30-year block of data: 1991 to 2020) by 131mm and 77mm respectively (Table 18).

Table 18. Annual rainfall summary statistics for the Ross Basin and Black Basin.

Basin	Annual Rainfall	Long-term mean 1991-2020 (ltm)	Anomaly (+/- ltm)	Percentage of the ltm
Ross	930mm	1061mm	-131mm	87.7%
Black	1343mm	1420mm	-77mm	94.6%

Annual rainfall was the greatest in the north of the Black Basin with just over 2000mm, while the least amount of rainfall was recorded on the western ridge of the Ross and Black Basins with only 800 to 1000mm. Across both basins, only the furthest northern reaches of the Black Basin received more rain than average. (Figure 8, Figure 9). Historic annual rainfall trends for each basin are presented in Appendix A and Appendix B. Season specific annual rainfall trends for each basin are presented in Appendix C.

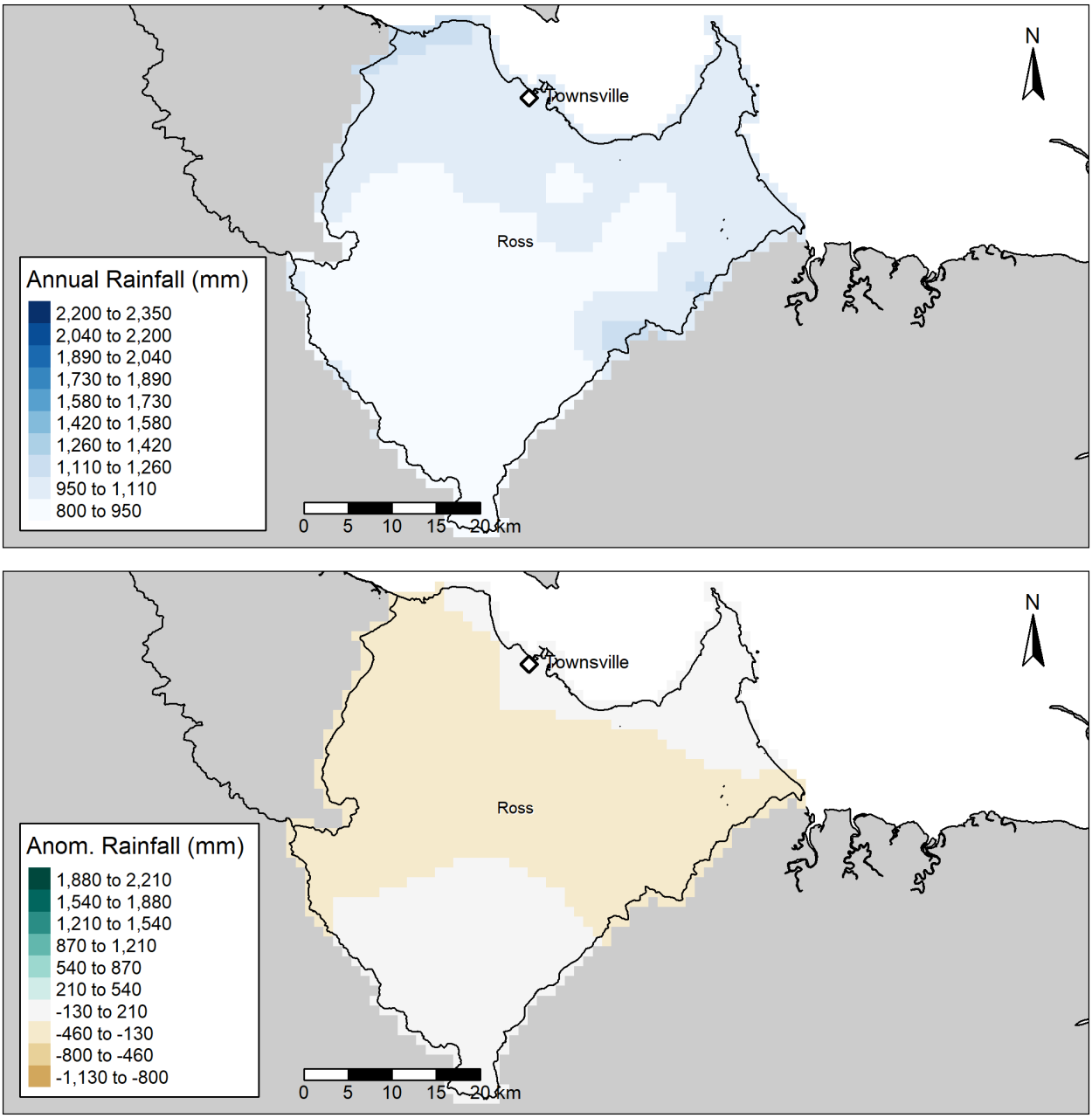

Figure 8. Total annual rainfall for the Ross Basin, of the Dry Tropics region for 2023-2024, and the anomaly of the 2023-2024 rainfall from the long-term mean (i.e., how much more or less (mm) was the 2023-2024 rainfall in comparison to the long-term historic average. Rainfall values were derived by summing monthly averages calculated across spatial grid sub-sets of each basin. The long-term mean was calculated from the most recent 30-year block (climate normal), which is 1991-2020. The scale for the annual rainfall map is based on the actual rainfall recorded for the financial year across the entire Dry Tropics Region (inclusive of the Black Basin). The scale for the anomaly rainfall map is based on the absolute min and max anomaly values recorded within the 30-year reference period inclusive of the current financial year.

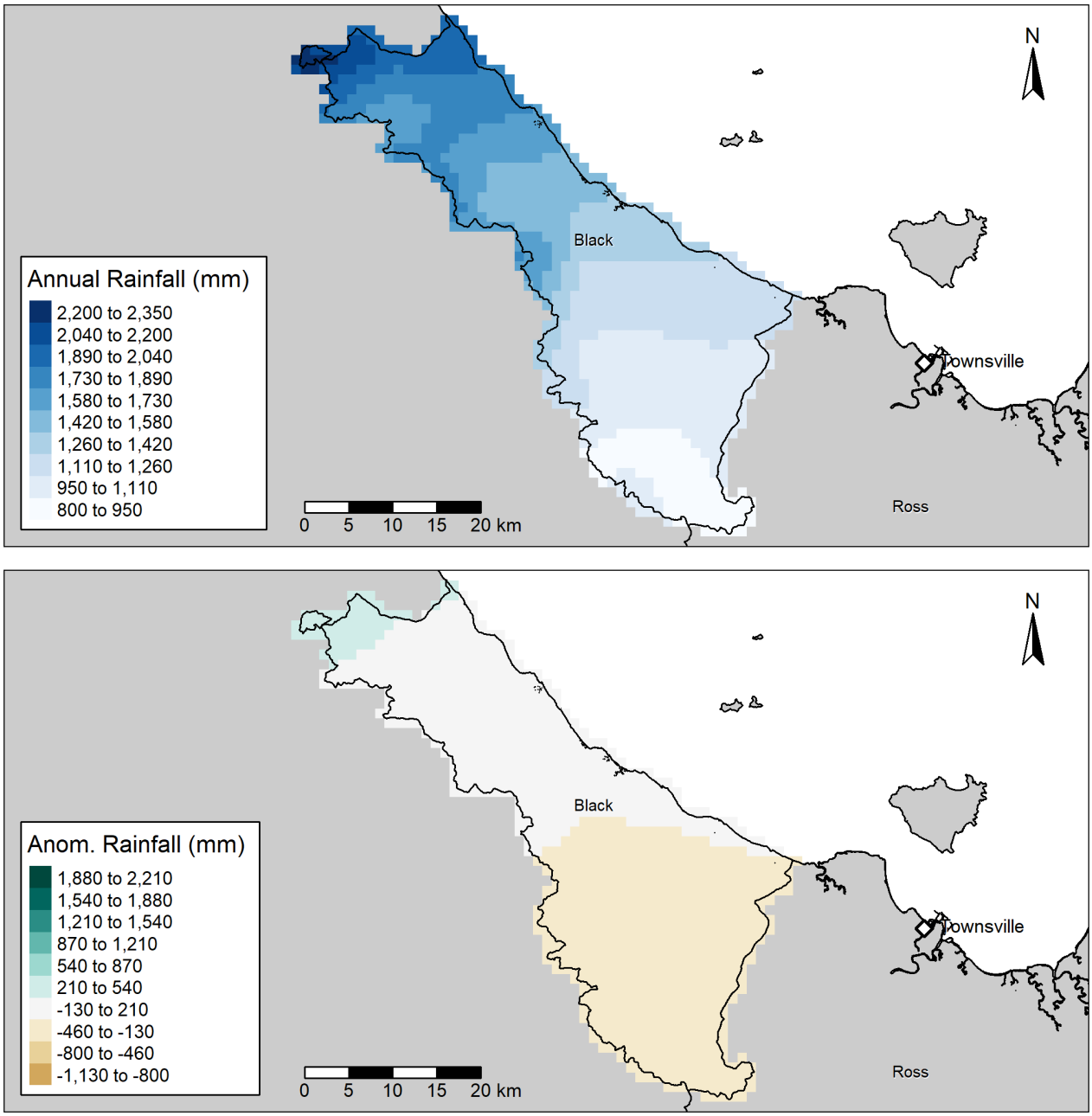

Figure 9. Total annual rainfall for the Black Basin, of the Dry Tropics region for 2023-2024, and the anomaly of the 2023-2024 rainfall from the long-term mean (i.e., how much more or less (mm) was the 2023-2024 rainfall in comparison to the long-term historic average. Rainfall values were derived by summing monthly averages calculated across spatial grid sub-sets of each basin. The long-term mean was calculated from the most recent 30-year block (climate normal), which is 1991-2020. The scale for the annual rainfall map is based on the actual rainfall recorded for the financial year across the entire Dry Tropics Region (inclusive of the Ross Basin). The scale for the anomaly rainfall map is based on the absolute min and max anomaly values recorded within the 30-year reference period inclusive of the current financial year.

3.2.2 Air Temperature

Mean monthly air temperature remained at or above the respective monthly means in both basins throughout the entire reporting period, with several months placed into the “highest 1%” of temperatures category for the month (Table 19). The monthly averages which are compared to the current year of data are calculated from the oldest 30-year block of data available in the dataset (from 1911 to 1940). This dataset was selected to reflect a “pre-industrial” baseline for comparison.

Table 19. Monthly air temperature percentiles in the Ross Basin and Black Basin grouped into seven categories.

Basin	2023						2024						Annual
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Ross													
Black													

■ = Lowest 1% | ■ = Very much below average | ■ = Below Average | ■ = Average | ■ = Above Average | ■ = Very much above average | ■ = Highest 1%

The mean annual air temperature was 24.9°C in the Ross Basin, and 24.4°C in the Black Basin. This was greater than the long-term mean (calculated from the oldest 30-year block of data available in the dataset (from 1911 to 1940) by 1.2°C and 1.3°C respectively (Table 20).

Table 20. Annual air temperature summary statistics for the Ross Basin and Black Basin.

Basin	Annual Air Temperature	Long-term mean 1911-1940 (ltm)	Anomaly (+/- ltm)	Percentage of the ltm
Ross	24.9°C	23.7°C	+1.2°C	105.1%
Black	24.4°C	23.1°C	+1.3°C	105.6%

Mean annual temperatures ranged from 20.7°C along the hinterlands of the Black Basin, to 25.6°C along the coastal regions of each basin. All areas within the Townsville Dry Tropics region consistently recorded a mean annual temperature greater than that of the long-term mean (calculated from 1991-1940), of approximately 1°C (Figure 10 and Figure 11). Historic annual temperature trends for each basin are presented in Appendix C and Appendix E.

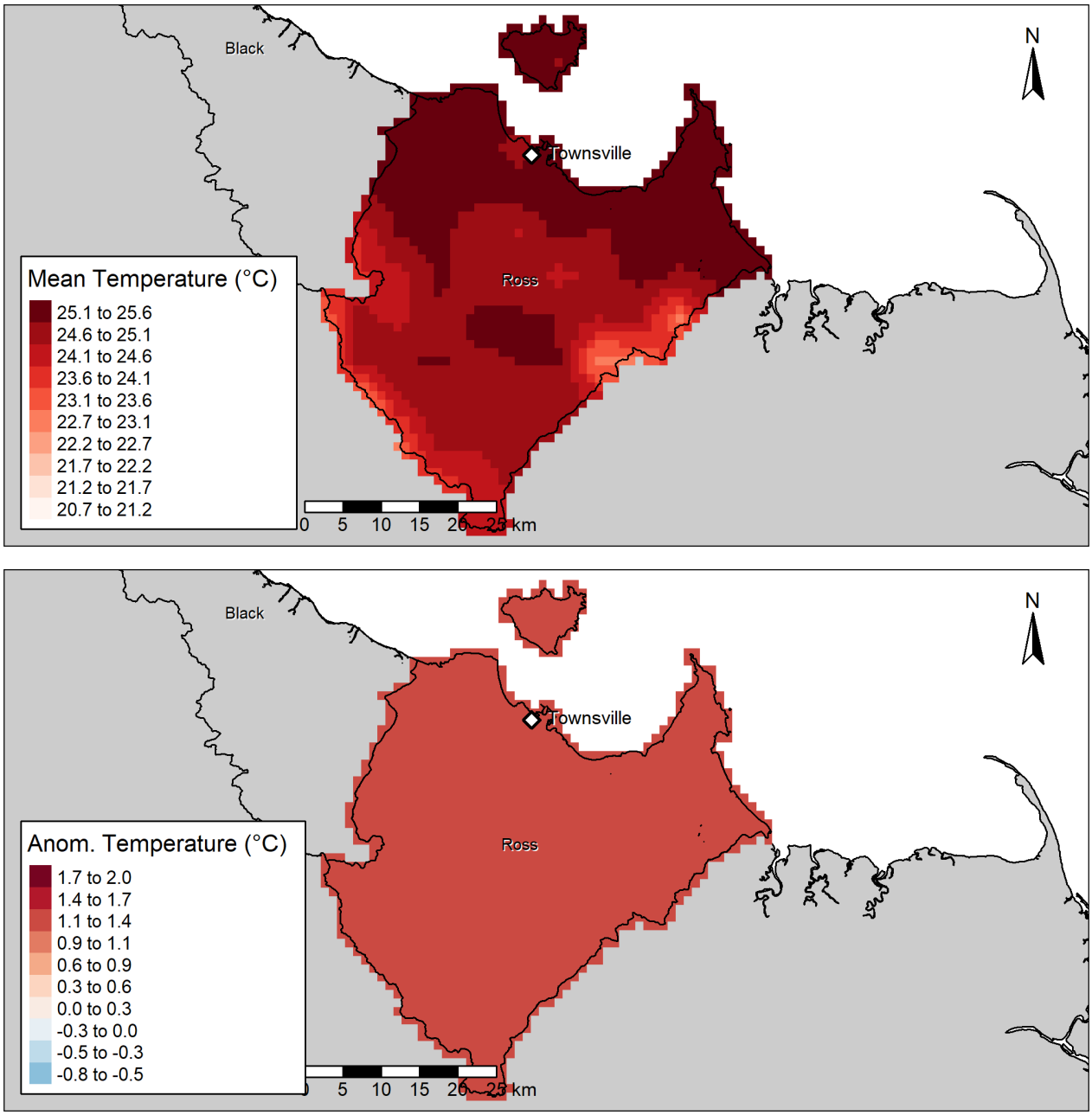

Figure 10. Mean annual air temperature for the Ross Basin, of the Dry Tropics region for 2023-2024, and the anomaly of the 2023-2024 air temperature from the long-term mean (i.e., how much more or less (C) was the 2023-2024 air temperature in comparison to the long-term historic average. Air temperature values were derived by taking the mean of monthly averages calculated across spatial grid sub-sets of each basin. The long-term mean was calculated from the oldest 30-year block (climate normal), which is 1911-1940. The scale for the annual air temperature map is based on the actual air temperature recorded for the financial year across the entire Dry Tropics Region (inclusive of the Black Basin). The scale for the anomaly air temperature map is based on the absolute min and max anomaly values recorded within the 30-year reference period, or, within the past 5-years (as the greatest anomalies mostly occurred during recent reporting years).

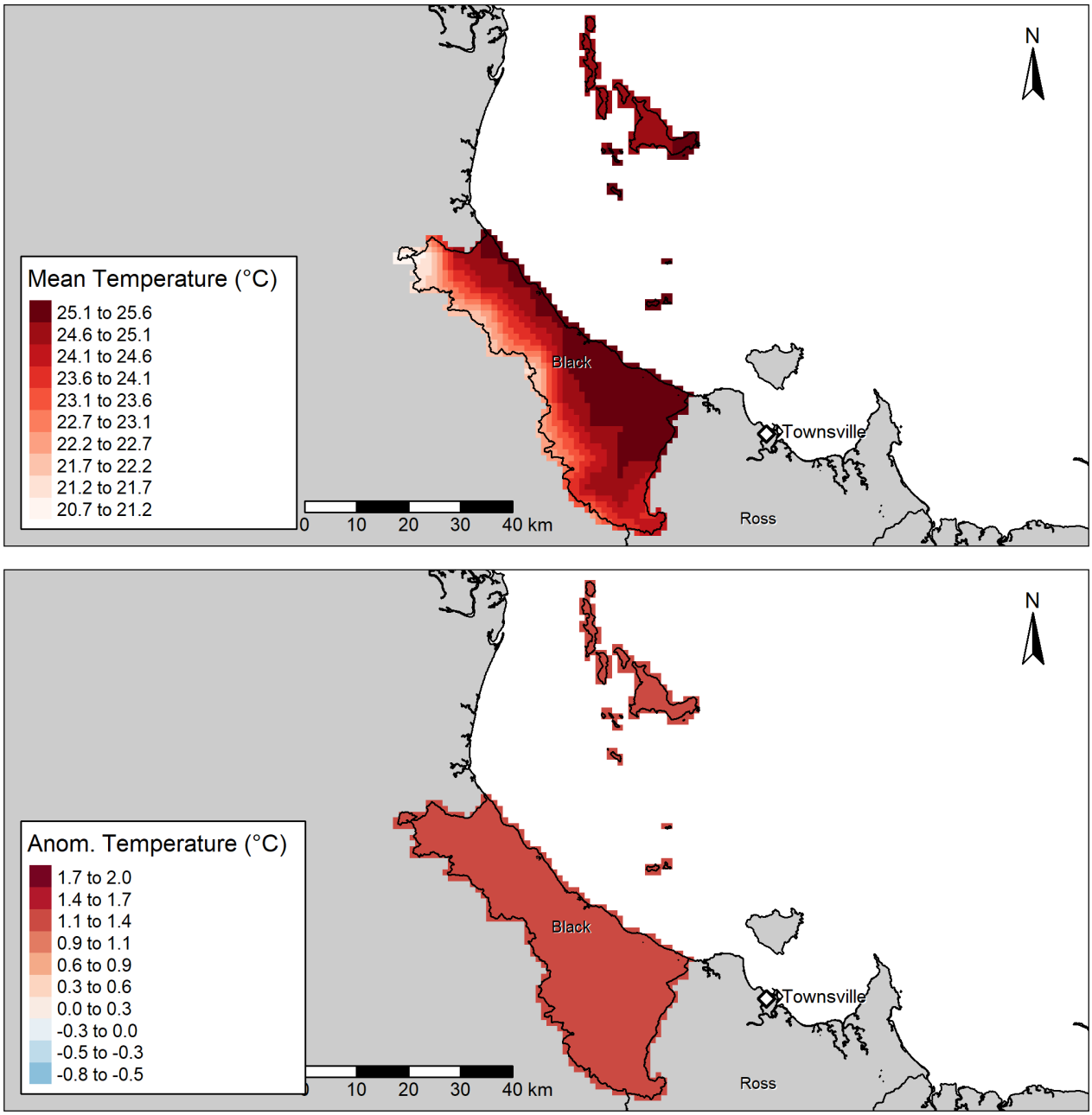

Figure 11. Mean annual air temperature for the Black Basin, of the Dry Tropics region for 2023-2024, and the anomaly of the 2023-2024 air temperature from the long-term mean (i.e., how much more or less (C) was the 2023-2024 air temperature in comparison to the long-term historic average. Air temperature values were derived by taking the mean of monthly averages calculated across spatial grid sub-sets of each basin. The long-term mean was calculated from the oldest 30-year block (climate normal), which is 1911-1940. The scale for the annual air temperature map is based on the actual air temperature recorded for the financial year across the entire Dry Tropics Region (inclusive of the Ross Basin). The scale for the anomaly air temperature map is based on the absolute min and max anomaly values recorded within the 30-year reference period, or, within the past 5-years (as the greatest anomalies mostly occurred during recent reporting years).

3.2.3 Sea Surface Temperature

Monthly sea surface temperature in the Townsville Dry Tropics marine region fell into the "average" or "above average" category for every month of the reporting period. In October, November, and December, sea surface temperatures for the month were in the "average" category, and for every other month of the year, the month was above its own monthly average. The monthly averages are calculated from the most recent 30-year block of data: 1991 to 2020 (Table 21).

Table 21. Monthly sea surface temperature percentiles in the Ross Basin and Black Basin grouped into seven categories.

	2023						2024						
Region	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Annual**
TSV													

■ = Lowest 1% | ■ = Very much below average | ■ = Below Average | ■ = Average | ■ = Above Average | ■ = Very much above average | ■ = Highest 1%

There were notable peaks in sea surface temperatures during the summer months of the year, with temperatures clearly exceeding 29°C in both January and February; this peak is connected to the likelihood of coral bleaching noted under Section 3.2.4 (Figure 12).

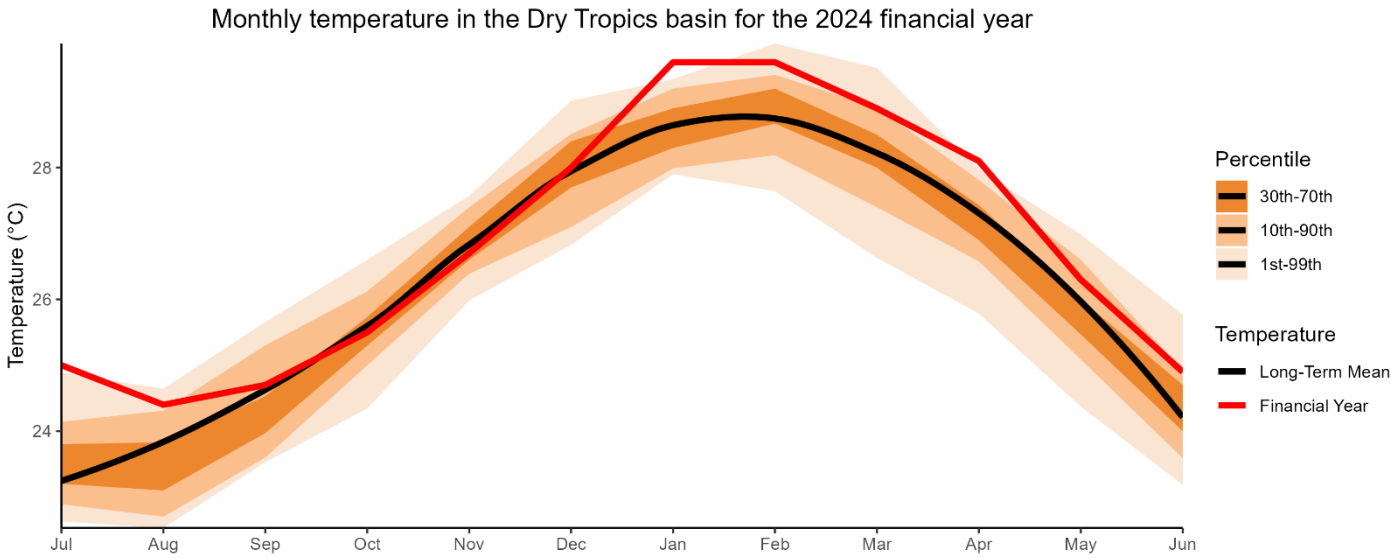

Figure 12. Monthly sea surface temperature in the Dry Tropics marine environment in comparison to the long-term mean (calculated from 1991 to 2020). The red line indicates the temperature for the current financial year. The black line indicates the long-term temperature. The dark orange shading represents the 30th to 70th percentiles of the long-term mean, the medium orange shading represents the 10th to 90th percentiles of the long-term mean, and the light orange shading represents the 1st to 99th percentiles of the long-term mean.

The mean annual sea surface temperature in the Townsville Dry Tropics marine region was 26.8°C, which was 0.6°C greater than the long-term mean (calculated from the most recent 30-year block of data: 1991 to 2020) (Table 22). The highest temperatures were recorded in the northern most reaches of the marine region and gradually decreased southward. Annual sea surface temperature anomalies highlighted that increased temperatures were consistent across the region (Figure 13). Historic annual sea surface temperature trends are presented in Appendix F.

Table 22. Annual sea surface temperature summary statistics for the Townsville Dry Tropics marine region.

Region	Annual Sea Surface Temperature	Long-term mean 1991-2020 (ltm)	Anomaly (+/- ltm)	Percentage of the ltm
Townsville Dry Tropics	26.8°C	26.2°C	+0.6°C	102.3%

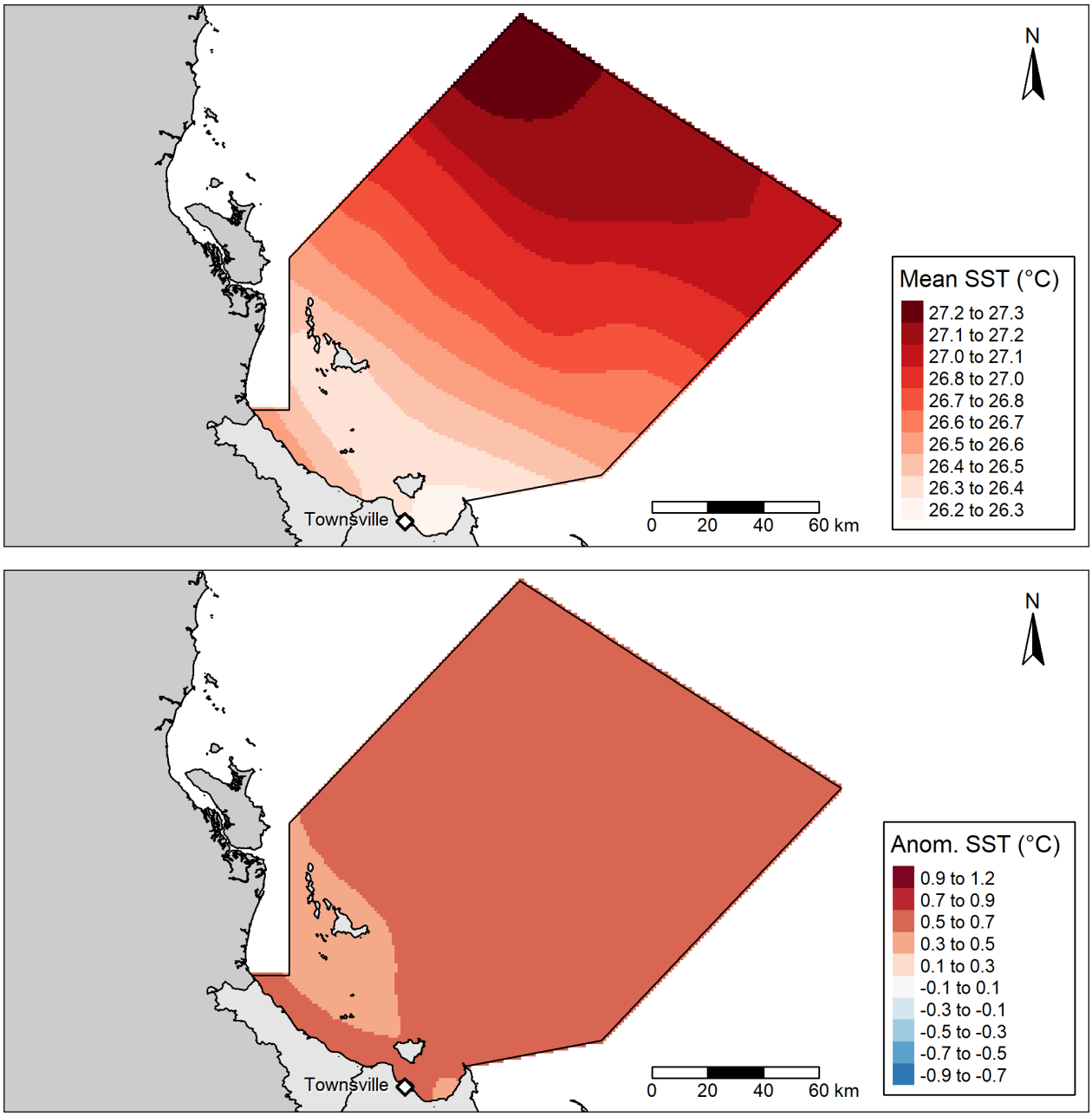

Figure 13. Total annual sea surface temperature for the Dry Tropics Region for 2023-2024, and the anomaly of the 2023-2024 sea surface temperature from the long-term mean (i.e., how much more or less (C) was the 2023-2024 sea surface temperature in comparison to the long-term historic average. Sea surface temperature values were derived by taking the mean of monthly averages calculated across spatial grid sub-sets of each basin. The long-term mean was calculated from the most recent 30-year block (climate normal), which is 1991-2020. The scale for the annual sea surface temperature map is based on the actual sea surface temperature recorded for the financial year across the entire Dry Tropics Region. The scale for the anomaly sea surface temperature map is based on the absolute min and max anomaly values recorded within the 30-year reference period inclusive of the current financial year.

3.2.4 Degree Heating Weeks

Mass coral bleaching has been linked to prolonged periods of heat stress (Glynn and D'Croz 1990). NOAA's Coral Reef Watch degree heating weeks (DHW) dataset provides a measure of this heat stress and acts as a proxy for the likelihood of coral bleaching (NOAA 2023). In 2023–2024, coral beaching risk in the Townsville Dry Tropics marine region ranged from "bleaching warning likely (2-4 DHW)" aka low risk, all the way to "severe bleaching likely (>8 DHW)" aka very high risk, with only a very small part of the marine region recorded DHW's of 4 or less (Figure 14). Historic degree heating weeks are presented in Appendix F.

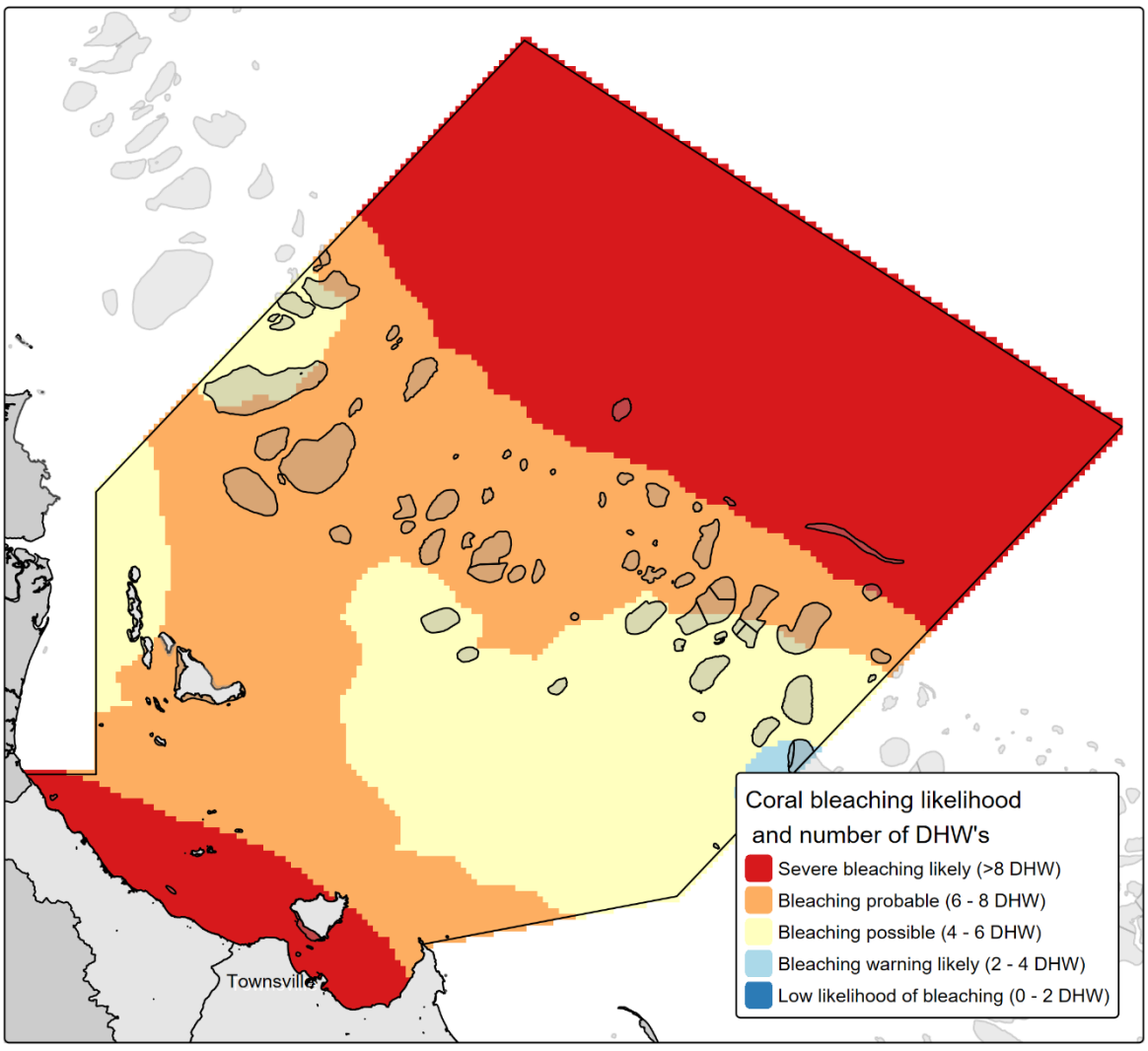

Figure 14. Total annual degree heating weeks (DHWs) in the Dry Tropic marine region for the 2023-2024 financial year. Coral reef outlines presented in grey.

Freshwater 2024–2025

Written by Adam Shand

As part of the results for the Townsville Dry Tropics Report Card 2025 (Reporting on data from July 2023– June 2024)

Healthy Waters Partnership for the Dry Tropics (HWP)

July 2025

4 Freshwater Environment

Within the freshwater environment, water quality, pesticides, habitat and hydrology, and fish are the four 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 Partnership. In the Townsville Dry Tropics region, the water quality and pesticides indices are updated annually, with the most recent data from the 2023–2024 financial year.

For the second time since the Partnership began reporting, the Pesticides index has been included in the technical report. However, as of the 2023-2024, report the pesticides index is not combined with the water quality index and is not representative of the entire Ross and Black Basins, but rather the specific sampling sites within the Ross and Black Basins. This is because it uses a different method of calculation in comparison to the other water quality measures and data is only sourced from two locations.

Index scores are calculated for the Ross Freshwater Basin and the Black Freshwater Basin. The extent of each basin is shown in Figure 15 (below), and the results are presented below.

4.1 Water Quality

The water quality index for the freshwater environment of the Townsville 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 DO), calculated from the monthly medians, and,
- The weighted basin scores include the proportion of the sub basin area for each basin area.

The Townsville Dry Tropics Methods Document (2025) 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 percentiles, and sub basin weights. Values can also be found in Appendix H and Appendix J.

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.

4.1.1 Monitoring Sites

Data for the two freshwater indicator categories are collected from the same sites. There are 24 sites (codes) spread across the two basins, divided into eight (8) sub basins in line with the Water Quality Improvement Plan (WQIP) WQIP (Townsville City Council, Queensland Government, Australian Government 2010) (Table 23 and Figure 15).

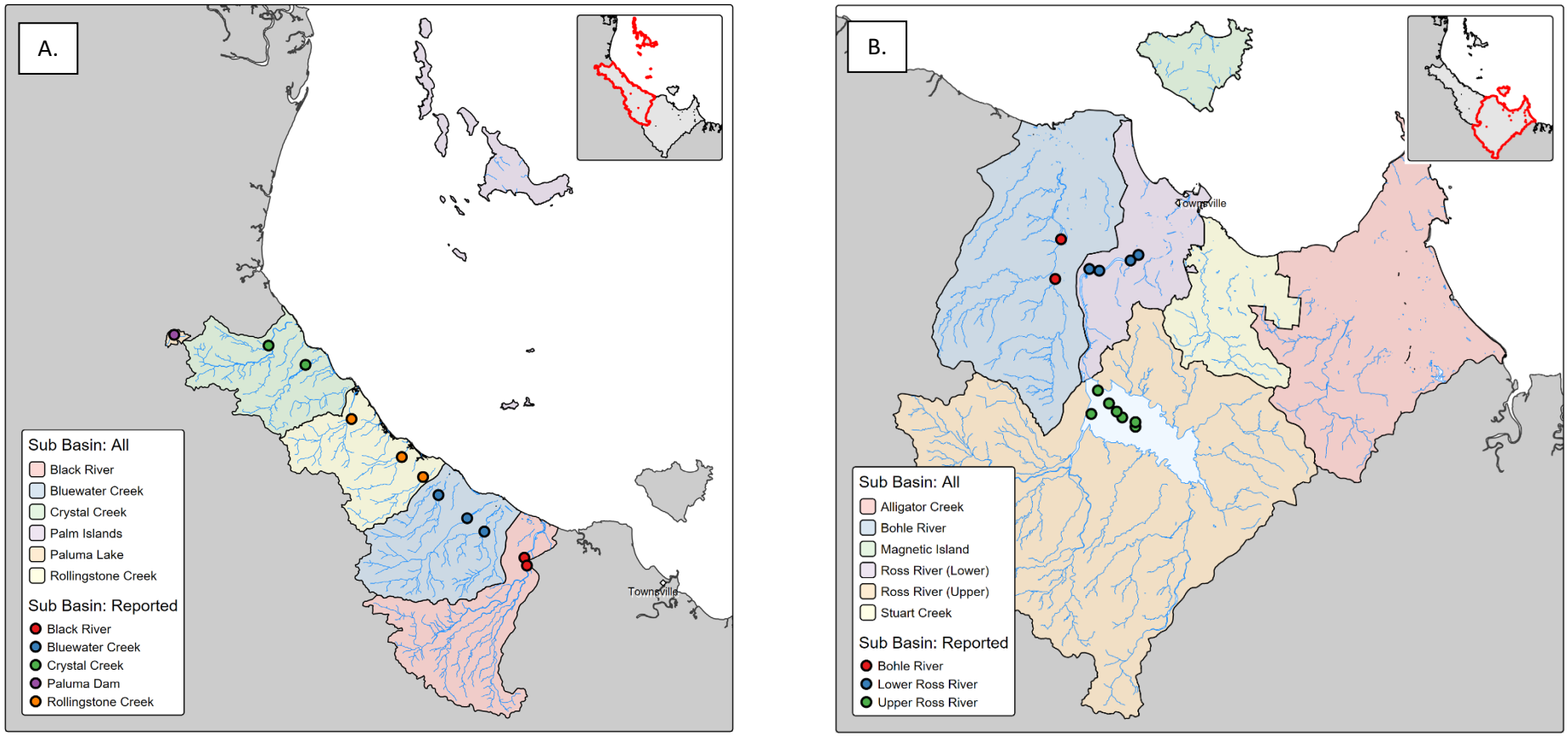

Figure 15. Freshwater basins (A. = Black, B. = Ross), and sub basins (see legend).

Table 23. Townsville Dry Tropics freshwater water quality site summary.

Basin	Sub Basin	Watercourse	Number of Sites
Ross	Upper Ross	Ross Lake	7
	Lower Ross	Ross River	4
	Bohle	Bohle River	2
Black	Black River	Black River	2
	Bluewater Ck	Althaus Ck	1
		Bluewater Ck	1
		Sleeper Log Ck	1
	Rollingstone Ck	Leichhardt Ck	1
		Saltwater Ck	1
		Rollingstone Ck	1
	Crystal Ck	Ollera Ck	1
		Crystal Ck	1
	Paluma	Paluma Lake	1

4.1.2 Overall Summary: Freshwater Water Quality

The overall water quality grade remained "good" in both the Black and Ross Freshwater Basins, and no score change was recorded in the Ross Basin. However, the overall water quality score increased in the Black Basin (from 66 to 71) (Table 24), and the nutrients grade and score increased in the Ross Basin (from "moderate" (60) to "good" (72) (Table 24, Table 25)).

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

Basin	Nutrients	Phys-Chem Properties	Water Quality					
			23-24	22-23	21–22	20–21	19–20	18–19
Ross	72	63	67	67	70	73	70	66
Black	67	74	71	66	68	68	67	62

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.

Table 25. 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				
	23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20
Upper Ross	90	81	75	90	65	81	90	90	90	90	85	85	82	90	77
Lower Ross	75	66	75	75	68	58	71	57	70	82	67	68	66	72	75
Bohle River	6	0	24	27	7	41	44	58	54	45	24	22	41	40	26
Ross Basin (Weighted)	72	60	71	73	60	63	74	68	74	80	67	67	70	73	70
Black River	51	51	62	ND[4]	ND	77	68	68	ND	ND	64	60	65	ND	ND
Bluewater Ck	64	73	76	ND	ND	72	45	44	ND	ND	68	59	60	ND	ND
Rollingstone Ck	82	85	85	ND	ND	78	69	74	ND	ND	80	77	79	ND	ND
Crystal Ck	90	90	79	ND	ND	69	67	67	ND	ND	79	78	73	ND	ND
Paluma Lake	90	90	90	ND	ND	71	71	72	ND	ND	80	67	69	ND	ND
Black Basin (Weighted)	67	70	73	66	67	74	63	64	70	67	72	66	68	68	67

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.

[4] These scores cannot be back calculated due to changes in the method of grouping data.

4.1.2.1 *Key Messages*

- The Ross Freshwater Basin grade remained "good" with no change in overall water quality score.
    - However, the nutrients grade and score increased in the Ross Basin (from "moderate" (60) to "good" (72), while the physical chemical properties score decreased from 74 to 63.
    - In both instances these changes were predominantly driven by changes in the Lower Ross Sub Basin, with notably improved DIN scores and reduced Low DO scores. For both indicators, no strong temporal trends are yet apparent.
    - The Bohle River TP grade remained "very poor" for the sixth[5] year in a row, and the DIN grade remained "very poor" although increased compared with 2022-2023.
    - DIN values in the Upper Ross and Paluma Lake sub basins remain "NA" due to the Water Quality Objective values (WQOs) being equal to or less than the Limit of Reporting values (LOR).
- The Black Freshwater Basin score increased from 66 to 71 within the same grade of "good".
    - This improvement was largely driven by an improvement in the physical-chemical indicator category from 63 to 74. Specifically, the turbidity indicator in the Bluewater Creek Sub Basin improved from "poor" (28) to "moderate" (59). This increase is after several years of lower scores and will need to be monitored for consistency.
    - Althaus Creek shows ongoing low scores and grades for the TP and Turbidity indicators (42 and 58, "moderate"), and further investigation would be required to isolate specific drivers. An increase in grade has been noted, however this may be driven by the limited number of samples collected (Appendix J), continued improvement is needed particularly in years with a greater number of samples.

4.1.3 Nutrients

For the 2023–2024 technical report the nutrients indicator category is comprised of two indicators, Dissolved Inorganic Nitrogen (DIN), and Total Phosphorus (TP). The scores and grades for the Ross and Black freshwater basins, and their associated sub basins are presented in Table 26. Annual medians, samples collected, months sampled, WQOs, and SFs are presented in Appendix H. Historical scores are presented in Appendix I.

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. Discussions for this are ongoing.

4.1.3.1 *Results: Freshwater Nutrients*

The nutrient indicator category for the Ross Freshwater Basin was graded as "good" with a weighted score of 72, a notable increase from the previous report of 60 (moderate). The Upper Ross sub basin maintained its "good" grade, however, did not receive DIN scores as the assigned water quality objective (WQO) is equal to or less than the limit of reporting (LOR). The Lower Ross sub basin maintained a "good" grade and showed improvements in the DIN indicator, whilst the Bohle River sub basins remained "very poor". The increase in DIN scores in the Lower Ross Sub Basin were the main driver of the overall improvement in Ross Basin nutrients. The source of nutrient inputs continues to require investigation, so that management can be implemented to improve the water

[5] Only five years of data are shown in each technical report. Historical scores are available upon request.

quality. Note; the Ross freshwater water quality index received a confidence grade of “low” (4.1.5 Confidence Scores).

The nutrients indicator category for the Black Freshwater Basin was graded as “good” with a weighted score of 67, a slight decrease from the previous reports score of 70 (good). Sub basins grades for nutrients ranged from “moderate” to “very good”, across the board despite an overall decrease in basin score. TP scores improved from “very poor” to “moderate” in Althaus Creek (Appendix I) however should be monitored closely to ensure the trend is maintained and will require additional investigation to determine the cause. Paluma Lake did not receive DIN scores due to issues with LOR and WQO values.

Table 26. Unweighted and weighted standardised scores and grades for the nutrient indicators and indicator category in the Townsville Dry Tropics Freshwater Basins.

Basin	Sub Basin	Watercourse	Unweighted Score and Grade			Weighting (proportion)	Area (km2)	Weighted Score and Grade	
			DIN	TP	Nutrients[6]			Sub Basin	Basin
Ross	Upper Ross	Ross Lake	NA[7]	90	90	0.32	458	23.4	72
	Lower Ross	Aplins Weir	60	ND	60	-	-	-	
		Gleesons Weir	90	ND	90	-	-	-	
		Blacks Weir	64	90	77	-	-	-	
			71	90	75	0.56	786	37.1	
	Bohle River	Bohle Mid-Field	0	0	0	-	-	-	
		Bohle Far-Field	25	0	12	-	-	-	
			12	0	6	0.12	169	0	
			47	45	54	1	1413		
Black	Black River	Black River	59	42	51	0.37	250	19.1	67
	Bluewater Ck	Althaus Ck	68	42	55	-	-	-	
		Bluewater Ck	46	76	61	-	-	-	
		Sleeper Log Ck	90	61	75	-	-	-	
			68	60	64	0.24	162	17.6	
	Rollingstone Ck	Leichhardt Ck	90	73	81	-	-	-	
		Saltwater Ck	90	90	90	-	-	-	
		Rollingstone Ck	61	90	75	-	-	-	
			80	84	82	0.21	145	18.3	
	Crystal Ck	Ollera Ck	90	90	90	-	-	-	
		Crystal Ck	90	90	90	-	-	-	
			90	90	90	0.17	116	15.5	
	Paluma Lake	Paluma Lake	NA[7]	90	90	0	2	0.3	
			76	74	76	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) | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

[6] 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.

[7] Data removed as the LOR was >= the WQO, and more than half (Ross Lake: 157 of 158, Paluma Lake: 17 of 24) of the concentration values were <= the WQO.

4.1.4 Physical-Chemical Properties

For the 2023–2024 technical report the physical-chemical properties indicator category is comprised of three indicators, Turbidity (NTU), High DO, and Low DO. The scores and grades for the Ross and Black freshwater basins, and their associated sub basins are presented in Table 27. Annual medians, samples collected, months sampled, WQOs, and SFs are presented in Appendix J. Historical scores are presented in Appendix K.

4.1.4.1 *Results: Freshwater Physical-Chemical Properties*

The physical-chemical indicator category for the Ross Freshwater Basin was graded as “good” with a weighted score of 63, a decrease from the previous report of 74 (good). The Upper Ross sub basin was graded as “very good”, the Lower Ross sub basin was graded as “moderate”, and the Bohle River sub basin was graded as “moderate”. Both the Upper Ross and Bohle sub basins did not record a change in grade, however the Lower Ross basin decreased (from “good” to “moderate”). This decrease was driven largely by a decline in the low DO indicator at all three sites in the Sub Basin (decreased from “moderate” and “good” to “poor”). It is acknowledged that the Lower Ross River often experiences high weed growth, further investigation and an increased sampling frequency would be required to establish if this is a driving influence. Further, increased sampling frequency is recommended for all sites measuring DO, such as via loggers. Note; the Ross freshwater water quality index received a confidence grade of “low” (4.1.5 Confidence Scores).

The physical-chemical indicator category for the Black Freshwater Basin was graded as “good” with a weighted score of 74, an increase from the previous report of 63 (good). All sub basins received physical-chemical properties grades of “good”, however, turbidity ranged from “poor” to “very good”, and Low DO ranged from “very poor” to “very good” at select sites. The increase in overall Basin score was driven largely by improvements in the turbidity indicator at multiple sites in the Bluewater Creek Sub Basin (e.g. 0 – 58, 70 – 90, and 13 – 30). However, it is likely that the low number of sampling opportunities due to limited rainfall influenced these scores (Appendix J). Despite these improvements the Althaus Creek and Sleeper Log Creek sites should be monitored closely to ensure the trend is maintained, particularly in years with more sampling, and will require additional investigation to determine the cause.

Table 27. Unweighted and weighted standardised scores and grades for the physical-chemical properties indicators and indicator category in the Townsville Dry Tropics Freshwater Basins.

Basin	Sub Basin	Watercourse	Unweighted Score and Grade						Weighted Score and Grade	
			Turbidity	High DO	Low DO	PhysChem	Weighting (proportion)	Area (km2)	Sub Basin	Basin
Ross	Upper Ross	Ross Lake	72	90	90	81	0.32	458	28.8	63
	Lower Ross	Aplin's Weir	90	90	34	62	-	-	-	
		Gleesons Weir	78	90	34	56	-	-	-	
		Blacks Weir	90	90	22	56	-	-	-	
			86	90	30	58	0.56	786	40.0	
	Bohle River	Bohle Mid-Field	90	90	0	45	-	-	-	
		Bohle Far-Field	77	90	0	38	-	-	-	
			83	90	0	41	0.12	169	5.3	
			82	90	30	56	1	1413		
Black	Black River	Black River	90	64	90	77	0.37	250	25.4	74
	Bluewater Ck	Althaus Ck	58	73	90	65	-	-	-	
		Bluewater Ck	90	90	90	90	-	-	-	
		Sleeper Log Ck	30	90	90	60	-	-	-	
			59	84	90	72	0.24	162	10.8	
	Rollingstone Ck	Leichhardt Ck	90	90	61	75	-	-	-	
		Saltwater Ck	90	90	90	90	-	-	-	
		Rollingstone Ck	90	90	49	69	-	-	-	
			90	90	66	78	0.2148	145	15	
	Crystal Ck	Ollera Ck	90	90	8	49	-	-	-	
		Crystal Ck	90	90	90	90	-	-	-	
			90	90	49	69	0.1719	116	11.6	
	Paluma Lake	Paluma Lake	90	90	53	71	0.003	2	0.2	
			80	85	71	73	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) | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

4.1.5 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 28.

Table 28. Confidence scores for the freshwater water quality indicator categories.

Basin	Indicator category	Maturity (*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).

4.2 Pesticides

The pesticides index (Pesticides Risk Metric – PRM) for the freshwater environment of the Townsville Dry Tropics region represent the average pesticide risk over the wet season for 182 days. 22 pesticides, including nine PSII herbicides (Photosystem II inhibitors), 10 non PSII herbicides and three insecticides were measured. The wet season is determined as commencing when a rise in river water level occurs, which coincides with an increase in aqueous pesticides concentrations (Warne, et al. 2023).

4.2.1 Monitoring Sites

Data for the pesticides index are collected from two sample sites, one in the Ross Freshwater Basin, along Ross River, and one in the Black Freshwater Basin, along Black River (Table 29, and Appendix N).

Table 29. Townsville Dry Tropics freshwater pesticides site summary.

Basin	Sub Basin	Watercourse
Ross	Lower Ross	Ross River
Black	Black	Black River

4.2.2 Overall Summary: Pesticides

As noted above, the pesticide index and pesticide results are not representative of the entire Ross and Black Basins, but rather the individual monitoring sites within each Basin. Further, the pesticides index is a risk matrix, even if scores are “very good”, this does not necessarily indicate the absence of pesticides completely.

The overall pesticides grade was “very good” (84) for the Black River sampling site and increased from the previous reporting period, however the pesticides grade for the Ross River sampling site was only “good” (75) and decreased in both score and grade since the previous reporting period. (Table 24). This is the second year that pesticides data have been reported in the HWP Technical Report. Historical data shown has been back calculated.

Table 30. Freshwater Pesticides Index Scores and Grades with comparison to previous years.

Monitoring Site	Pesticides					
	23-24	22-23	21–22	20–21	19–20	18–19
Ross River	75 (B)	81 (A)	89 (A)	94 (A)	89 (A)	98 (A)
Black River	84 (A)	82 (A)	91 (A)	92 (A)	89 (A)	100 (A)

Standardised scoring range: ■ = Very High Risk: 0 to <21 | ■ = High Risk: 21 to <41 | ■ = Moderate Risk: 41 to <61 | ■ = Low Risk: 61 to <81 | ■ = Very Low Risk: 81 to 100 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

4.2.2.1 *Key Messages*

- This is the second year in which pesticides data have been reported in the Townsville Dry Tropics Technical Report.
- Pesticide results and scores are not representative of the entire basin, as pesticides were only monitored at two sites (one in Ross River and one in Black River).
- The pesticides index is a risk metric, even if scores are “very low risk”, this does not indicate the absence of pesticides completely.

- The score for the Black Basin sample site increased from 82 to 84 although did not change grade.
- Notably, both the score and grade decreased for the Ross River sample site, from "very low risk" (81) to "low risk" (75).
    - Two new pesticides were detected (Hexazinone (PSII) and Metsulfuron-methyl (non-PSII)), for the first time in more than 5 years, while one pesticide was not detected from the previous year (Triclopyr (non-PSII)).
    - In particular, even a single detection of Metsulfuron-methyl for a single day can result in a notable contribution to the annual wet season Pesticide Risk Metric PRM due to its high toxicity and very low guideline value. Continued monitoring is required to understand if this sharp decrease in scores continues.

4.2.3 Results: Pesticides

The scores and grades for the Ross and Black freshwater monitoring locations, are presented in Table 31. The relevant contribution of each of the pesticide classes are presented in Figure 44 and Figure 43 in Appendix O.

Table 31. The percentage of species protect and standardised scores for the pesticide risk metric in the Ross and Black freshwater basins.

Monitoring Site	% of Species Affected: Insecticides	Other Herbicides	PSII Herbicides	% of Species Protected	Standardised Scores
Ross River	1.51	0.53	0.0	97.9	75 (B)
Black River	0.64	0.50	0.0	99.2	84 (A)

Pesticide risk metric scoring range: Very Poor = <80% (very high risk)| Poor = <90 to 80% (high risk)| Moderate = <95 to 90% (moderate risk)| Good = <99 to 95% (low risk)| Very Good = ≥99% (very low risk). **Standardised scoring range:** = Very High Risk: 0 to <21 | = High Risk: 21 to <41 | = Moderate Risk: 41 to <61 | = Low Risk: 61 to <81 | = Very Low Risk: 81 to 100 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

Analysis of the samples found that 6 unique pesticides were detected at the Ross River site (Tebuthiuron, Fluroxypyr, Fipronil, Hexazinone, Metsulfuron-methyl, and MCPA), and 8 were detected at the Black River site (Fipronil, Fluroxypyr, 2,4-D, Metsulfuron-methyl, Triclopyr, MCPA, Imidacloprid, and Metolachlor). This is an increase in the Ross and decrease in the Black since the 2022-2023 reporting period (Ross: 5, Black: 10). In the Ross Basin, two new pesticides were detected for the first time in more than five years (Hexazinone and Metsulfuron-methyl), and in the Black Basin three pesticides were detected for the first time in more than five years (Fluroxypyr, Imidacloprid, and Metolachlor). Note; the freshwater pesticides index received a confidence grade of "low" (4.2.4 Confidence Scores).

4.2.4 Confidence Scores

There was low confidence in the pesticide scores for both the Ross and Black Freshwater Basins due to limited spatial and temporal sampling in the basin (only two rivers sampled and only for part of the year) (Table 32).

Table 32. Confidence scores for the freshwater pesticide index.

Index	Maturity (*0.36)	Validation (*0.71)	Representativeness (*2)	Directness (*0.71)	Measured error. (*0.71)	Final Score	Rank
Pesticides	3	2	1	2	2	7.3	Low (2)

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).

4.3 Habitat and Hydrology

The habitat and hydrology index in the freshwater environment consists of the habitat indicator categories (Freshwater Riparian Extent and Freshwater Wetland Extent), and the hydrology indicator category (Artificial Barriers). Results are provided by a combination of partners of the Partnership and from the Reef 2050 Report Card. There is no update for the 2023-2024 Technical Report; data for these indicator categories is updated approximately every four years with the most recent update occurring in 2023.

4.3.1 Overall Summary: Freshwater Habitat and Hydrology

For the 2023-2024 reporting period the standardised scores for the habitat and hydrology index did not change (see above). The Ross Freshwater Basin received a score of 61 (good), and the Black Freshwater Basin received a score of 79 (good) (Table 33). For the second time since the beginning of this technical report, sub basin results have also been calculated and presented. Note; the habitat and hydrology index received a confidence grade of "low" to "very low" (4.3.5 Confidence Scores).

Table 33. 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				
				23-24	22-23	21–22	20–21	19–20
Ross	54	80	49	X	61	X	X	51
Black	81	64	100	X	79	X	X	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.

4.3.1.1 *Key Messages*

- There is no new data available for the freshwater habitat and hydrology section, thus scores have not changed since the previous report. Historic key messages are presented below:
    - Standardised scores for the habitat and hydrology index increased in both freshwater basins.
        - The riparian extent indicator category improved in both basins, with the Black Freshwater Basin recording its first increased in freshwater riparian vegetation since the beginning of this Dry Tropics Technical Report.
    - Sub basin scores have been calculated and presented for the first time. This allowed for several new observations such as:
        - Identifying the Stuart Creek sub basin as the location with the greatest loss of riparian vegetation extent between 2019 and 2021.
        - Identifying the Bluewater and Rollingstone Creek sub basins as the locations with the greatest loss of wetland extent between 2019 and 2021.
        - Identifying several sub basins with the Black Freshwater Basins that have gained riparian vegetation extent between 2019 and 2021.

4.3.2 Freshwater Riparian Extent

The Partnership uses methods sourced from the Reef Water Quality Report Card, although presents results at a sub basin level. Data is scored based on the amount of vegetation coverage in

comparison to the most recent previous dataset. For this report 2021 vegetation data (published in late 2023) is compared against 2019 data. The objective of this index is to record zero loss in vegetation between datasets.

4.3.2.1 *Monitoring Sites*

The area for the riparian extent indicator category is provided in Appendix P and Appendix Q.

4.3.2.2 *Results: Freshwater Riparian Extent*

For the 2023–2024 reporting period no sub basins in the Ross Basin gained vegetation, and no sub basins in the Black Basin lost vegetation (Table 34). The Stuart Creek sub basin had greatest percent-loss change, possibly due to the "state development area" within its boundaries (Queensland Government State Development and Infrastructure 2003).

Table 34. Riparian extent area, loss and standardised score in the freshwater basins and sub basins of the Townsville Dry Tropics.

Basin/Sub Basin	Freshwater Riparian Extent						
	Area (ha)				Extent Change (19-21)		Standardised Score
	Pre-Clear	…	2019	2021	ha	%	
Alligator Ck	5,303.2	…	4,551	4,542.7	-8.3	-0.18	57
Bohle River	6,544.4	…	4,874.3	4,868.5	-5.9	-0.12	60
Magnetic Island	2,013.0	…	1,916.1	1,916.1	0	0	80
Ross River (Lower)	2,097.5	…	1,527.5	1,527.5	0	0	80
Ross River (Upper)	19,426.9	…	16,328.2	16,282.2	-46.0	-0.28	52
Stuart Ck	2,889.8	…	2,307.7	2,292.8	-14.9	-0.64	35
Ross freshwater	38,274.8	…	31,504.9	31,429.8	-75.1	-0.24	54
Black River	9,918.1	…	8,904.9	8,909.2	+4.3	+0.05	81
Bluewater Ck	7,614.3	…	6,896.2	6,908.2	+12.0	+0.17	81
Crystal Ck	7,071.3	…	6,337.7	6,345.7	+8.0	+0.13	81
Palm Islands	901.2	…	775.1	775.1	0	0	80
Paluma Lake	121.7	…	28	28	0	0	80
Rollingstone Ck	5,806.1	…	5,396.7	5,406.5	+9.8	+0.18	81
Black freshwater	31,432.7	…	28,338.5	28,372.6	+34.1	+0.12	81

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 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

The final standardised scores were 54 in the Ross Basin, and 81 (very good) in the Black Basin. Notably, the Black Basin recorded an increase in freshwater riparian vegetation, however it is not clear if this is the result of growth of native vegetation or weed species (Table 35). Further, it should be noted that because vegetation is compared to most recent previous assessment, a score of "good" simply means that there was no vegetation loss since the previous assessment, not since

"pre-European times". Historic vegetation trends for each basin are presented in Appendix R and Appendix T.

Table 35. Historic standardised score for the Freshwater Riparian indicator category.

Basin	Freshwater Riparian Extent Standardised Scores					
	23-24	22-23	21-22	20-21	19-20	18-19
Ross Freshwater	X	54	X	X	X	44
Black Freshwater	X	81	X	X	X	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 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

4.3.3 Freshwater Wetland Extent

The Partnership uses methods sourced from the Reef Water Quality Report Card, however, presents results at a sub basin level with minor changes to the assessed area: including Magnetic Island and the Palm Island group in the analysis of wetland extent. Data is scored based on the amount of wetland coverage in comparison to the most recent previous dataset. For this report 2019 wetland data (published in late 2023) is compared against 2017 data. The objective of this index is to record zero loss in vegetation between datasets.

4.3.3.1 *Monitoring Sites*

The area for the wetland extent indicator category is provided in Appendix U and Appendix V.

4.3.3.2 *Results: Freshwater Wetland Extent*

For the 2023–2024 reporting period only the Bluewater Creek and Rollingstone Creek sub basins recorded a loss in vegetation, no sub basins recorded a gain in vegetation (Table 36). The final standardised scores were 54 (moderate) in the Ross Basin, and 81 (very good) in the Black Basin. It should be noted that although no increases in wetland vegetation were detected, due to selective nature of the assessment (only measuring pristine palustrine) this does not mean that there wasn't a gain/loss of other types of wetlands within the area. Further, because vegetation is compared to most recent previous assessment, a score of "good" simply means that there was no vegetation loss since the previous assessment, not since the "pre-European times". Historic vegetation trends for each basin are presented in Appendix W and Appendix X.

Table 36. Freshwater wetland area, loss and standardised score in the freshwater basins and sub basins of the Townsville Dry Tropics.

Basin/Sub Basin	Freshwater Wetland Extent						
	Area (ha)				Extent Change (17-19)		Standardised Score
	2001	...	2017	2019	ha	%	
Alligator Ck	528.1	...	526.5	526.5	0.0	0.0	80
Bohle River	227.4	...	206.1	206.1	0.0	0.0	80
Magnetic Island	28.3	...	28.3	28.3	0.0	0.0	80
Ross River (Lower)	62.5	...	61.0	61.0	0.0	0.0	80
Ross River (Upper)	46	...	46.0	46.0	0.0	0.0	80
Stuart Ck	11.1	...	11.1	11.1	0.0	0.0	80
Ross freshwater	903.4	...	879.0	879.0	0.0	0.0	80
Black River	33.5	...	33.5	33.5	0.0	0.0	80
Bluewater Ck	52.1	...	45.1	44.9	-0.2	-0.46	43
Crystal Ck	222	...	219.1	219.1	0.0	0.0	80
Palm Islands	61.9	...	61.9	61.9	0.0	0.0	80
Paluma Lake	ND	...	ND	ND	ND	ND	ND
Rollingstone Ck	77.7	...	76.9	76.8	-0.2	-0.2	56
Black freshwater	447.3	...	436.6	436.2	-0.4	-0.08	64

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 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

Table 37. Historic standardised score for the Freshwater wetland indicator category.

Basin	Freshwater Wetland Extent Standardised Scores					
	23-24	22-23[8]	21-22	20-21	19-20	18-19
Ross Freshwater	X	80	X	X	40	45
Black Freshwater	X	64	X	X	58	40

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 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

[8] The data and method used to map wetland extent was updated in 2023 (Version 6.0). Although results can no longer be compared to previous technical reports the latest data includes a remapping of all previous years of data. This remapping has been used to back calculate all historic scores presented in Table 36. A comparison between new and old scores is shown in Appendix Z.

4.3.4 Freshwater Artificial Barriers

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 and fish barriers scheduled to be updated in 2025.

4.3.4.1 *Monitoring Sites*

The area for the artificial barriers indicator category is provided in Appendix Z and Appendix AA.

4.3.4.2 *Results: Freshwater Artificial Barriers*

There is no change to the results for the artificial barriers indicator category or the impoundment length and fish barrier indicators in this technical report. 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 38).

Table 38. 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 (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.

4.3.4.3 *Results: Freshwater Impoundment length*

Impoundment length in the Townsville Dry Tropics region has remained consistent between reporting periods. The Black Basin received a score of 100 (very good), with no impoundments. In the Ross Basin, of the 895km of assessed waterways, 72km were impounded. The Ross basin received a score of 34 (poor) due to the Ross River Dam, and three weirs (Black, Gleeson and Aplin's) on the Ross River.

Table 39. Natural and Impounded stream length and standardised score in the freshwater basin of the Townsville 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 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

4.3.4.4 *Results: Freshwater Fish Barriers*

In the Ross Basin, there were 12 barriers across five measured waterways, four were classified as impassable, and all were located on the Ross River. In the Black Freshwater Basin 92km of the Black River was assessed, and no fish barriers, passable or impassable, were identified (Table 40). Barrier density in the Ross Basin ranged from 3.5km of waterway per barrier, to 65.9km per barrier, and the

percentage of stream to first barrier ranged from 0.4% to 100%. In the Black Basin, percentage of stream to first barrier was 100% (Table 41). The fish barrier indicator received a standardised score of 65 (good) in the Ross Basin, and 100 (very good) in the Black Basin (Table 41).

Table 40. Waterway characteristics and fish barriers in the Ross Freshwater Basin and Black Freshwater Basin.

Basin	Waterway Name	length	Number of Barriers: Passable	Number of Barriers: Impassable	Length to first barrier: Passable	Length to first barrier: Impassable
Ross freshwater	Ross River	263.6km	0	4	1.0km	1.0km
	Bohle River	51.1km	2	0	7.2km	51.1km
	Stuart Ck	17.5km	5	0	11.9km	17.5km
	Alligator Ck	13.7km	1	0	0.7km	13.7km
	Whites Ck	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

Table 41. Standardised scores for the components of the fish barrier's indicator.

Waterway	Barrier density (km/barrier)	Percentage of stream to first … barrier: Passable	Percentage of stream to first … barrier: 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 Average	27.2km	37.6%	80.1%	65
Black River	NA	100%	100%	100

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.

4.3.5 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.

Table 42. 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.

4.4 Fish

The Fish index for the freshwater basin of the Townsville Dry Tropics regions consists of two indicator categories, the Proportion of Indigenous Species Expected (POISE), and the Proportion of Non-Indigenous Species (PONIS). Results for this index are provided by partners of the Partnership and are updated every three years. There are no updates for the 2023-2024 Technical Report, the latest update occurred in the 2022–2023 Technical Report using data collected in 2021-2022. This is the second time since the beginning of the report card that the fish index has been measured.

4.4.1 Monitoring Sites

The monitoring sites used for the fish index are provided in Appendix BB.

4.4.2 Overall Summary: Freshwater Fish

For the 2023-2024 reporting period the standardised scores for the fish index declined in both freshwater basins. The Ross Basin received a score of 49 (moderate), and the Black Basin received a score of 55 (moderate) (Table 43).

Table 43. Standardised scores for the POISE and PONIS indicator categories and fish index in the Ross and Black Basins.

Basin	POISE	PONIS	Fish Index				
			23-24	22-23	21-22	20-21	19-20
Ross	58	41	X	49	X	X	57
Black	25	84	X	55	X	X	78

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.

4.4.2.1 *Key Messages*

- There is no new data available for the freshwater fish section, thus scores have not changed since the previous report. Historic key messages are presented below:
    - This is the second time the fish index has been measured and scores for the fish index declined in both basins.
        - The primary driver was the PONIS indicator category in the Ross Basin (decreased from 60 to 41), and the POISE indicator category in the Black basin (decreased from 66 to 25).
    - Within the Ross Basin, 4011 fish from 29 species were caught during sampling.
        - 86% (3447) were indigenous and were released after identification.
        - 14% (564) were non-indigenous and were euthanised.
            - 529 fish were alien, 35 were translocated.
        - Scores indicate that most waterways were “moderate”.
    - Within the Black Basin, 2217 fish from 25 species were caught during sampling.
        - 83% (1830) were indigenous and were released after identification.
        - 17% (387) were non-indigenous and were euthanised.
            - All non-indigenous species were alien.
        - Scores indicate that some waterways were “very good’ whilst others were “very poor”.

- The large decrease in the POISE indicator category score is most likely connected to heavy rainfall before sampling dispersing the fish populations.

4.4.3 Proportion of Indigenous Species Expected (POISE)

The proportion of indigenous species expected (POISE) indicator category is a measure of observed versus expected species and compares the richness of indigenous[9] species. Presence/Absence and site scores are provided in Appendix CC to Appendix EE.

4.4.3.1 *Results: POISE*

The POISE indicator category was measured to be 0.645 in the Ross Basin and 0.429 in the Black Basin, showing that despite the large number of indigenous species, presence is still lower than the pre-disturbance model for both basins. Standardised scores were 58 (moderate) and 25 (poor) in the Ross and Black Basins respectively (Table 44). The grade did not change within the Ross Basin (moderate) however did decrease from "good" to "poor" in the Black Basin. This grade change was most likely driven by heavy rainfall preceding sampling that dispersed the fish populations. Several site locations had to be altered as they were no longer suitable due to a large increase in water depth.

Table 44. The Proportion of Indigenous Species Expected (POISE) indicator category raw and standardised scores for each basin in the Townsville Dry Tropics Region.

Basin	POISE	Standardised Score				
		23-24	22-23	21-22	20-21	19-20
Ross	0.645	X	58	X	X	54
Black	0.429	X	25	X	X	66

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.

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 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

In the Ross Basin 4011 fish of 29 species were caught, 86% (3447) of which were indigenous. In the Black Basin 2217 fish of 25 species were caught, 83% (1830) of which were indigenous. All indigenous species were released after identification. Despite the similar percentages, the standardised score for the Black Freshwater Basin was notably lower (58 compared to 25). This is because the standardised scores are calculated from the median POISE value. In turn this indicates that the Black Freshwater Basin had a great number of waterways with a very poor number of indigenous species found compared to what was expected, and a few waterways with an exceptional (very good) number of indigenous species. Comparatively, most waterways in the Ross Freshwater Basin were moderate.

[9] Species classification definitions can be found in "Methods for Townsville Dry Tropics 2023–2024 Report Card (released in 2025)".

4.4.4 Proportion of Non-Indigenous Species (PONIS)

The proportion of non-indigenous species (PONIS) indicator category is a measure of observed translocated and alien species compared to the total number of observed species. Presence/Absence and site score are provided in Appendix CC to Appendix EE.

4.4.4.1 *Results: PONIS*

Within the PONIS indicator category, the median proportion of translocated species 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 (note that although some translocated species were reported, the median measurement was 0.0). While the median proportion of alien species was 0.102 in the Ross Freshwater Basin, and 0.029 in the Black Freshwater Basin. Thus, the PONIS indicator category was also measured to be 0.102 and 0.029 in the Ross and Black Basins respectively. Standardised scores were 41 (moderate) in the Ross Basin and 96 (very good) in the Black Basin (Table 45).

Table 45. The Proportion of Non-Indigenous Species (PONIS) indicator category raw and standardised scores for each basin in the Townsville Dry Tropics Region.

Basin	Proportion of:		PONIS	Standardised Score				
	Translocated	Alien		23-24	22-23	21-22	20-21	19-20
Ross	0.0	0.102	0.102	X	41	X	X	60
Black	0.0	0.029	0.029	X	96	X	X	91

Scoring range (PONIS): ■ = 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 0.03.

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 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

In the Ross Basin, of the 4011 fish caught, 14% (564) were non-indigenous (529 alien, 35 translocated). In the Black Basin, of the 2217 fish caught, 17% (387) were non-indigenous (all of which were alien). All non-indigenous species were euthanised. Once again, despite similar percentages, the standardised scores for each basin are notably different (41 compared to 96). This is because the standardised scores are calculated from the median PONIS value. In turn this indicates that the Black Freshwater Basin had a great number of waterways with a very good (low) numbers of non-indigenous species, and a few waterways with a very poor (high) numbers of non-indigenous species. Comparatively, most waterways in the Ross Freshwater Basin were moderate.

4.4.5 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 46).

Table 46. Confidence scores for the fish index in the freshwater basin of the Townsville 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	9.7 (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.

Estuarine 2023–2024

Written by Adam Shand

As part of the results for the Townsville Dry Tropics Report Card 2025 (Reporting on data from July 2023– June 2024)

Healthy Waters Partnership for the Dry Tropics (HWP)

July 2025

5 Estuarine Environment

Within the estuarine environment, water quality, and habitat are the two 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 Partnership. In the Townsville Dry Tropics region, the water quality index is updated annually, with the most recent data from the 2023-2024 financial year. The habitat index is updated approximately every four years with the most recent update (2021 data) occurring for the 2022-2023 technical report.

Index scores are calculated for the Ross Estuarine Basin and the Black Estuarine Basin. The extent of each basin is shown in Figure 16 (below), and the results are presented below.

5.1 Water Quality

The water quality index for the estuarine environment of the Townsville Dry Tropics regions consists of two indicators 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,
- Annual medians, calculated from the monthly medians,
- 80th percentile (and 20th percentile for DO), calculated from the monthly median, and,
- The weighted basin scores include the proportion of each individual estuary area of the total basin estuary area.

The Townsville Dry Tropics Methods Document (2025) provides definition of the WQOs, and SFs used for each watercourse, and the conversion of raw data to standardised scores using the annual medians, percentiles, and sub basin weights. Values can also be found in Appendix FF and Appendix HH.

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.

5.1.1 Monitoring Sites

Data for the two estuarine indicator categories are collected from the same sites. There are 22 sites (codes) spread across 12 estuaries within the two basins. These are divided into seven (7) sub basins in line with the WQIP (Townsville City Council, Queensland Government, Australian Government 2010) (Table 47, and Figure 16).

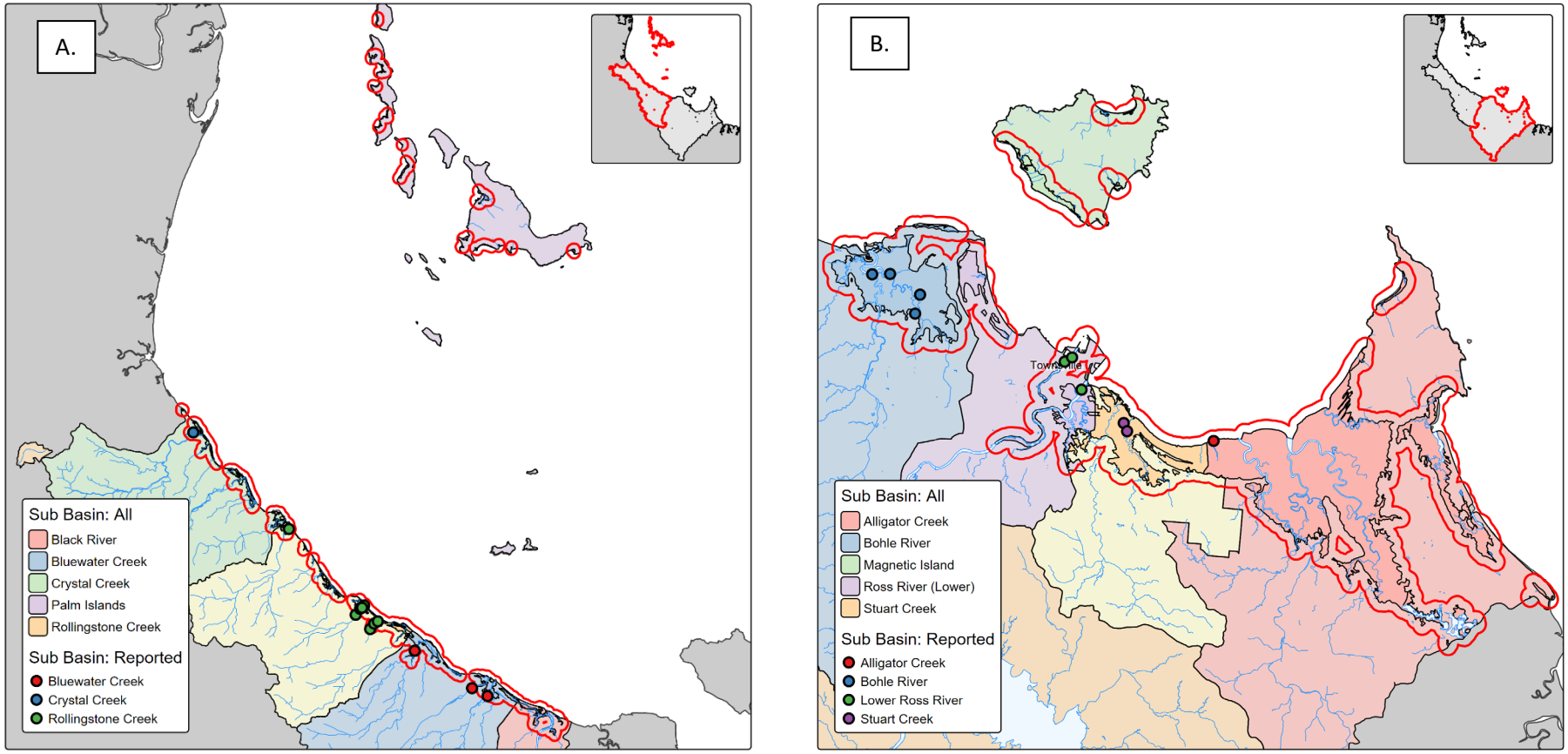

Figure 16. Estuarine Basins (A.= Black, B. = Ross) and Sub Basins (see legend). Red lines are added to highlight hard to see areas.

Table 47. Townsville Dry Tropics estuarine water quality site summary.

Basin	Sub Basin	Watercourse	Number of Sites
Ross Estuarine	Bohle	Bohle River	1
		Louisa Ck	3
	Lower Ross	Ross Ck	2
		Ross River	1
	Stuart	Sandfly Ck	2
	Alligator	Pearce's Ck	1
Black Estuarine	Bluewater	Althaus Ck	1
		Bluewater Ck	1
		Sleeper Log Ck	1[10]
	Rollingstone	Camp Oven Ck	3
		Saltwater Ck	3
		Rollingstone Ck	1
	Crystal	Crystal Ck	1

5.1.2 Overall Summary: Estuarine Water Quality

The water quality index was graded as "good" in both the Ross and Black Estuarine Basins, receiving the same grade as the previous report, however decreased in scores in both basins (79 to 69 for Ross, 68 to 61 for Black) (Table 48, Table 49). A reduction in both the nutrient and physical chemical properties indicator categories across both of the basins contributed to the reduction in overall water quality.

Table 48. Current and previous water quality scores and grades for the Townsville Dry Tropics Estuarine Basins.

Basin	Nutrients	Phys-Chem Properties	Water Quality					
			23-24	22-23	21–22	20–21	19–20	18–19
Ross Estuarine	75	62	69	79	83	88	88	39
Black Estuarine	64	59	61	68	64	66	47	52

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.

[10] This decreased from 2 sites to 1 site during the 2023-2024 sampling regime.

Table 49. A comparison of nutrient and physical chemical properties indicator category scores, and the water quality index scores, for estuarine sub basins and basins between years.

Sub Basin	Nutrients					Phys-Chem					Water Quality				
	23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20
Bohle River	37	61	63	[11]ND	ND	49	55	55	ND	ND	43	58	59	ND	ND
Lower Ross	90	90	90	ND	ND	68	86	85	ND	ND	79	88	87	ND	ND
Stuart Ck	80	90	81	ND	ND	55	62	77	ND	ND	67	76	79	ND	ND
Alligator Ck	82	90	90	ND	ND	61	69	90	ND	ND	72	79	90	ND	ND
Ross Basin (Weighted)	75	82	88	88	89	69	77	78	86	90	69	79	83	88	88
Bluewater Ck	66	68	85	ND	ND	55	61	58	ND	ND	61	64	71	ND	ND
Rollingstone Ck	68	77	82	ND	ND	66	69	73	ND	ND	67	73	77	ND	ND
Crystal Ck	53	73	77	ND	ND	61	66	48	ND	ND	57	69	63	ND	ND
Black Basin (Weighted)	64	71	74	66	77	59	64	55	66	49	61	68	64	66	64

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 | - = Not Applicable (data available but not usable) | X = Data was not updated this year.

[11] These scores cannot be back calculated due to changes in the method of grouping data.

5.1.2.1 *Key Messages*

- The Ross Estuarine Basin overall water quality grade remained “good”, however the score decreased from 79 to 69.
    - Most influential was the decline in the score for DIN in the Louisa Creek watercourse, which saw a decrease in grade from “good” (67) to “very poor" (0). This decline is the first notable decrease in DIN scores in five years of reporting. The cause(s) of this decline have not been determined, however could have results from increasing land use impacts, weather conditions and/or the sample timing in relation to environmental events. Additional, years of sampling are required to establish trends.
    - Louisa Creek showed ongoing low scores and grades for the Low DO and Nutrients indicators, along with recent low scores for the DIN indicator. Further investigation would be required to isolate specific drivers.
- The Black Estuarine Basin overall water quality grade remained “good”, however the score decreased from 68 to 61.
    - Most influential was the decrease in score for the Low DO indicator in Camp Oven Creek (42 to 2), Turbidity in Bluewater Creek (63 to 28) and Sleeper Log Creek (59 to 35), and DIN in Bluewater Creek (65 to 50). However, minor improvements that occurred across several indicators in several watercourses “muted” the effect of this decline on the overall basin grade.
    - Althaus Creek showed ongoing low scores and grades for the turbidity indicator, and further investigation would be required to isolate specific drivers. An increase in grade has been noted, however continued improvement is needed.
    - Over several years Sleeper Log Creek has shown a consistent decline in Turbidity for both score and grade. It is recommended that further investigation is conducted to isolate specific drivers.
    - Scores and grades decreased in Crystal Creek for DIN, TP, and Turbidity. Ongoing monitoring is essential to determine if this continues.
- Across all estuaries in the Dry Tropics Region, 10 of 13 watercourses received a grade of “good” or “very good” for nutrients, and 8 of 13 received a grade of "good” or “very good” for physical-chemical properties.

5.1.3 Nutrients

For the 2023–2024 technical report the nutrients indicator category is comprised of two indicators, Dissolved Inorganic Nitrogen (DIN), and Total Phosphorus (TP). The scores and grades for the Ross and Black Estuarine Basins, and their associated sub basin estuaries are presented in Table 50. Annual medians, samples collected, months sampled, WQOs, and SFs are presented in Appendix FF. Historical scores are presented in Appendix GG.

5.1.3.1 *Results: Estuarine Nutrients*

The Ross Estuarine Basin received a nutrient indicator category score of 75 (good). Within the basin, five of six watercourses received nutrient indicator category grades of “good” or “very good”, with scores ranging from 75 to 90. The Louisa Creek watercourse was the only location to receive a grade of “very poor” (score of 0), which was driven by both the TP and DIN indicators. Other than in the Louisa Creek watercourse, both the TP and DIN indicators received grades of “very good” or “good” (Table 50).

The low scores for the TP indicator at Louisa Creek have consistently occurred across multiple years of reporting. Low scores have been identified to be driven by concentration rather than differences in water quality objective, sampling methodology, or scaling factors (Appendix FF), and the creek is considered “urbanised” in nature. The distribution of sites along the Louisa Creek watercourse, and their associated scores, also suggests a diluting effect, with scores generally increasing further downstream (Table 50). These consistent spatial and temporal trends suggest an ongoing source of increased TP upstream of the sampling location that is unique to the Louisa Creek watercourse, such as its proximity to the outflow of the Mount St Johns Wastewater Treatment Plant, industrial areas, and residential developments, particularly those with septic systems.

The Black Estuarine Basin received a nutrient indicator category score of 64 (good). Within the basin, five of seven watercourses received a nutrient indicator category grade of “good” or “very good”, with scores of 61 or greater. The Rollingstone Creek and Crystal Creek watercourses were the only locations to receive grades of “moderate” (58 and 53), which was driven predominately by “poor” scores in the DIN indicator. This is the second year a “poor” score has occurred in the Rollingstone Creek watercourse. Although these scores are not yet consistently low across multiple reporting periods possible drivers include groundwater, soil type, landuse, and timing relative to tides and rainfall (Appendix GG). This trend has been noted in some previous reports and may require further investigation of aspects such as runoff and the surrounding land use (Table 50).

Table 50. Weighted and unweighted standardised scores and grades for the nutrient indicator category and indicators in the Townsville Dry Tropics Estuarine Environment.

Basin	Sub Basin Estuary	Watercourse	Unweighted Score and Grade			Weighting (proportion)	Area (km2)	Weighted Score and Grade	
			DIN	TP	Nutrients			Sub Basin	Basin
Ross Estuarine	Bohle	Bohle River	90	61	75	-	-	-	75
		Louisa Ck	0	0	0	-	-	-	
			45	30	37	0.28	348	17.3	
	Lower Ross	Ross Ck	90	90	90	-	-	-	
		Ross River	90	90	90	-	-	-	
			90	90	90	0.69	864	62.5	
	Stuart	Sandfly Ck	90	70	80	0.02	28	2.0	
	Alligator	Pearce's Ck	90	74	82	0	5	0.4	
			75	64	69	1	1245		
Black Estuarine	Bluewater Ck	Althaus Ck	62	74	68	-	-	-	64
		Bluewater Ck	50	72	61	-	-	-	
		Sleeper Log Ck	62	77	69	-	-	-	
			58	74	66	0.52	277	45.9	
	Rollingstone Ck	Camp Oven Ck	62	90	76	-	-	-	
		Saltwater Ck	52	90	71	-	-	-	
		Rollingstone Ck	27	90	58	-	-	-	
			47	90	68	0.25	135	19.6	
	Crystal Ck	Crystal Ck	36	71	53	0.22	118	16.3	
			50	80	65	1	531		

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) | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

5.1.4 Physical-Chemical Properties

For the 2023–2024 technical report the physical-chemical properties indicator category is comprised of three indicators, Turbidity (NTU), High DO, and Low DO. The scores and grades for the Ross and Black Estuarine Basins, and their associated sub basins are presented in Table 51. Annual medians, samples collected, months sampled, WQOs, and SFs are presented in Appendix HH. Historical scores are presented in Appendix II.

5.1.4.1 *Results: Estuarine Physical-Chemical Properties*

The Ross Estuarine Basin received a physical-chemical properties score of 62 (good). Four of six watercourses received physical-chemical indicator category grades of “very good” or “good”, with scores of 61 or greater. The Sandfly Creek watercourse received a grade of “moderate” due to a “moderate” Turbidity score, however the Louisa Creek watercourse was the only location to receive a grade of “poor” (score of 33), which was driven by the Low DO indicator (Table 51). The watercourse also received a “very poor” grade for TP and DIN (Results: Estuarine Nutrients). The relationship between DO and nutrients is well established, and the “very poor” Low DO score is likely due to increased TP upstream of the sampling location. Sources of increased nutrients may include the outflow of the Mount St Johns Wastewater Treatment Plant, industrial areas, and residential developments.

The Black Estuarine Basin received a physical-chemical properties indicator category score of 59 (moderate). Four of seven watercourses received a physical-chemical properties indicator category grade of “good” or “very good”, with scores of 61 or greater. The Althaus Creek, Bluewater Creek, and Camp Oven Creek watercourses received grades of “moderate” (54, 49, 46), which were driven by either the Turbidity or Low DO indicator. Althaus Creek has received “very poor” grades for the Turbidity indicator for several years and should be investigated for probable causes (Appendix II).

High turbidity can be caused by silt, mud, algae, plant detritus, ash, or chemicals. Given the sandy clay nature of the stratigraphy of the Althaus Creek alluvium, it is possible that the turbidity is naturally occurring, with high readings occurring either during or following rainfall events. Investigation of the turbidity data with rainfall suggests that the baseline (no rainfall for an extended period) turbidity in the creek is very close to the WQO. Analysis of the suspended solids within water samples for mineral and organic content would assist in determining the cause of the turbidity.

Table 51. Weighted and unweighted standardised scores and grades for the physical-chemical indicator category and indicators in the Townsville Dry Tropics Estuarine Environment.

Basin	Sub Basin Estuary	Watercourse	Unweighted Score and Grade						Weighted Score and Grade	
			Turbidity	High DO	Low DO	Phys-Chem	Weighting (proportion)	Area (km2)	Sub Basin	Basin
Ross Estuarine	Bohle	Bohle River	62	90	66	64				62
		Louisa Ck	67	90	0	33				
			64	90	33	49	0.28	348	15.6	
	Lower Ross	Ross Ck	90	90	61	75				
		Ross River	90	90	33	61				
			90	90	47	68	0.69	864	60.0	
	Stuart	Sandfly Ck	42	90	68	55	0.02	28	1.4	
	Alligator	Pearce's Ck	58	90	65	61	0	5	0.3	
			68	90	49	58	1	1245		
Black Estuarine	Bluewater Ck	Althaus Ck	18	90	90	54				59
		Bluewater Ck	28	90	70	49				
		Sleeper Log Ck	35	90	90	62				
			27	90	83	55	0.52	277	31.9	
	Rollingstone Ck	Camp Oven Ck	90	90	2	46				
		Saltwater Ck	75	90	90	82				
		Rollingstone Ck	62	76	90	69				
			75	85	60	66	0.25	135	17.6	
	Crystal Ck	Crystal Ck	32	90	90	61	0.22	118	14.9	
			48	88	74	60	1	531		

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) | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

5.1.5 Confidence Scores

Overall, there was moderate confidence in the results due to limited ability to define the measured error, however, all other criterion received a score of 2 or greater (Table 52).

Table 52. Confidence scores for the nutrients, and physical-chemical properties indicator categories.

Indicator Category	Maturity (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured error (x0.71)	Score (Rank)
Nutrients	2	3	2	3	1	9.6 (3)
Phys-Chem	2	3	2	3	1	9.6 (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.

5.2 Habitat

In the estuarine environment the habitat index is comprised of two indicator categories: Mangrove and Saltmarsh Extent, and Estuarine Riparian Extent. There is no update for the 2023-2024 Technical Report; data for these indicator categories is updated approximately every four years with the most recent update occurring in 2023.

5.2.1 Overall Summary: Estuarine Habitat

The scores and grades for the estuary habitat indicator categories and habitat index for 2023–2024, and the indices for previous reporting years are presented in Table 53. Scores in the Ross Basin Estuarine Basin have increased over reporting years, however scores in the Black Estuarine Basin have decreased. In the Ross Estuarine Basin, the habitat index received a score of 74 (good) and in the Black Estuarine Basin, the habitat index received a score of 50 (moderate) (Table 53).

Table 53. Standardised score for the estuarine habitat index.

Basin	Mangrove and Saltmarsh Extent	Riparian Extent	Habitat Index				
			23-24	22-23	21-22	20-21	19-20
Ross Estuarine	68	81	X	74	X	X	73
Black Estuarine	81	20	X	50	X	X	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.

5.2.1.1 *Key Messages*

- There is no new data available for the estuarine habitat section, thus scores have not changed since the previous report. Historic key messages are presented below:
  - Sub Basins scores have been calculated and presented for the first time. This allowed for several new observations such as:
    - Identifying the Bohle River and Crystal Creek sub basins as the main areas of mangrove and saltmarsh loss and all other sub basins either undergoing no change or receiving small increases in mangrove and saltmarsh vegetation.
    - Identifying the Black River, Bluewater Creek and Rollingstone Creek sub basins as key drivers of riparian vegetation loss and several sub basins as the main areas of gain of riparian vegetation.
  - The Black Estuarine Basin recorded its first increase (11.7ha) in mangrove and saltmarsh vegetation since the beginning of the Dry Tropics Technical Report.
  - The Black Estuarine Basin also recorded its first ever loss in riparian vegetation (-9.8ha) since the beginning of the Dry Tropics Technical Report.
    - This may be connected to the ongoing urban development throughout the basin.
  - In the Ross Estuarine Basin mangrove and saltmarshes decreased (-8.5ha) and riparian vegetation increased (0.2ha).

5.2.2 Mangrove and Saltmarsh Extent

The mangrove and saltmarsh extent indicator category provides a measure of the total area of mangrove and saltmarsh and the amount of change (loss or gain) of this vegetation relative to the last time it was measured. Detailed methods can be found in 2025 Methods document (Healthy Waters Partnership for the Dry Tropics 2025). Data is scored based on the amount of mangrove and saltmarsh coverage in comparison to the most recent previous dataset. For this report 2021 mangrove and saltmarsh data (published in late 2023) is compared against 2019 data. The objective of this index is to record zero loss in vegetation between datasets.

5.2.2.1 *Monitoring Sites*

The area assessed for this indicator category is provided in Appendix LL and Appendix MM.

5.2.2.2 *Results: Estuarine Mangrove and Saltmarsh*

The standardised score and grade for the mangrove and saltmarsh extent indicator category is calculated as a percentage lost/gained from 2019 to 2021. For the 2023–2024 reporting period the total area of mangrove and saltmarsh extent was 13,633.4ha in the Ross Estuarine Basin, and 1,197.9ha in the Black Estuarine Basin. This represents a loss of 8.5ha (0.06%) in the Ross Estuarine Basin, and a gain of 11.7ha (0.99%) in the Black Estuarine Basin (Table 55). The loss was primarily driven by the loss of saltmarsh in the Ross River (Lower) and the Bohle River, and the loss of mangroves in the Crystal Creek and Bluewater Creek estuaries. The Ross Estuarine Basin received a final standardised score of 68 (B) and the Black Estuarine Basin received a standardised score of 81 (A) (Table 55). Several factors may have contributed to these changes in vegetation extent, including saltwater intrusion, coastal squeeze, and sea level rise. Historic analysis of mangrove and saltmarsh extent is provided in Appendix NN and Appendix OO.

Table 54. Historic standardised score for the Estuarine mangrove and saltmarsh extent indicator category.

Basin	Estuarine Mangrove and Saltmarsh Extent Standardised Scores					
	23-24	22-23	21-22	20-21	19-20	18-19
Ross Estuarine	X	68	X	X	X	67
Black Estuarine	X	81	X	X	X	63

Mangrove and Saltmarsh scoring range: ■ = Very Poor: >3% loss | ■ = Poor: 0.51 – 3% loss | ■ = Moderate: 0.11 – 0.5% loss | ■ = Good: 0 – 0.1% loss | ■ = Very Good: increase in mangrove of saltmarsh area.

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 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

Table 55. Mangrove and saltmarsh area, loss, and standardised score in the Townsville Dry Tropics estuarine basins and sub basins.

Basin/Sub Basin	Mangroves						Saltmarsh						Total (Mangrove + Saltmarsh)						Standardised Score
	Area (ha)				Change (19-21)		Area (ha)				Change (19-21)		Area (ha)				Change (19-21)		
	Pre-Clear	...	2019	2021	ha	%	Pre-Clear	...	2019	2021	ha	%	Pre-Clear	...	2019	2021	ha	%	
Alligator Ck	2,406.0	...	2,442.0	2,441.4	-0.6	-0.03	6,085.6	...	5,998.2	6,008.7	+10.5	+0.18	8,491.5	...	8,440.2	8,450.1	+9.9	+0.12	81
Bohle River	525.6	...	588.8	591.9	+3.1	+0.53	1,819.5	...	1,692.5	1,677.9	-14.6	-0.86	2,345.1	...	2,281.3	2,269.9	-11.4	-0.5	40
Magnetic Island	181.2	...	179.6	179.6	0.0	0.0	79.2	...	78	78	0.0	0.0	260.4	...	257.6	257.6	0.0	0.0	80
Ross River (Lower)	487.9	...	400.4	401.8	+1.4	+0.35	658.9	...	572.6	560.5	-12.1	-2.12	1,146.7	...	973	962.3	-10.7	-1.1	36
Ross River (Upper)	ND	...	ND	ND	ND	ND	ND	...	ND	ND	ND	ND	ND	...	ND	ND	ND	ND	ND
Stuart Ck	454.1	...	473.1	476.3	+3.3	+0.69	1,343.3	...	1,216.7	1,217.3	+0.5	+0.04	1,797.5	...	1,689.8	1,693.6	+3.8	+0.22	81
Ross freshwater	4,0548.8	...	4,083.8	4,091	+7.2	+0.18	9,986.4	...	9,558	9,542.4	-15.6	-0.16	14,041.2	...	13,641.9	13,633.4	-8.5	-0.06	68
Black River	81.7	...	81.0	84.4	+3.3	+4.12	63.9	...	62.2	64.7	+2.4	+3.91	145.7	...	143.3	149.1	+5.8	+4.03	81
Bluewater Ck	282.1	...	280.0	273.4	-6.6	-2.36	138.1	...	131.4	138.1	+6.7	+5.13	420.2	...	411.4	411.5	+0.1	+0.03	81
Crystal Ck	234.3	...	224.0	219.3	-4.7	-2.11	19.4	...	16.7	16.9	+0.2	+1.34	253.7	...	240.7	236.2	-4.5	-1.87	29
Palm Islands	136.7	...	135.6	135.6	0.0	0.0	2.2	...	0.7	0.7	0.0	0.0	138.9	...	136.3	136.3	0.0	0.0	80
Paluma Lake	ND	...	ND	ND	ND	ND	ND	...	ND	ND	ND	ND	ND	...	ND	ND	ND	ND	ND
Rollingstone Ck	170.3	...	170.3	187.8	+17.4	+10.24	91.5	...	84.2	77.1	-7.1	-8.43	261.8	...	254.5	264.9	+10.3	+4.07	81
Black freshwater	905.2	...	890.9	900.4	+9.4	+1.06	315.1	...	295.3	297.6	+2.3	+0.78	1,220.3	...	1,186.2	1,197.9	+11.7	+0.99	81

Mangrove and Saltmarsh scoring range: ■ = Very Poor: >3% loss | ■ = Poor: 0.51 – 3% loss | ■ = Moderate: 0.11 – 0.5% loss | ■ = Good: 0 – 0.1% loss | ■ = Very Good: increase in mangrove of saltmarsh area.

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 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

■ = increase in vegetation, ■ = no change in vegetation, ■ = decrease in vegetation.

5.2.3 Estuarine Riparian Extent

The Partnership uses methods sourced from the Reef Water Quality Report Card, however, presents results at an estuarine level. The most recent results from the Reef Water Quality Report Card are from 2017, however results presented in this report are from 2021.

5.2.3.1 *Monitoring Sites*

The area assessed for this indicator category is provided in Appendix PP and Appendix QQ.

5.2.3.2 *Results: Estuarine Riparian Extent*

The standardised score and grade for the estuarine riparian extent indicator category is calculated as a percentage lost/gained from 2019 to 2021. For the 2023–2024 reporting period the total area of estuarine remnant riparian vegetation was 4,627.7ha in the Ross Estuarine Basin, and 848.5ha in the Black Estuarine Basin. From 2019 to 2021, the Ross Estuarine Basin gained 0.2ha (0.0% due to rounding) of vegetation, and the Black Estuarine Basin lost 9.8ha (1.14%) of vegetation. No estuaries in the Ross Estuarine Basin lost vegetation. Estuaries in the Black Estuarine Basin varied from “very poor” (Black River, Bluewater Creek, Rollingstone Creek), to “very good” (Crystal Creek), which recorded a gain in vegetation (Table 57). Notably, the Ross Basin recorded an increase in estuarine riparian vegetation, however it is not clear if this is the result of growth of native vegetation or weed species. Further, it should be noted that because vegetation is compared to most recent previous assessment, a score of “good” simply means that there was no vegetation loss since the previous assessment, not since “pre-European times”. The standardised score in the Ross Estuarine Basin was 81 (very good), and the standardised score in the Black Estuarine Basin was 20 (very poor) (Table 56). Historic vegetation trends for each basin are presented in Appendix RR and Appendix SS.

Table 56. Historic standardised score for the Estuarine riparian extent indicator category.

Basin	Estuarine Riparian Extent Standardised Scores			
	23-24	22-23	21-22	20-21
Ross Estuarine	X	81	80	ND
Black Estuarine	X	20	80	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.

Table 57. Riparian Extent area, loss and standardised score in the estuarine basins and sub basins of the Townsville Dry Tropics.

Basin/Sub Basin	Estuarine Riparian Extent						
	Area (ha)				Extent Change (19-21)		Standardised Score
	Pre-Clear	...	2019	2021	ha	%	
Alligator Ck	2,324.8	...	2,320.2	2,320.3	+0.2	+0.01	81
Bohle River	884.9	...	867	867	0.0	0.0	80
Magnetic Island	90.5	...	88.3	88.3	0.0	0.0	80
Ross River (Lower)	564.7	...	530.4	530.4	0.0	0.0	80
Ross River (Upper)	ND	...	ND	ND	ND	ND	ND
Stuart Ck	824.4	...	821.7	821.7	0.0	0.0	80
Ross estuarine	4,689.3	...	4,627.5	4,627.7	+0.2	+0.0	81
Black River	151.2	...	151.1	149.3	-1.9	-1.24	20
Bluewater Ck	315.1	...	316.3	312.3	-4.0	-1.26	20
Crystal Ck	160.5	...	159.4	159.6	+0.2	+0.11	81
Palm Islands	50.4	...	50.1	50.1	0.0	0.0	80
Paluma Lake	ND	...	ND	ND	ND	ND	ND
Rollingstone Ck	178.3	...	181.4	177.3	-4.1	-2.25	20
Black estuarine	855.6	...	858.2	848.5	-9.8	-1.14	20

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 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

5.2.4 Confidence Scores

Overall, there was moderate confidence in the results due to a lack of ability to directly measure the environment, however, all other criterion received a score of 2 or greater (Table 58).

Table 58. 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)
M. & S. Extent	2	2	2	1	2	8.2 (3)
R. Extent	2	2	2	1	2	8.2 (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.

Inshore Marine 2023–2024

Written by Adam Shand

As part of the results for the Townsville Dry Tropics Report Card 2025 (Reporting on data from July 2023– June 2024)

Healthy Waters Partnership for the Dry Tropics (HWP)

July 2025

6 Inshore Marine Environment

Within the inshore environment, water quality and habitat are the two indices scored. Each of these indices are made up of indicator categories and indicators which are updated annually. All indicator categories use data provided by multiple partners of the Partnership team.

Index scores are calculated for the Cleveland Bay Inshore Marine Zone, and the Halifax Bay Inshore Marine Zone.

6.1 Water Quality

The water quality index for the Inshore Marine Environment of the Townsville Dry Tropics regions consists of three indicator categories: Nutrients, Physical-Chemical Properties, and Chlorophyll *a*. These are divided into eight indicators and for each indicator the parameters used to calculate scores are the:

- Water Quality Objectives (WQOs), and
- Annual means or medians (depending on the indicator), calculated from the monthly medians or means.

The Townsville Dry Tropics Methods Document (2025) provides definitions of the WQOs and guidelines for using mean or median values. Values can also be found in Appendix TT and Appendix VV.

The nutrients indicator category is comprised of four indicators, Nitrogen Oxides (NOx), Particulate Nitrogen (PN), Particulate Phosphorus (PP), and Total Phosphorus (TP). The scores for nutrients are averaged from the scores of the four indicators. The physical-chemical properties indicator category is comprised of three indicators, Turbidity, Total Suspended Solids (TSS), and Secchi Depth, and the score is calculated as the average from the scores of the three indicators. Finally, the Chlorophyll *a* indicator category is comprised of only one indicator, the Chlorophyll *a* indicator.

6.1.1 Monitoring Sites

In the 2023–2024 technical report, water quality data was collected from 20 sites (codes). Sites were grouped into eight geographic areas, six sub zones, and two zones as detailed in Table 59, with locations presented in Figure 17.

Table 59. Townsville Dry Tropics Inshore Marine water quality site summary.

Zone	Sub Zone	Geographic Area	Number of Sites
Cleveland Bay	Enclosed Coastal	Enclosed Coastal: Inside Port Zone	3
		Enclosed Coastal: Outside Port Zone	4
	Open Coastal	Open Coastal: Inside Port Zone	1
		Open Coastal: Outside Port Zone	3
	Magnetic Island	Magnetic Island	3
Halifax Bay	Enclosed Coastal	Enclosed Coastal	2
	Open Coastal	Open Coastal	2
	Midshelf	Midshelf	2

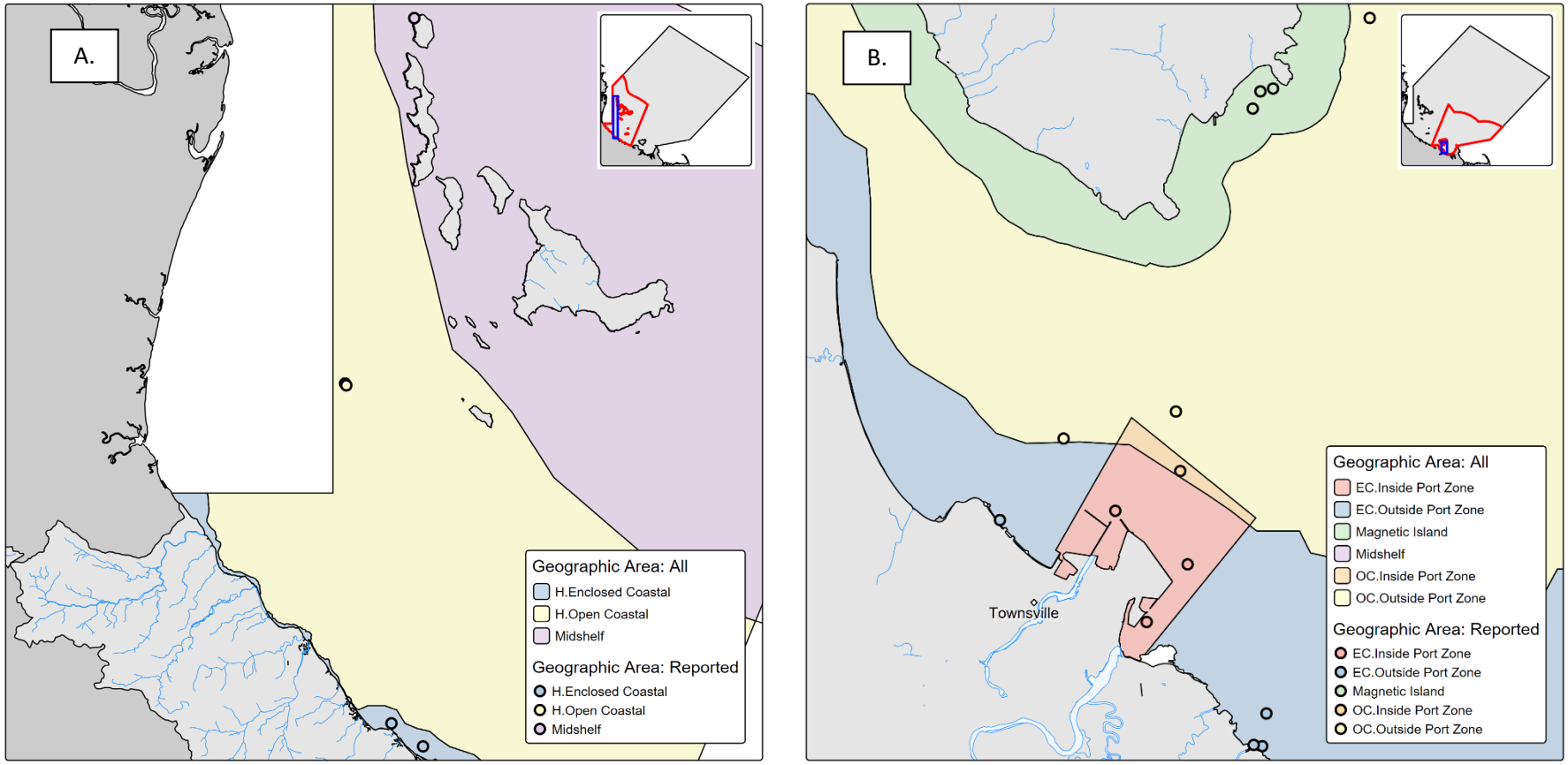

Figure 17. Inshore Marine Zones (A. = Halifax Bay, B. = Cleveland Bay), and Geographic Areas (see legend). In the inset map, the red boundary defines the extent of the inshore marine zone, the blue box defines the extent of the sampling sites.

6.1.2 Overall Summary: Inshore Water Quality

The water quality index was graded as “good” in both Cleveland Bay and in Halifax Bay. This marks an increase in score in Cleveland Bay (73 to 76) and a decrease in score in Halifax Bay (73 to 65) (Table 60, Table 61). In both Bays the Chlorophyll a indicator category declined an entire grade – the driving force for the overall decline in Halifax Bay. However, in Cleveland Bay this was offset by an increase in the Physical-Chemical Properties indicator category. Note; the inshore water quality index received a confidence grade of “low” (6.1.7 Confidence Scores).

Table 60. Current and previous water quality scores and grades for the Townsville Dry Tropics Inshore Marine Environment.

Zone	Nutrients	Phys-Chem Properties	Chlorophyll *a*	Water Quality					
				23-24	22-23	21–22	20–21	19–20	18–19
CB	87	69	72	76	73	78	73	79	36
HB	76	61	59	65	73	69	73	54	45

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.

Table 61. A comparison of nutrient and physical chemical properties indicator category scores, and the water quality index scores, for inshore sub zones between years.

Zone	Sub Zone	Nutrients					Phys-Chem					Chla					Water Quality				
		23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20
	CB.Enclosed Coastal	100	100	100	77	77	61	39	63	64	57	63	90	81	64	100	75	76	81	68	78
	CB.Open Coastal	100	100	100	100	100	72	36	72	74	82	ND	ND	ND	ND	ND	86	68	86	87	91
	Magnetic Island	38	22	20	26	16	79	91	79	80	85	80	84	83	83	80	66	66	61	63	60
Cleveland Bay		87	84	78	ND	ND	69	48	74	ND	ND	72	87	92	ND	ND	76	73	81	ND	ND
	HB.Enclosed Coastal	100	100	100	100	34	56	88	65	92	62	100	100	100	100	67	85	96	88	97	54
	HB.Open Coastal	61	65	64	49	28	49	60	49	55	67	40	61	75	69	69	50	62	62	58	54
	Midshelf	66	65	56	65	77	78	80	61	68	57	36	43	53	61	100	60	63	57	64	78
Halifax Bay		76	77	61	ND	ND	61	76	65	ND	ND	59	68	77	ND	ND	65	73	67	ND	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 | - = Not Applicable (data available but not usable) | X = Data was not updated this year.

6.1.2.1 *Key Messages*

- The Cleveland Bay inshore marine zone overall water quality grade remained "good" and the score increased from 73 to 76.
    - Grades for indicators with the nutrient indicator category continue to remain moderate to "very poor" within the Magnetic Island Sub Zone. These scores are the result of high concentrations of nutrients, stringent water quality objectives, and proximity to a range of anthropogenic activities.
    - Grades for Turbidity and TSS remained "very poor" in the Enclosed Coastal Outside Port Zone area. This location has had several years of low results and it is recommended that further investigation is conducted to determine the cause of the decline.
- The Halifax Bay inshore marine zone overall water quality grade remained "good" however declined from 73 to 65.
    - Most influential was the Chlorophyll a indicator in the Open Coastal and Midshelf Sub Zones.
    - Chlorophyll a decline from "good" (61) to "poor" (40) in the Open Coastal and Sub Zone and decline from "moderate" (43) to "poor" (36) in the Midshelf Sub Zone. Continued sampling is required to monitor for trends.

6.1.3 Nutrients

For the 2023–2024 technical report the nutrients indicator category is comprised of four indicators, Nitrogen Oxides (NOx), Particulate Nitrogen (PN), Particulate Phosphorus (PP), and Total Phosphorus (TP), however not all indicators are measured at each site (determined by data provider). The scores and grades for Cleveland and Halifax Bay, and their associated sub zones are presented in Table 62. Annual mean or median values (depending on the indicator), samples collected, months sampled, and WQOs are presented in Appendix TT. Historical scores are presented in Appendix UU.

6.1.3.1 *Results: Inshore Nutrients*

Cleveland Bay received a nutrient indicator category score of 87 (very good). Within the zone, the enclosed coastal and open coastal sub zones received nutrient indicator category grades of "very good" (100 each) while the Magnetic Island Sub Zone received a grade of "moderate" (38), with all three indicators in this sub zone (NOx, PN, and PP) graded as "moderate" or "very poor" (Table 62).

A lower nutrients indicator category score in the Magnetic Island Sub Zone relative to other sub zones could be attributed to a) environmental condition, and/or b) variations in sampling design.

Sampling design considerations include the use of more stringent water quality objectives (WQOs) due to its status as a green zone, the difference in sampling times and frequency of loggers compared to grab samples, or the minor variations in sampling programs and analysis methods conducted by the range of data providers (for example, LORs) (Appendix TT).

Equally, environmental condition considerations include nutrient sources such as septic systems, large infrastructure projects in close proximity, and a greater exposure to large southern influences such as the Burdekin River likely also contribute to a low grade and score.

A comparison of median values indicate that NOx concentrations were roughly equal to, or in some cases less than, the median values in other geographic areas (Appendix TT). Thus, it is possible to attribute differences in WQOs as the main driver of a low NOx score in the Magnetic Island Sub Zone

for the 2023-2024 report. However, it is important to note that over several reports, the Magnetic Island Sub Zone has consistently received low scores and grades, and not always due to more stringent WQOs. It is likely that the multitude of unique geographic and regulatory characteristics of the Magnetic Island Sub Zone, in combination, continue to result in a low NOx score.

Halifax Bay Inshore received a nutrient indicator category score of 65 (good). Within the zone, the open coastal and Midshelf sub zones received a nutrient indicator category grade of “good”, while the enclosed coastal sub zone received a grade of “very good” (Table 62).

Across all geographic areas the NOx indicator received a grade of “very good”, however no other indicator was measured at all geographic areas. Where measured, the PN indicator always received a grade of “poor”, while the PP indicator received a grade of “moderate” or “good”. The TP indicator was only measured at one geographic area (Enclosed Coastal), was graded as “very good”, and played a notable role in the final score for the Sub Zone.

Table 62. Standardised scores and grades for the nutrient indicator category and indicators comprising the nutrient indicator category in the Townsville Dry Tropics Inshore Marine Environment.

Zone	Sub Zone	Area	NOx	PN	PP	TP	Nutrients	Zone Nutrients
Cleveland Bay	Enclosed Coastal	Inside Port Zone	100	ND	ND	100	100	87
		Outside Port Zone	100	ND	ND	100	100	
			100	ND	ND	100	100	
	Open Coastal	Inside Port Zone	100	ND	ND	100	100	
		Outside Port Zone	100	ND	ND	100	100	
			100	ND	ND	100	100	
	Magnetic Island	Magnetic Island	57	15	41	ND	38	
			89	15	41	100	87	
Halifax Bay	Enclosed Coastal	Enclosed Coastal	100	ND	ND	100	100	76
	Open Coastal	Open Coastal	100	28	56	ND	61	
	Midshelf	Midshelf	85	35	79	ND	66	
			95	32	67	100	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.

6.1.4 Physical-Chemical Properties

For the 2023–2024 technical report the physical-chemical properties indicator category is comprised of three indicators, Turbidity (NTU), Total Suspended Solids (TSS), and (Secchi) Depth. The scores and grades for Cleveland and Halifax Bay, and their associated sub zones are presented in Table 63. Annual mean or median values (depending on the indicator and WQO), samples collected, months sampled, and WQOs are presented in Appendix VV. Historical scores are presented in Table 97.

6.1.4.1 *Results: Inshore Physical-Chemical Properties*

Cleveland Bay received a physical-chemical properties indicator category score of 69 (good). Within the zone, all three sub zones received a grade of "good" (Enclosed Coastal: 61, Open Coastal: 72, Magnetic Island: 79). Grades for indicators ranged from 0 to 84 for Turbidity, 3 to 100 for TSS, and 54 to 100 for Secchi, suggest a wide variability across the Bay (Table 63).

The wide variety in scores between, and within, three water-clarity related indicators of Turbidity, TSS and Secchi suggest a disconnected between the WQO's for these indicators and the ambient conditions at the sampling sites. (Appendix VV). Equally, spatial variations such as the proximity of sites relative to natural gradients related to distance from rivers, the coast and the port zone within each water body will contribute to variations in grades and scores measured against whole of water-body WQOs. For example, mean values for Secchi were similar in the Open Coastal Inside Port Zone and Open Coastal Outside Port Zone areas (1.2 and 1.1), with the Outside Port Zone having a greater Secchi value (more clarity) but differences in WQOs (i.e. the Inside Port Zone have objectives representative of a moderately disturbed environment) resulted in very different standardised scores (99 and 54) (Table 63, Appendix VV). Further, in the Enclosed Coastal Outside Port Sub Zone, the Secchi indicator did not record the same very low scores and grades as the Turbidity and TSS indicators for the same sub zone as there is only one location where Secchi depth is monitored (compared to the additional sites that measure Turbidity and TSS). The additional Turbidity and TSS sample sites are in close proximity to the mouth of Sandfly Creek where the bay is very shallow and muddy and can be subject to constant resuspension due to the tide and wind, particularly during and after events such as TC Kirrily, in addition to discharge from the Cleveland Bay Wastewater Treatment plant (Figure 17). Regardless of the influence, it should be noted that low scores for the Turbidity and TSS indicators in the Enclosed Coastal Outside Port Zone area have consistently occurred across multiple years of reporting.

Halifax Bay received a physical-chemical properties indicator category score of 61 (good). Within the zone, both the Enclosed Coastal and Open Coastal sub zone received a physical-chemical indicator category grade of "moderate", with the Midshelf sub zone receiving a grade of "good" (Table 63). For all indicators, scores showed a spatial correlation with improvements occurring in conjunction with distance offshore, with a comparison of concentrations at each site supporting this observation (Appendix VV).

Table 63. Standardised scores and grades for the physical-chemical properties indicator category and indicators comprising the physical-chemical properties indicator category in the Townsville Dry Tropics Inshore Marine Environment.

Zone	Sub Zone	Area	Turbidity	TSS	Secchi	Phys Chem	Zone Phys Chem
Cleveland Bay	Enclosed Coastal	Inside Port Zone	63	100	100	87	69
		Outside Port Zone	0	3	100	34	
			31	51	100	61	
	Open Coastal	Inside Port Zone	84	100	99	94	
		Outside Port Zone	0	95	54	50	
			42	97	77	72	
	Magnetic Island	Magnetic Island	67	98	73	79	
			43	79	85	69	
Halifax Bay	Enclosed Coastal	Enclosed Coastal	46	66	ND	56	61
	Open Coastal	Open Coastal	75	69	2	49	
	Midshelf	Midshelf	98	100	36	78	
			73	78	19	61	

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.

6.1.5 Chlorophyll *a*

For the 2023–2024 technical report the scores and grades for the chlorophyll *a* indicator in Cleveland and Halifax Bays, and their associated sub zones are presented in Table 64. Annual mean values, samples collected, months sampled, and WQOs are presented in Appendix VV. Historical scores are presented in Table 97.

6.1.5.1 *Results: Inshore Chlorophyll a*

Cleveland Bay received a Chlorophyll *a* indicator category score of 72 (good), with both sub zones also receiving grades of "good" (Magnetic Island sub zone: 80, Enclosed Coastal Sub Zone: 63). The Open Coastal Sub Zone was not graded (Table 64). These grades declined from previous years' chlorophyll a grades of "very good" and potentially suggest the impact of a widespread environmental event such as TC Kirrily, however additional years of data would be required to confirm this assessment. Mean values were orders of magnitude greater in the Enclosed Coastal Sub Zone, however scores remained similar due water quality objectives (WQOs) which are designed to reflect the less stringent desired condition of the location (Appendix VV).

Halifax Bay received chlorophyll *a* score of 59 (moderate). The Enclosed Coastal Water Sub Zone receiving a score of 100 (very good), the Open Coastal Waters Sub Zone scored 40 (poor), and the Midshelf Sub Zone scored 36 (poor). Interestingly a spatial gradient is apparent in the annual mean concentration values of chlorophyll a, with concentration decreasing for the two sites further offshore (Open Coastal and Midshelf) (Appendix VV). However, similar to the Cleveland Bay WQOs which are designed to reflect the desired condition of the location indicate that chla concentration values should be even less in the Open Coastal Waters Sub Zone, which has more stringent requirements (Appendix VV, Table 97).

Table 64. Standardised scores and grades for the Chlorophyll a indicator in the Townsville Dry Tropics Inshore Marine Environment.

Zone	Sub Zone	Area	Chl *a*	Zone Chl *a*
Cleveland Bay	Enclosed Coastal	Inside Port Zone	ND	72
		Outside Port Zone	63	
			63	
	Open Coastal	Inside Port Zone	ND	
		Outside Port Zone	ND	
			ND	
	Magnetic Island	Magnetic Island	80	
			72	
Halifax Bay	Enclosed Coastal	Enclosed Coastal	100	59
	Open Coastal	Open Coastal	40	
	Midshelf	Midshelf	36	
			59	

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.

6.1.6 Overlap with the Wet Tropics Technical Report

The Townsville Dry Tropics reporting region shares four sites (BUR1, BUR2, Pandora, Pelorus) with the Wet Tropics reporting region (Appendix ZZ). Underlying data is identical, however differences in aggregation and reporting style may result in minor discrepancies in the presentation of results.

6.1.7 Confidence Scores

Overall, there was low confidence in the results due to limited spatial and temporal sampling for some indicators in both bays (Table 65). For example, within Cleveland Bay almost all sites are within an 11km section of water near the coastline, despite the Enclosed Coastal Waters stretching more than 58km. It is noted that there is less development in these other areas and thus current monitoring may capture most of the areas impacted by human activities. More sampling, both along the coast and further offshore, would enable a more accurate understanding of the water quality within the inshore area.

Further, variations in the sampling design and indicator selection between different data providers, as well as a range of limit of reporting values also reduce confidence in final scores.

Table 65. Confidence scores for the nutrients, physical-chemical properties, and Chlorophyll a indicator categories.

Indicator Category	Maturity (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured error (x0.71)	Score (Rank)
Nutrients	2	3	1	3	1	7.6 (2)
Phys-Chem	2	3	1	3	1	7.6 (2)
Chlorophyll *a*	2	3	1	3	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.

6.2 Habitat

The habitat index is comprised of two indicator categories: coral and seagrass, and both indicator categories source their results and discussion from reports published by partner organisations (Mckenna S., et al. 2025, Thompson, et al. 2025).

6.2.1 Overall Summary: Inshore Habitat

Overall habitat scores decreased in both bays (47 to 44 for Halifax, 53 to 37 for Cleveland), with the habitat grade decreasing from "moderate" to "poor" in Cleveland Bay. Both bays received their lowest scores since this technical report began, and these results highlight the ongoing and complex environmental and anthropogenic factors affecting coral and seagrass health including two acute disturbances over the 2023–24 summer. Most notably, marine heat wave conditions that caused coral bleaching and TC Kirrily that crossed the coast on 25th January 2024 causing minor storm damage (Table 66).

Table 66. Standardised score for the Inshore Marine Environment habitat index.

Zone	Coral	Seagrass	Habitat Index					
			23-24	22-23	21-22	20-21	19-20	18-19
Cleveland Bay	37	37	37	53	57	54	48	56
Halifax Bay	44	ND	44	47	45	49	52	52

Coral 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.

Seagrass Standardised scoring range: ■ = Very Poor: 0 to <25 | ■ = Poor: 25 to <50 | ■ = Moderate: 50 to <65 | ■ = Good: 65 to <85 | ■ = Very Good: 85 to 100 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

6.2.1.1 *Key Messages*

- The Cleveland Bay inshore marine zone grade declined from moderate to poor, and also showed a large score decrease (53 to 37).
    - The seagrass grade within Cleveland Bay declined from good to poor, while the score decreased from 68 to 37.
        - The biomass condition indicator was the primary driver of the decline scores. However, the area and composition condition indicators largely remain stable or increased for most meadows, indicating the potential for biomass recovery.
        - Biomass losses were driven primarily by system-wide induced pressures such as TC Kirrily, high winds, elevated wave heights and rainfall that resulted in extended periods of low light, potentially impacting seagrass. Realised impacts form environmental factors may take months to arrive and may linger for several months.
        - Concurrent and successive environmental conditions that are not favourable for seagrass growth and persistence, during and over multiple years are likely to have caused the seagrass condition loss recorded in the Townsville region.
    - The coral grade within Cleveland Bay remained "poor", however the score decreased slightly from 39 to 37. Scores and grades from coral in Cleveland Bay have fluctuated

within this range for the past four years due to exposure to several pressures including cyclones, and increased water temperatures leading to bleaching.
    - Low scores are primarily driven by the Juvenile and macroalgae indicators, suggesting limited coral recruitment and a high density of macroalgae competing for available space.
- The Halifax Bay inshore marine zone grade remained "moderate" although the score decreased slightly from 47 to 44.
    - The coral grade with Halifax Bay was 44 (moderate), the lowest score received in the past five years (by 1).
    - There remains a large amount of macroalgae recorded at three of six sites.

6.2.2 Coral

Coral data was primarily collected by the Great Barrier Reef Marine Monitoring Program (MMP)[12], and the Australian Institute of Marine Science's Long-term Monitoring Program (LTMP)[12]. Data was also collected by the citizen science group, Reef Check Australia (RCA)[12].

6.2.2.1 *Monitoring Sites*

Within Cleveland Bay six sites were sampled, with one site sampled twice by different monitoring programs (Geoffrey Bay). In Halifax Bay six sites were sampled, (Table 67). Reef locations are shown in Figure 19, noting that the Palms West Reef consists of two sites.

[12] MMP, LTMP, RCA

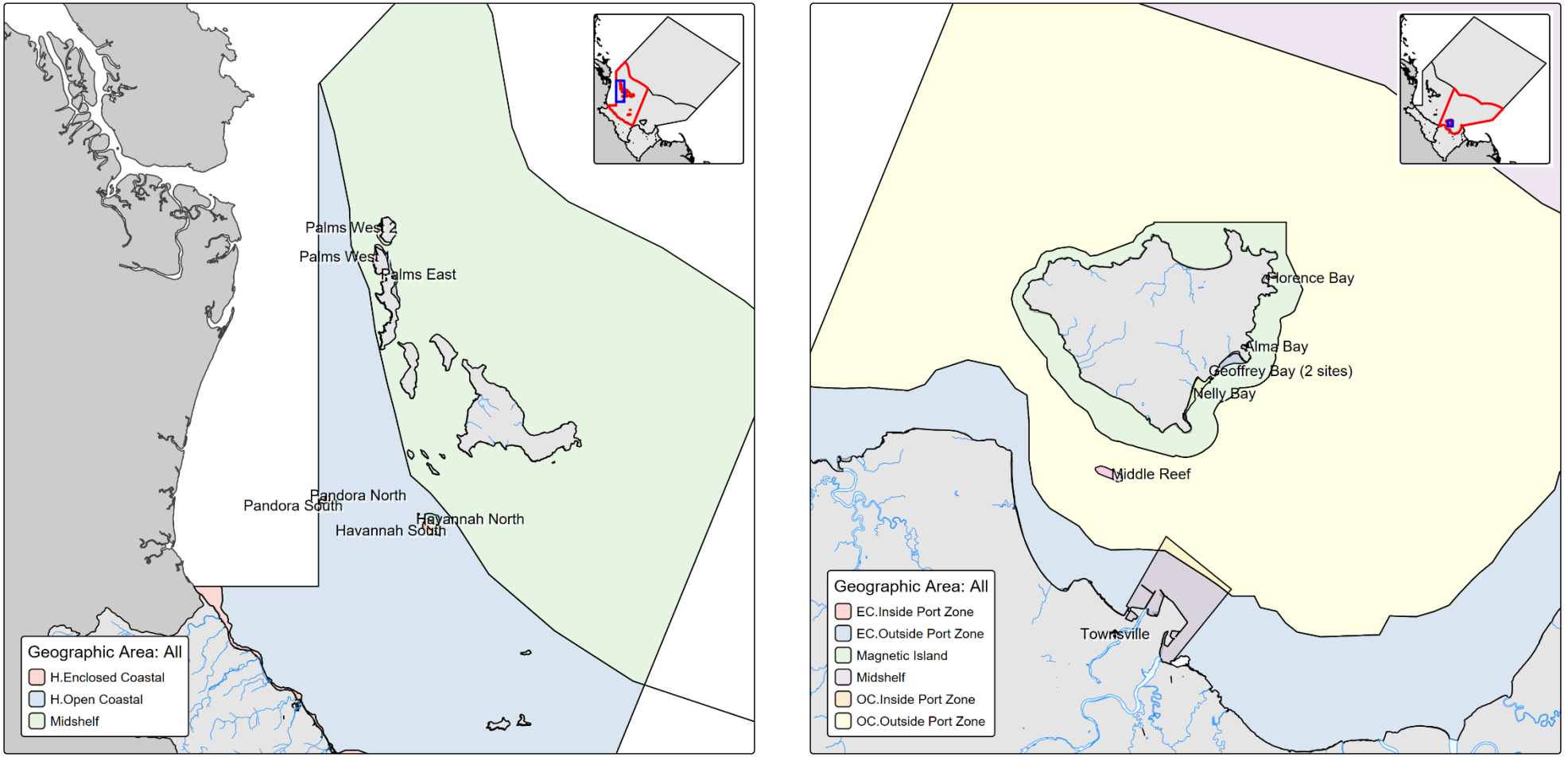

Figure 19. Coral reef sampling locations in the Halifax Bay and Cleveland Bay Inshore marine zones.

Table 67. Inshore Marine coral sampling locations and sampling programs.

Zone	Sampling Program	Sampling Site	ID
Cleveland Bay	MMP & RCA	Geoffrey Bay	1
	RCA	Alma Bay	2
		Florence Bay	3
		Middle Reef	4
		Nelly Bay	5
Halifax Bay	MMP	Palms East	6
		Palms West	7
		Pandora South	8
		Havannah South	9
	LTMP	Pandora North	10
		Havannah North	11

6.2.2.2 *Results: Inshore Coral*

In both bays scores decreased slightly however grades remained the same. In Cleveland Bay, the grade for the coral indicator category was “poor”, with a score of 37, while in Halifax Bay, the grade for the coral indicator category was “moderate” with a score of 44. Analysing these results across several years show a mixed trend of overall coral health decline and recovery as reefs have been exposed to pressures, such as increased water temperatures that contributed to coral bleaching in 2020. All indicators except Coral cover remain below the score for 2020 (Table 68).

Table 68. Inshore Marine Environment coral indicator category scores for current and previous technical reports.

Zone	Coral Standardised Score					
	23-24	22-23	21–22	20–21	19–20	18–19
Cleveland Bay	37	39	41	36	44	38
Halifax Bay	44	47	45	48	50	52

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.

Discussion has been paraphrased from the Marine Monitoring Program Annual Report for inshore coral reef monitoring 2023-24 report and applies to the Cleveland Bay and Halifax Bay sites collectively. Reference: (Thompson, et al. 2025).

Reefs in the Burdekin region were exposed to two acute disturbances over the 2023–24 summer:

- A marine heat wave caused coral bleaching adding to impacts of bleaching that occurred as a result of marine heat wave conditions in 2017, 2020 and to a lesser degree 2022 and,
- Cyclone Kirrily crossed the coast on 25th January 2024 causing minor storm damage.

The Coral cover indicator score remained categorised as “moderate” having declined slightly each year since 2024. Of the reefs monitored by the MMP in 2024, coral cover declined at Palms East, Lady Elliot and Magnetic.

The Cover change indicator score has been declining since 2019 but remains “moderate” in Halifax Bay, and “good” in Cleveland Bay. However, the rate of hard coral recovery was variable and scored “poor” at half of the reefs monitored.

The Juvenile coral indicator remained categorised as “poor”. Juvenile density increased at Havannah North while most other reefs remained close to densities observed in 2023.

The Macroalgae indicator was slightly improved from 2023 and remained categorised as “moderate” in Halifax Bay, and “very poor” in Cleveland Bay. The scores for this indicator varied drastically between reefs and depths ranging from “very poor” at Magnetic Island and 2m depths on reefs other than Palms East and Palms West where scores at both 2 m and 5 m depths were “very good”.

Table 69. Inshore Marine coral indicator and indicator category scores for all sites and zones.

Zone	ID	Hard Coral Composition	% Coral Cover	% Change Hard Coral	Juvenile Density	Macroalgae	Indicator Category
Cleveland Bay	1	50	43	65	25	0	36
	2	ND	54	ND	ND	ND	ND
	3	ND	62	ND	ND	ND	ND
	4	ND	49	ND	ND	ND	ND
	5	ND	40	ND	ND	ND	ND
Cleveland Bay		50	47	65	25	0	37
Halifax Bay	6	100	50	26	12	97	57
	7	0	47	54	35	100	47
	8	75	33	46	30	29	43
	9	100	56	33	29	1	44
	10	0	84	44	21	0	30
	11	50	32	50	78	0	42
Halifax Bay		54	50	42	34	38	44

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.

6.2.3 Seagrass

Data for the seagrass indicator category was sourced from the Port of Townsville Long-Term Seagrass Monitoring Program (LTSMP), with monitoring conducted by James Cook University (JCU) (Mckenna S., et al. 2025). The 2023–2024 technical report uses data collected during September to October in 2023.

6.2.3.1 *Monitoring Sites*

Seagrass was only monitored in Cleveland Bay in 2023-2024. Across Cleveland Bay ten seagrass meadows are monitored in the LTSMP and divided into three spatially distinct groups: Magnetic Island, Cape Pallarenda/Strand, and Cleveland Bay (Table 70). Meadow locations are provided in Figure 20.

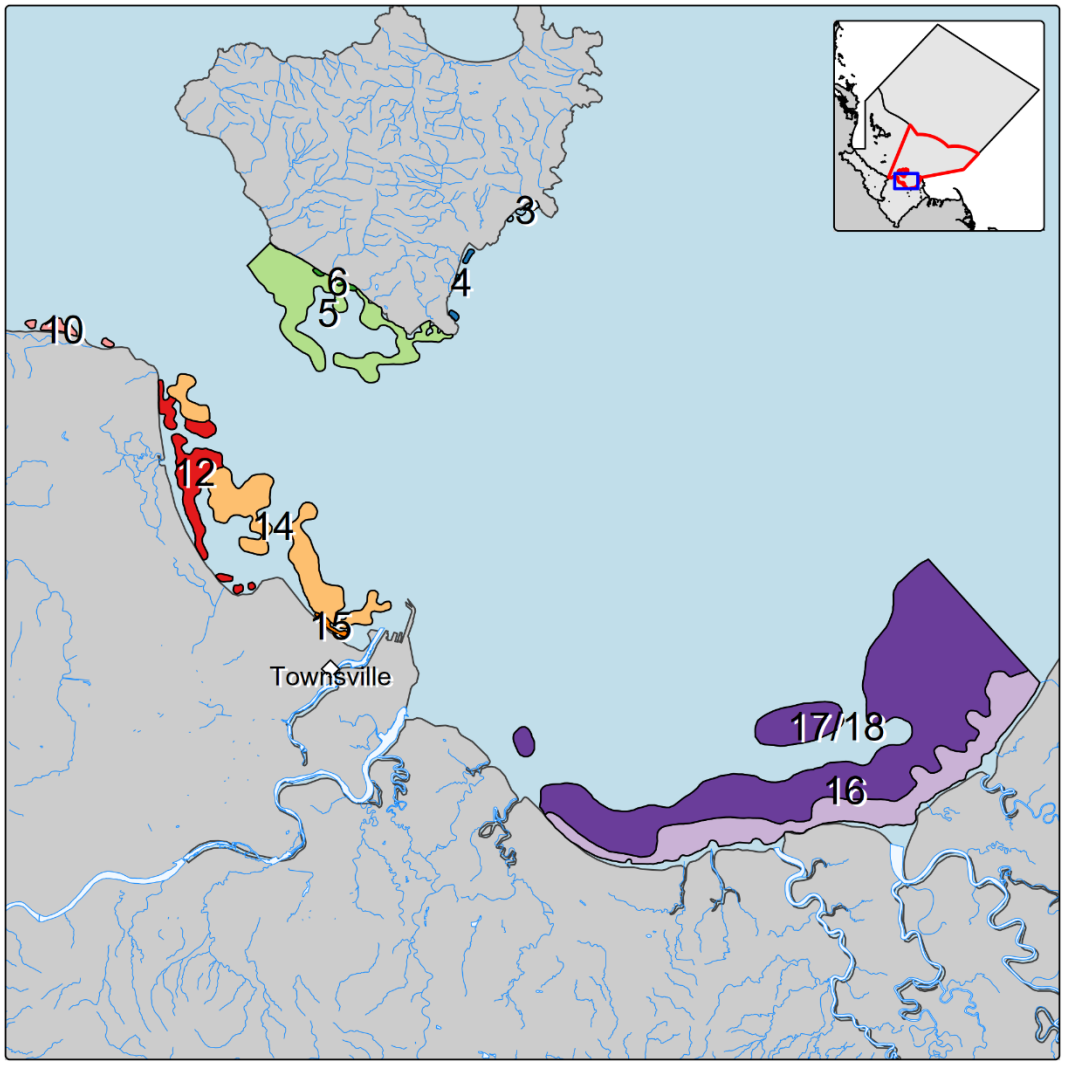

Figure 20. Seagrass meadow monitored for the LTSMP 2024 assessment.

Table 70. Overview of the Long-term Seagrass Monitoring Program (LTSMP) meadows. Adapted from (Mckenna S., et al. 2025).

Region	Meadow	ID	History
Magnetic Island	Geoffrey Bay	3	Detailed Annual >10 years
	Nelly Bay	4	Detailed Annual >10 years
	Cockle/Picnic Bay	5	Detailed Annual >10 years
	Cockle Bay	6	Detailed Annual >10 years
Cape Pallarenda – Strand	Shelly Beach	10	Detailed Annual >10 years
	Rowes Bay	12	Detailed Annual >10 years
	Pallarenda inc. Virago Shoal	14	Detailed Annual >10 years
	Strand	15	Detailed Annual >10 years
Cleveland Bay	Cleveland Bay	16	Detailed Annual >10 years
	Cleveland Bay	17/18	Detailed Annual >10 years

6.2.3.2 *Results: Inshore Seagrass*

In Cleveland Bay, the grade for seagrass monitoring meadows was poor with a score of 37. This is a large decrease in both score and grade from the previous reporting period (68, good) and all previous reporting periods (average grade of good). These results show a notable impact on overall seagrass health during the 2023-2024 reporting period (Table 71).

Table 71. Standardised score for the seagrass indicator category.

Zone	Seagrass Standardised Score					
	23-24	22-23	21-22	20-21	19-20	18-19
Cleveland Bay Inshore Marine Zone	37	68	73	71	52	74

Standardised scoring range: ■ = Very Poor: 0 to <25 | ■ = Poor: 25 to <50 | ■ = Moderate: 50 to <65 | ■ = Good: 65 to <85 | ■ = Very Good: 85 to 100| ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

Discussion has been paraphrased from the Port of Townsville Seagrass Monitoring Program 2024 report. Reference: (Mckenna S., et al. 2025).

"The seagrass condition category is comprised of three indicators: biomass, area, and species composition. Meadow scores are calculated as the lowest individual score of the three indicators, except when species composition is the lowest. When species composition is the lowest score the final meadow score is calculated as the average of the two lowest indicator scores" (Mckenna S., et al. 2025) (Carter, et al. 2025).

6.2.3.2.1 Magnetic Island Seagrass Meadows

Three of the four seagrass meadows measured in the Magnetic Island region received a grade of "very poor" in comparison to their long-term baseline due to the biomass condition indicator. Across the three seagrass condition indicators grades ranged from "very poor" to "very good" for Magnetic Island meadows. All meadows except one had a good-very good score for area and/or species composition.

Geoffrey Bay (meadow 3) seagrass biomass declined from "poor" to "very poor" and has become very sparse, with less than 5% cover. Nelly Bay (meadow 4) recorded its highest density in October 2023 however underwent a large decline by October 2024 to a "satisfactory" condition due to the loss of biomass 'hotspots'. Cockle Bay seagrass meadows (5 and 6) were both in "very poor" condition and declined in biomass. However, meadow 5 increased to the largest seagrass extent recorded in the Long-Term Seagrass Monitoring Program (LTSMP) for this meadow, with most gains occurring along the seaward edge. Much of this meadow expansion was by *Halophila ovalis* which has colonising traits (Kilminster, et al. 2015). A high number of dugong feeding trails were noted.

6.2.3.2.2 Cape Pallarenda – Strand Seagrass Meadows

The condition of meadows in Cape Pallarenda – Strand ranged from "very poor" to "very good". Meadow 10 has been on a downward trend for both the biomass and area condition indicators since 2017. A large amount of sediment scouring and sediment deposition has been noted by the LTSMP and MMP teams, and the seagrass that was present had rhizomes and roots exposed (scouring) or only had the rhizomes of the plant remaining. For meadows 12, 14, and 15, the condition of meadow 12 declined ("good" to "satisfactory"), meadow 14 remained the same (poor), and meadow 15 increased (from "good" to "very good").

6.2.3.2.3 Cleveland Bay Seagrass Meadows

The Cleveland Bay region of seagrass contains the largest continuous meadows across the entire Bay. The extent of the intertidal meadow 16 was in satisfactory condition while the subtidal meadow (17/18) was in good condition at the end of 2024. However, the density (biomass condition indicator) of meadow 16 is highly variable – fluctuating between peaks and troughs every three to four years. For example, meadow 16 has recently experienced a decline in meadow biomass at certain locations in the meadow, from 100 g DWm^2 in 2022, down to 9 g DWm^2 in 2024. The density of seagrass in meadow 17/18 remained satisfactory.

A timeseries map of meadow extent is available in (Appendix BBB).

Table 72. Seagrass indicator scores for all meadows in the Cleveland Bay Inshore Marine Environment.

Region	ID	Biomass	Area	Species Comp.	Meadow Score
Magnetic Island	3	5	85	77	5
	4	52	90	100	52
	5	24	100	95	24
	6	15	28	65	15
Cape Pallarenda – Strand	10	1	32	52	1
	12	60	95	78	60
	14	45	57	95	45
	15	85	99	99	85
Cleveland Bay	16	28	56	79	28
	17/18	50	73	96	50
Overall					37

Standardised scoring range: ■ = Very Poor Condition: 0 to <25 | ■ = Poor Condition: 25 to <50 | ■ = Satisfactory Condition: 50 to <65 | ■ = Good Condition: 65 to <85 | ■ = Very Good Condition: 85 to 100 | ND = No Data | NA = Not Applicable (data available but not usable) | X = Data was not updated this year.

6.2.4 Confidence Scores

There is very high confidence in the seagrass and coral indicator categories due to the efficacy and maturity of the habitat monitoring programs. Seagrass received a rank of 5 out of 5, and coral received a rank of 3, and 4 (Cleveland Bay was not as well represented as Halifax Bay) (Table 73).

Table 73. Confidence scores for the coral and seagrass indicator categories.

Indicator Category	Maturity (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured error (x0.71)	Score (Rank)
Coral (CB)	3	3	1.5	3	2	9.8 (3)
Coral (HB)	3	3	2	3	2	10.8 (4)
Seagrass	3	3	3	3	3	13.5 (5)

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.

Offshore Marine 2023–2024

Written by Adam Shand

As part of the results for the Townsville Dry Tropics Report Card 2025 (Reporting on data from July 2023– June 2024)

Healthy Waters Partnership for the Dry Tropics (HWP)

July 2025

7 Offshore Marine Environment

The Offshore Marine Environment in the Townsville Dry Tropics region consists of only one zone (the Offshore Marine Zone). The water quality and habit indices are measured in this zone, however currently only the habitat index is reported (see section 7.1.1 Data source). The extent of the zone is shown in Figure 21, and results are presented below.

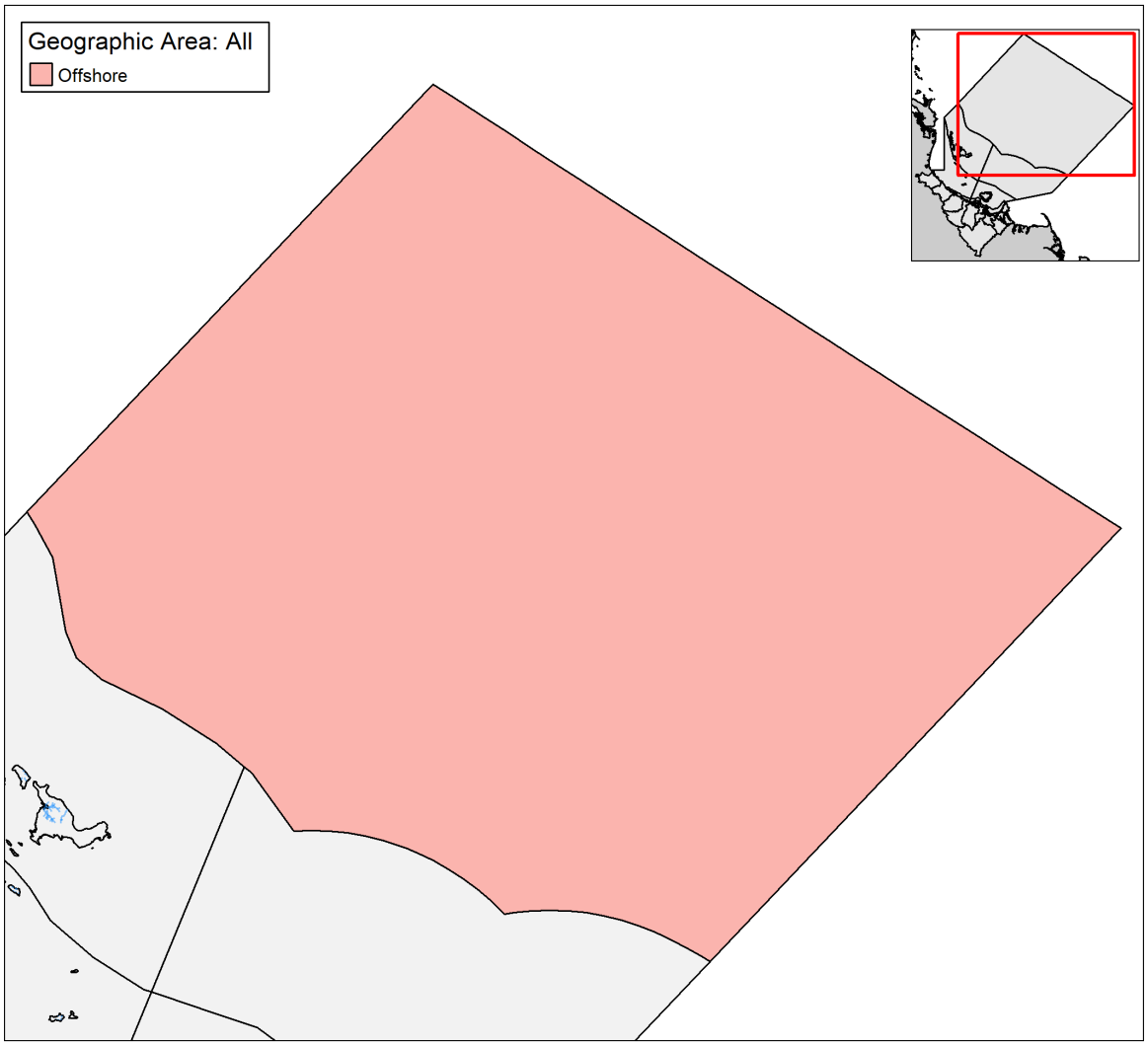

Figure 21. Dry Tropics offshore marine zone.

7.1 Water Quality

The 2023–2024 reporting period was the fourth year in which the water quality index has not been reported (see section 7.1.1 Data source). For years previous to 2020–2021 offshore water quality results were obtained from the BoM Marine Water Quality (MWQ) dashboard and were based upon relative area (%) of the water body where the annual mean value met the water quality guideline value (Table 74). The scores were similar for all reporting years.

Table 74. Current and previous water quality scores and grades for the Townsville Dry Tropics Offshore Marine Zone.

Zone	Water Quality					
	23-24	22-23	21–22	20–21	19–20	18–19
Offshore Marine	ND	ND	ND	ND	100	97

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.

7.1.1 Data source

Since the 2020-21 reporting year there has been no data available for scoring and grading water quality for the offshore zones of the regional report cards. Up until 2019-20, the data for the offshore assessment of water quality was extracted from the marine water quality (MWQ) Bureau of Meteorology dashboard based on remotely sensed analysis of reflectance. In early 2021 the Bureau of Meteorology advised that the MWQ dashboard and underlying data preparation workflow was to be discontinued. Since 2022, the Technical Working Group for regional report cards and the Independent Science Panel recommended that services and products produced by CSIRO for eReefs are used for offshore water quality reporting and progress towards this has been made.

The Technical Working Group recommended in early 2025 that the reporting of offshore water quality is more effective using a contextual approach and should replace the scoring and grading approach. The rationale for this recommendation was based upon the following points.

- The offshore area for each report card is an extremely large water body in comparison to the other reporting zones.
- Offshore water quality under normal conditions is not affected by catchment influences.
- Applying a score and grade implies that the condition of offshore water quality can be affected by management actions.
- Average conditions across an offshore zone are expected to consistently score and grade highly with very minimal change over time.

Proposed information to be included for contextual reporting of offshore water quality include historical data of key indicators (e.g. chlorophyll a and total suspended solids or their surrogates) derived from eReefs, and mapping of flood plume extent for key indicators, which may include turbidity, total suspended solids, chlorophyll a and nutrients, derived from MMP inshore water quality reports and directly from remote sensing sources. Contextual reporting of offshore water quality will be developed and implemented as part of the 2027 Program Design update for regional report cards. Note that limitations on annual reporting of offshore water quality using eReefs data include the biennial timing of data releases which align with the Reef Report Card reporting cycle.

7.2 Habitat

The habitat index for the Offshore Marine Zone consists only of the coral indicator category. The coral indicator category sources its results from AIMS' Long-Term Monitoring Program (LTMP) (Australian Institute of Marine Science 2024). In the Townsville Dry Tropics region this data is updated every year with the most recent update occurring in 2024.

7.2.1 Overall Summary: Offshore Habitat

The score for the habitat index in the Offshore Marine Zone was similar to the previous reporting period, receiving a score of 64 within the same grade (good). These results show the continued stability of coral health in the Offshore Marine Zone after several years of disturbances (Table 75).

Table 75. Standardised score for the Offshore Marine Zone habitat index.

Zone	Coral	Habitat Index					
		23-24	22-23	21–22	20–21	19–20	18–19
Offshore Marine Zone	64	64	63	64	62	54	59

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.

7.2.1.1 *Key Messages*

- The Offshore Marine Zone coral grade remained “good”, with minimal changes to the previous Technical Report.
    - Juvenile density was graded as “very good” at 7 of 9 reefs surveyed.
    - All coral reefs had an overall grade of “moderate” or “good”.
    - John Brewer Reef shows signs of recovering from a recent crown-of-thorns starfish outbreak.
    - TC Kirrily had a limited impact on total coral cover at survey sites; however, the positioning of some sites (e.g. leeward) may have provided protection.

7.2.2 Coral

Coral data was collected by the Australian Institute of Marine Science’s LTMP (Australian Institute of Marine Science 2024). In previous reporting years additional coral monitoring has been conducted by Reef Check Australia (RCA), however no additional sampling occurred during 2023–2024 due to a limited budget.

7.2.2.1 *Monitoring Sites*

The coral indicator category was monitored at nine locations in the Offshore Marine Zone. All sites were monitored as part of the LTMP and have been sampled in previous years (Figure 22).

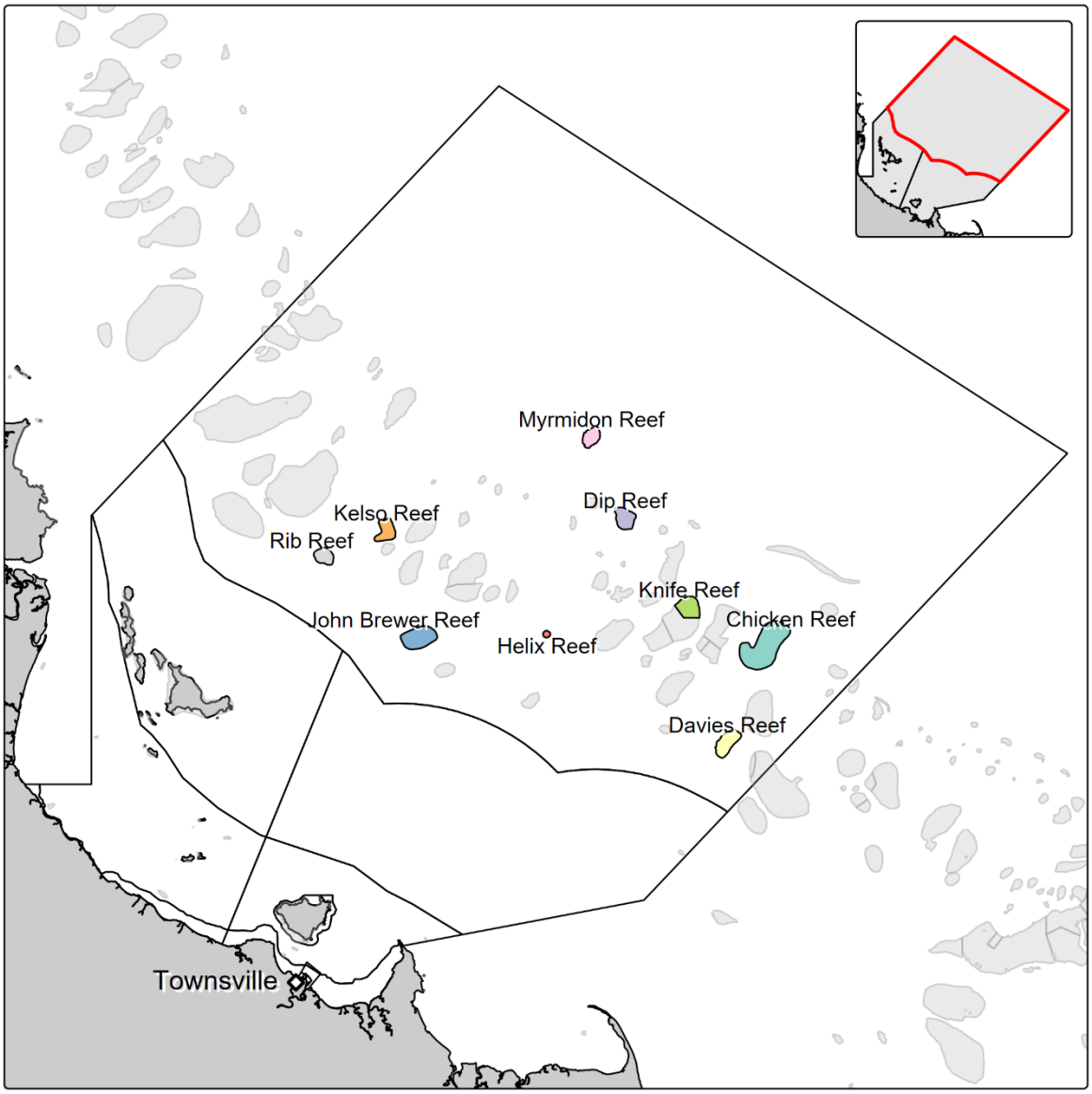

Figure 22. Offshore marine coral sampling locations in the Dry Tropics region.

7.2.2.2 *Result: Offshore Coral*

In the Offshore Marine Zone, the coral indicator category is comprised of three indicators: change in coral cover, percentage of coral cover, and juvenile density. Based on the combined scores of these indicators overall offshore coral index score remained good with grades at all reefs being in either moderate or good condition (Table 76). Contributing strongly to the good coral index score were high numbers of juvenile corals with scores for the Juvenile density indicator remaining good or very good at all reefs. In contrast, both the Change in Coral Cover, and Percentage of Coral Cover indicators showed greater variability, with grades ranging from “poor” to “good”. Notably, John Brewer Reef is now showing signs of recovery from a recent crown-of-thorns starfish outbreak[13]. It should be noted that the coral data is assessed at fixed sites which may be on the leeward side of some sites (i.e.

[13] Reef Monitoring | John Brewer Reef | Benthic community cover (aims.gov.au)

protected from some swell and wind directions) and thus scores might not demonstrate the impact of severe disturbances such as TC Kirrily. Monitoring from different programs for the entire reef site are available on the Reef Monitoring Dashboard.

Fluctuation in coral cover is expected as reefs are exposed to severe disturbances; of concern is the slower recovery suggested by poor scores from the Cover change indicator at Davies and Helix. However, the moderate to good cover change scores at other reefs demonstrate ongoing recovery potential (Table 76).

Table 76. Coral indicator and indicator category scores for the Offshore Marine Zone.

Reef	Change in Coral Cover	% Coral Cover	Juvenile Density	Standardised Score (Grade)
Chicken Reef	54	67	100	74
Davies Reef	39	53	100	64
Dip Reef	61	41	69	57
Helix Reef	27	40	97	55
John Brewer Reef	51	23	78	51
Kelso Reef	45	35	100	60
Knife Reef	66	62	100	76
Myrmidon Reef	43	58	100	67
Rib Reef	74	38	100	71
Offshore Marine Zone	51	46	94	64

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.

7.2.3 Confidence Scores

The overall confidence of the coral indicator category was high with a rank of 4 out of 5. Only Representativeness and Measured Error were not given 3/3 as some components of the indicator do not have their error quantified, and there are several reefs that are not part of the LTMP surveys.

Table 77. Confidence scores for the coral and seagrass indicator categories.

Indicator Category	Maturity (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured error (x0.71)	Score (Rank)
Coral	3	3	2	3	2	10.8 (4)

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.

Litter 2023–2024

Written by Dinny Taylor

As part of the results for the Townsville Dry Tropics Report Card 2025 (Reporting on data from July 2023– June 2024)

Healthy Waters Partnership for the Dry Tropics (HWP)

July 2025

8 Litter

The litter index is comprised of a single indicator to assess the “pressure” that the amount of litter and/or marine debris (from here referred to as litter) present in a location may be having on that environment. The litter pressure is the estimated mean amount of litter one person might collect from the site in one hour. The data used to derive the scores and grades for the litter index is from Tangaroa Blue Foundation's (TBF) Australian Marine Debris Initiative Database (AMDI). The data is collected by volunteers, and partners through the Reef Clean program which is funded through the Australian Government's Reef Trust.

The model was developed in 2023 for the combined regions of the Wet Tropics Waterways Partnership, Healthy Waters Partnership for the Dry Tropics, Healthy Rivers to Reef Partnership, and the Gladstone Healthy Harbours Partnership from ‘baseline’ data from the period ~2009 to June 2019 available from the AMDI following the method developed by Venables and Whitehead (2019). The litter collected at sites each year is compared with this baseline to determine their score and grade.

The model developed by Venables and Whitehead (2019) was based on a smaller dataset of 2016–2019 data that had been pre-cleaned by TBF. As more data became available in 2023, the model was re-fit using a negative binomial distribution (rather than Gaussian) to take the additional data into account. Further, as the model also included data for the Wet Tropics Waterways Partnership, the Healthy Rivers to Reef Partnership, and the Gladstone Healthy Harbours Partnership, the zones included in the model were redefined based on a combination of the location and the landuse category included within the AMDI data (refer Methods). During 2024, the score function used during the development for the previous year became unstable. A thorough investigation into a more stable score function was conducted (refer Methods 2024 Appendix I). All previous results for the model were recalculated during the 2022-2023 model year but have not been recalculated in the current year. These are provided in Section 8.2 below as a comparison with the current year data.

8.1 Monitoring Sites

There were 14 litter collection sites for the 2023–2024 period, and these are shown in Figure 23. There were eleven sites in Cleveland Bay, two sites in the Halifax Bay, and one site in the Ross Basin. There were no sites defined as the Black Basin. The litter collection sites include ReefClean monitoring and index sites by TBF (indicated in Table 78), TBF organised community collection events, and general community collections. Whilst the ReefClean sites are part of a monitoring program, TBF organised community collections are around this schedule, and general community collections are sporadic and dependent on the community providing the data to TBF.

Beach sites are defined by the AMDI landuse category where the volunteers collecting the litter have indicated whether the litter is largely sourced from direct deposit onto the land or washed up from the sea. It was considered that this was the best proxy available to define the boundary between a freshwater basin and the adjacent estuarine or inshore zone.

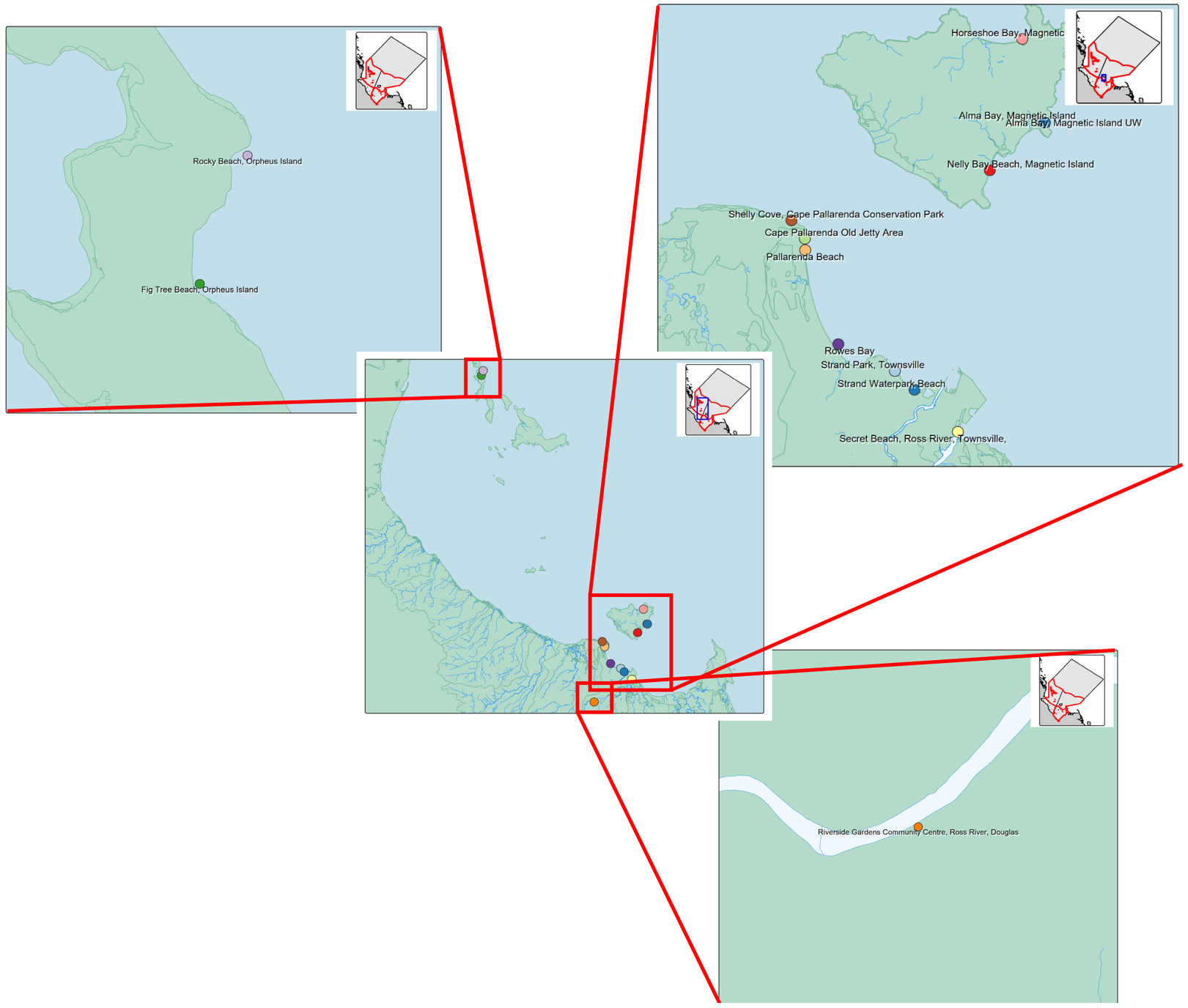

Figure 23: Litter collection sites in 2023-2024 in the Townsville Dry Tropics region

8.2 Comparison with previous years

Table 78 presents a comparison of the 2023–2024 year for the litter index with previous years.

Table 78: Comparison of Litter Index for 2023–2024 with previous Years

Zone	Site	Scores and Grades				
		2023-2024	2022-2023	2021-2022	2020-2021	2019-2020
Halifax Bay	North West Beach, Pelorus Island	ND	ND	ND	ND	95 (VLP)
	West Beach, Pelorus Island	ND	ND	ND	ND	80 (VLP)
	North Beach, Orpheus Island	ND	ND	ND	ND	4 (VHP)
	Little Pioneer Bay, Orpheus Island. underwater	ND	91 (VLP)	ND	ND	ND
	Rocky Beach, Orpheus Island	39 (HP)	ND	ND	ND	ND
	Fig Tree Bay, Orpheus Island	ND	28 (HP)	ND	ND	ND
	Big Rock Bay, Orpheus Island	ND	7 (VHP)	7 (VHP)	7 (VHP)	21 (HP)
	Fig Tree Beach, Orpheus Island	41 (MP)	ND	19 (VHP)	16 (VHP)	ND
	Pioneer Bay, Orpheus Island	ND	84 (VLP)	ND	ND	ND
	Picnic Bay, Orpheus Island	ND	5 (VHP)	2 (VHP)	11 (VHP)	0 (VHP)
	Boulder Beach North, Orpheus Island	ND	ND	14 (VHP)	ND	ND
	Yanks Jetty, Orpheus Island	ND	ND	ND	76 (LP)	74 (LP)
	Boulder Beach, Orpheus Island	ND	ND	1 (VHP)	ND	ND
	South Beach, Orpheus Island	ND	ND	10 (VHP)	ND	42 (MP)
	Fantome Island, Northern End	ND	57 (MP)	36 (HP)	12 (VHP)	ND
	North West Beach, Fantome Island	ND	61 (LP)	ND	ND	ND
	Ollera Beach	ND	ND	ND	ND	39 (HP)
	Rollingstone Beach	ND	ND	ND	ND	50 (MP)
	Toomulla Beach	ND	ND	ND	ND	53 (MP)
	Toomulla main beach	ND	ND	83 (VLP)	ND	ND
	Saunders Beach	ND	ND	ND	ND	71 (LP)
Cleveland Bay	Bushland Beach, Townsville	ND	55 (MP)	ND	62 (LP)	ND
	Myrmidon Reef underwater	ND	ND	ND	98 (VLP)	ND
	Radical Bay, Magnetic Island	ND	96 (VLP)	ND	ND	ND
	Horseshoe Bay, Magnetic Island#	91 (VLP)	83 (VLP)	34 (HP)	ND	ND
	Florence Bay, Magnetic Island	ND	51 (MP)	ND	ND	ND
	Arthur Bay, Magnetic Island	ND	ND	ND	43 (MP)	ND
	Alma Bay Beach, Magnetic Island#	33 (HP)	60 (LP)	71 (LP)	63 (LP)	45 (MP)
	Alma Bay, Magnetic Island underwater#	98 (VLP)	100 (VLP)	ND	98 (VLP)	97 (VLP)
	Geoffrey Bay, Magnetic Island	ND	ND	ND	80 (VLP)	ND
	Geoffrey Bay Reef, Magnetic Island underwater	ND	ND	ND	ND	93 (VLP)
	Nelly Bay Beach, Magnetic Island#	73 (LP)	77 (LP)	73 (LP)	77 (LP)	53 (MP)

Zone	Site	Scores and Grades				
		2023-2024	2022-2023	2021-2022	2020-2021	2019-2020
	Nelly Bay, Magnetic Island underwater	ND	99 (VLP)	99 (VLP)	99 (VLP)	100 (VLP)
	Shelly Beach, Pallarenda	ND	44 (MP)	ND	29 (HP)	63 (LP)
	Shelly Cove, Cape Pallarenda Conservation Park#	98 (VLP)	92 (VLP)	91 (VLP)	70 (LP)	67 (LP)
	Cape Pallarenda Old Jetty Area	56 (MP)				
	Pallarenda Beach#	85 (VLP)	84 (VLP)	72 (LP)	ND	ND
	Rowes Bay#	64 (LP)	89 (VLP)	87 (VLP)	75 (LP)	75 (LP)
	Kissing Point, Townsville	ND	ND	ND	79 (LP)	ND
	Strand Park, Townsville	80 (VLP)	ND	ND	74 (LP)	62 (LP)
	Strand Waterpark Beach	83 (VLP)	ND	ND	86 (VLP)	ND
	Secret Beach, Ross River, Townsville#	91 (VLP)	81 (VLP)	ND	ND	ND
Ross	Three Mile Creek, Pallarenda	ND	ND	ND	37 (HP)	ND
	Strand Rock Pool, Townsville	ND	74 (LP)	ND	47 (MP)	ND
	Jezzine Barracks Townsville Heritage Precinct	ND	63 (LP)	ND	ND	ND
	West End, Townsville	ND	66 (LP)	ND	ND	ND
	Ross Creek, Townsville	ND	59 (MP)	46 (MP)	ND	ND
	Queensland Country Bank Stadium	ND	ND	21 (HP)	23 (HP)	ND
	South Townsville Recreational Boat Park	ND	ND	ND	33 (HP)	ND
	Anderson Park, Townsville	ND	ND	91 (VLP)	ND	ND
	Sherriff Park Townsville	ND	ND	73 (LP)	ND	ND
	Aplins Weir Rotary Park#*	ND	74 (LP)	69 (LP)	35 (HP)	41 (MP)
	Lake Idalia Wetland Foreshore	ND	45 (MP)	ND	ND	ND
	Riverside Gardens Community Centre, Ross River, Douglas#	48 (MP)	ND	ND	ND	ND
	Apex Park, Condon	ND	ND	62 (LP)	ND	ND

Standardised scoring range: ■ Very High Pressure (VHP) = 0 to <20 | ■ High Pressure (HP) = 20 to <40 | ■ Moderate Pressure (MP) = 40 to <60 | ■ Low Pressure (LP) = 60 to <80 | ■ Very Low Pressure (VLP) = 80 to 100 | ND = No data available

Sites where litter has been collected underwater are indicated. Where there are two sites with the same location name, for example, Alma Bay, Magnetic Island is the beach area above the low tide mark and Alma Bay, Magnetic Island underwater is collected by diving out from the beach. If a site is not designated as underwater and is on the coast, it is above the low tide mark.

#ReefClean monitoring site or TBF Index Site cleaned with ReefClean partners.

*Aplin's Weir ceased as ReefClean monitoring site due to safety concerns.

As there are a small number of sites where litter collections occur each year, it is difficult to obtain a picture of whether improvement is occurring or not. There are a number of factors that are not included in the metric that could have a bearing on the amount of litter collected at sites, particularly land based sites, such as, the frequency of TCC emptying bins, the location of bins (ease of use to main trafficked areas), the number of people using the area on a daily, weekly, or monthly basis, proximity of the collection to a public holiday, or regional event. The variance associated with Zone, Site and Year accounted for a proportion of the total variance, however, the residual variance of the model indicates that there are potentially several variables that have not been identified.

8.3 Key Messages

- Alma Bay beach at Magnetic Island had the highest litter pressure in the region, and an increase in litter pressure from consistently low pressure in 2020-2023 to high pressure in 2023-2024.
- The litter pressure on the east coast of Orpheus Island appears to be decreasing which may be associated with regular collection as well as local factors.
- The most amount of litter pressure on the mainland was at Cape Pallarenda Old Jetty area with moderate litter pressure and Shelly Cove, Cape Pallarenda Conservation Park had the least with very low litter pressure on the mainland for Cleveland Bay. It is noted that Shelly Cove is a ReefClean monitoring site and has had consistently very low pressure since mid-2021 whereas Cape Pallarenda Old Jetty was a community member collection.
- The only site within the Ross Basin, the Riverside Gardens Community Centre had a moderate litter pressure.

8.4 Results

Litter pressure results are presented in Table 79. In the Ross Freshwater Basin, only one site was monitored and had moderate pressure.

For the Magnetic Island sites within Cleveland Bay, Horseshoe Bay, Alma Bay Beach, Alma Bay Underwater (diving), and Nelly Bay Beach are sites that are consistently cleaned and monitored under the ReefClean program. Alma Bay Beach has shown variable pressure across the monitoring years with moderate pressure in 2019-2020, which improved to low pressure for the period 2020-2023, and then decreased to high pressure in the most recent year. Alma Bay underwater site has consistently had very low pressure across the reporting years. The underwater sites are collected by diving and can be limited by the visibility on the day. The type of litter collected also tends to be heavier items that don't float and land on the beach sites. Nelly Bay Beach had moderate pressure in the first reporting year (2019-2020) but has had consistently low pressure since then.

The Townsville sites within Cleveland Bay are defined by the AMDI landuse category where the members collecting the data have indicated that the majority of the litter collected has been sea sourced. Sites that are regularly monitored under the ReefClean program include Shelly Cove, Pallarenda Beach, Rowes Bay Beach and Secret Beach. Shelly Cove has had consistently very low pressure for the last three years, which may be associated with the location access being more difficult for potential land deposited litter, particularly compared with Pallarenda Beach or Rowes Bay Beach, or the community collection from the Cape Pallarenda Old Jetty area which had moderate pressure. Pallarenda Beach has had consistently very low pressure for the last two years, however, at a lower score than achieved at Shelly Cove. Rowes Bay had low pressure in the current year, which is an increase in litter pressure from the previous two years where it had very low pressure. Secret Beach has only been monitored for the last two years as it is a new site to replace the previous Aplin's Weir site. Secret Beach has had consistently very low pressure for the two years of monitoring.

Only two sites were monitored within the Palm Island group of Halifax Bay with Fig Tree Beach having moderate pressure and Rocky Beach having high pressure. The litter pressure on the eastern side of Orpheus Island has decreased in the current year compared with the consistently very high pressure across most of these sites historically. The locations where the litter was collected in the most recent year were different from the previous years and this may have contributed to the reduction in the litter pressure. The Rocky Beach site, for example, is across some steep rocks where

it might be more difficult for litter to wash up, and the Fig Tree Beach site is easterly rather than south-easterly facing for some of the very high pressure sites historically. Discussion with K-M Coulter-Atkins (TBF, 2022) found that the litter on the eastern side of Orpheus Island is largely sourced from the sea and was found to be washing onto the beach whilst the litter collection was occurring. This suggests that the direction of onshore winds and currents may be a factor in the location of litter collected.

Table 79: Litter Index Results for 2023–2024

Zone	Site	Score (Grade)
Cleveland Bay	Alma Bay, Magnetic Island	33 (HP)
	Alma Bay, Magnetic Island Underwater	98 (VLP)
	Cape Pallarenda Old Jetty Area	56 (MP)
	Horseshoe Bay, Magnetic Island	91 (VLP)
	Nelly Bay Beach, Magnetic Island	73 (LP)
	Pallarenda Beach	85 (VLP)
	Rowes Bay	64 (LP)
	Secret Beach, Ross River, Townsville,	91 (VLP)
	Shelly Cove, Cape Pallarenda Conservation Park	98 (VLP)
	Strand Park, Townsville	80 (VLP)
	Strand Waterpark Beach	83 (VLP)
Halifax Bay	Fig Tree Beach, Orpheus Island	41 (MP)
	Rocky Beach, Orpheus Island	39 (HP)
Ross	Riverside Gardens Community Centre, Ross River, Douglas	48 (MP)

Standardised scoring range: ■ = Very High Pressure: 0 to <20 | ■ = High Pressure: 20 to <40 | ■ = Moderate Pressure: 40 to <60 | ■ = Low Pressure: 60 to <80 | ■ = Very Low Pressure: 80 to 100

8.5 Confidence Scores

The overall confidence score for the litter index was low with a score of 2 out of 5. The maturity is scored at 2, as a generalised linear negative binomial mixed model for data across a much larger region than solely the Townsville Dry Tropics has been developed. This has improved the robustness of the metric applying a distribution appropriate to the data and using a much larger dataset from which to derive the model. Validation is scored as 1 as modelling is used to derive an estimate of the amount of litter one might expect to collect in a one-hour period at each location at any time that location might be visited. This expected value considers the variability of the data available. Representativeness is scored at 1 as there is variation in the frequency of the data collection at each site, and variation in the way the data is reported. For example, some sites are cleaned up four times per year, whilst others may be cleaned once every few years. Whilst the model can consider the frequency of the collection by volunteers contributing to the AMDI in an individual year, it does not consider the last time litter was collected at each location (by anyone). It is not possible to do so as this information is not available. Some collectors may include the time they spend sorting the litter, whilst others may not. This brings variation into the data that is difficult to account for within the model. The measured error has been scored at 2 as the model provides estimates based on the variability of the data, however, there is also error associated with the transformation of the data to score and grade.

Table 80: Confidence scores for the Litter Index

Indicator Category	Maturity (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured error (x0.71)	Score (Rank)
Litter	2	1	1	3	2	2 (low)

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.

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Appendices 2023-2024

Written by Adam Shand and Dinny Taylor

As part of the results for the Townsville Dry Tropics Report Card 2025 (Reporting on data from July 2023– June 2024)

Healthy Waters Partnership for the Dry Tropics (HWP)

July 2025

9 Appendices

Appendix A. Ross Basin Long-Term Annual Rainfall Trends

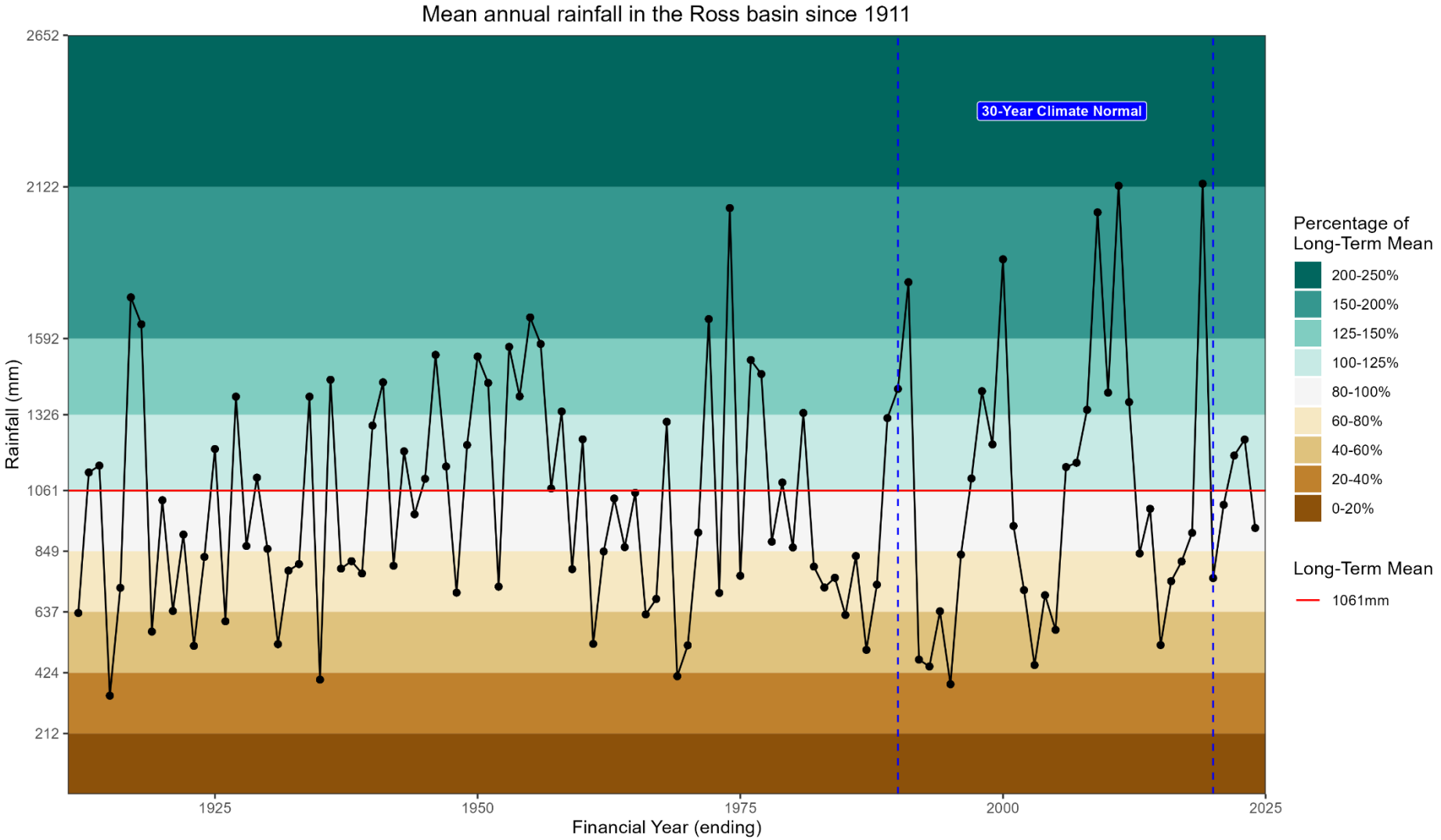

Figure 24. Ross Basin long-term annual rainfall trends.

Appendix B. Black Basin Long-Term Annual Rainfall Trends

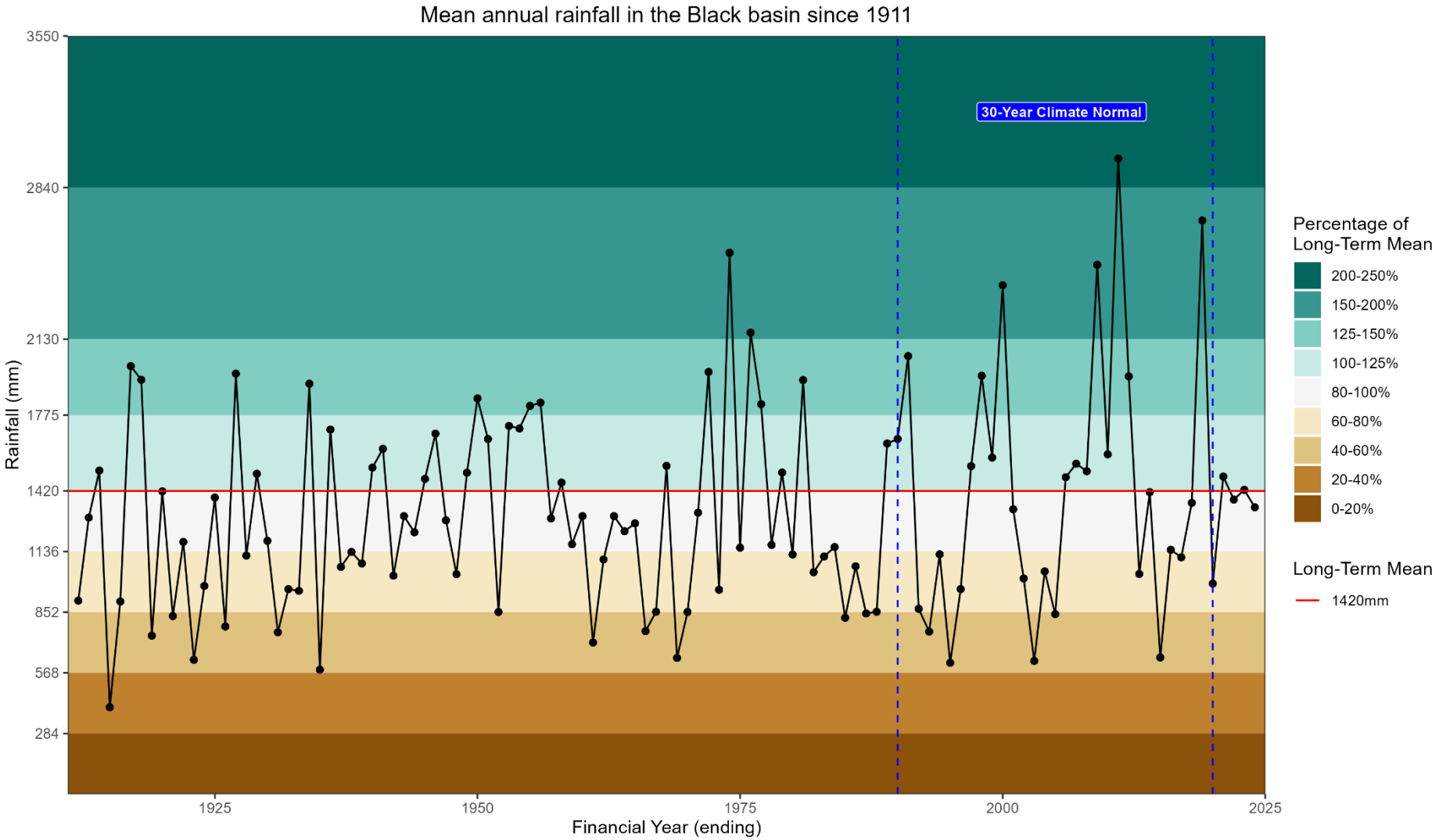

Figure 25. Black Basin long-term annual rainfall trends.

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

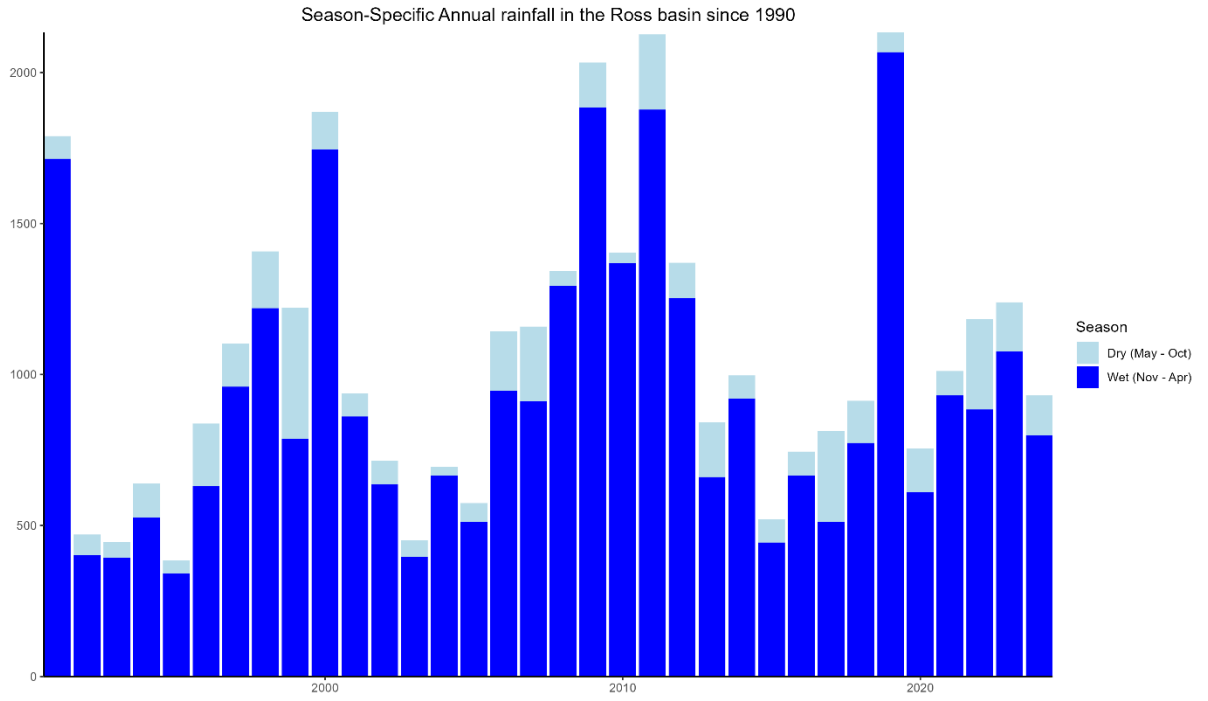

Figure 27. Season-specific annual rainfall in the Ross Basin since 1990.

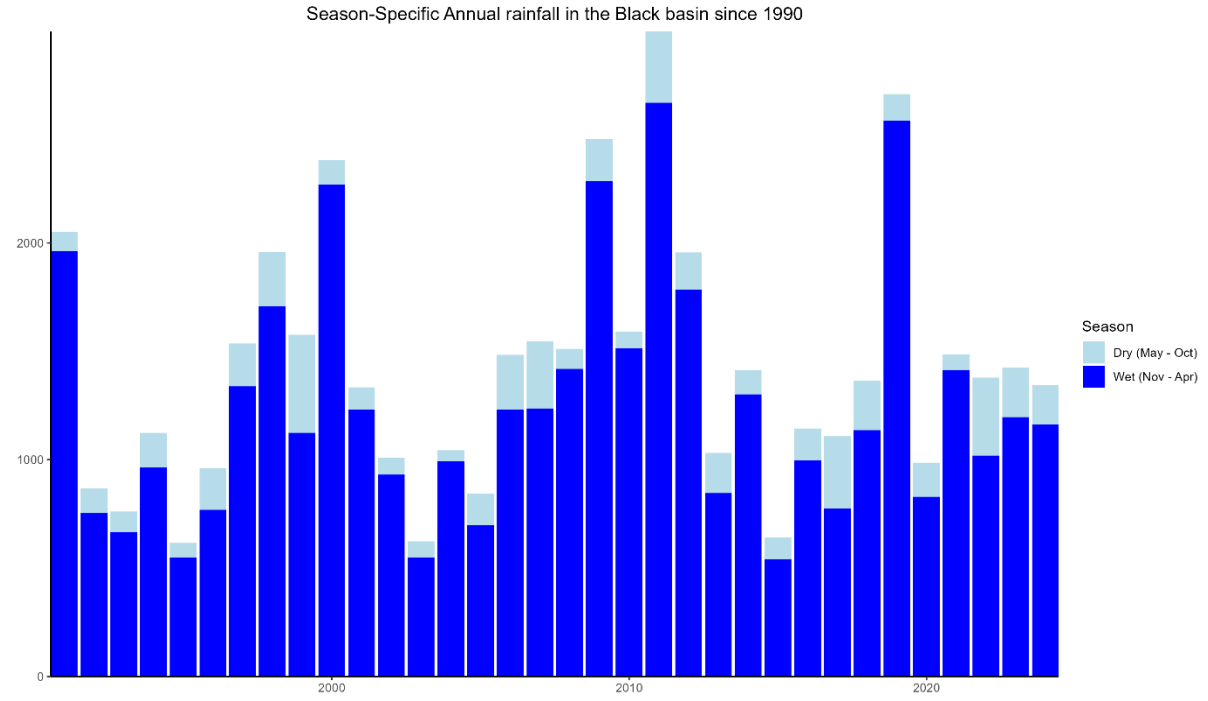

Figure 26. Season-specific annual rainfall in the Black Basin since 1990.

Appendix D. Ross Basin Long-Term Annual Air Temperature

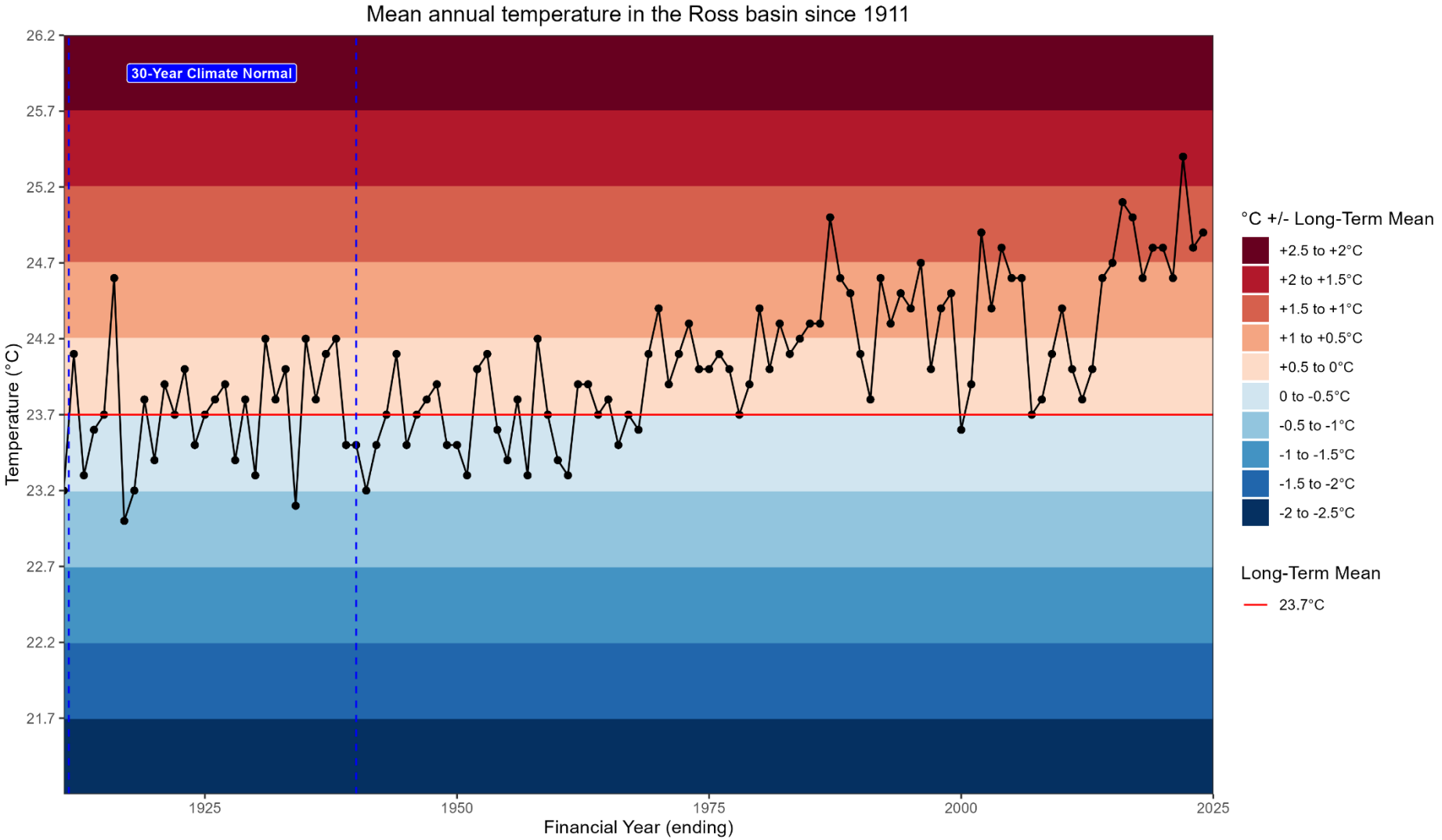

Figure 28. Ross Basin long-term annual air temperature trends.

Appendix E. Black Basin Long-Term Annual Air Temperature

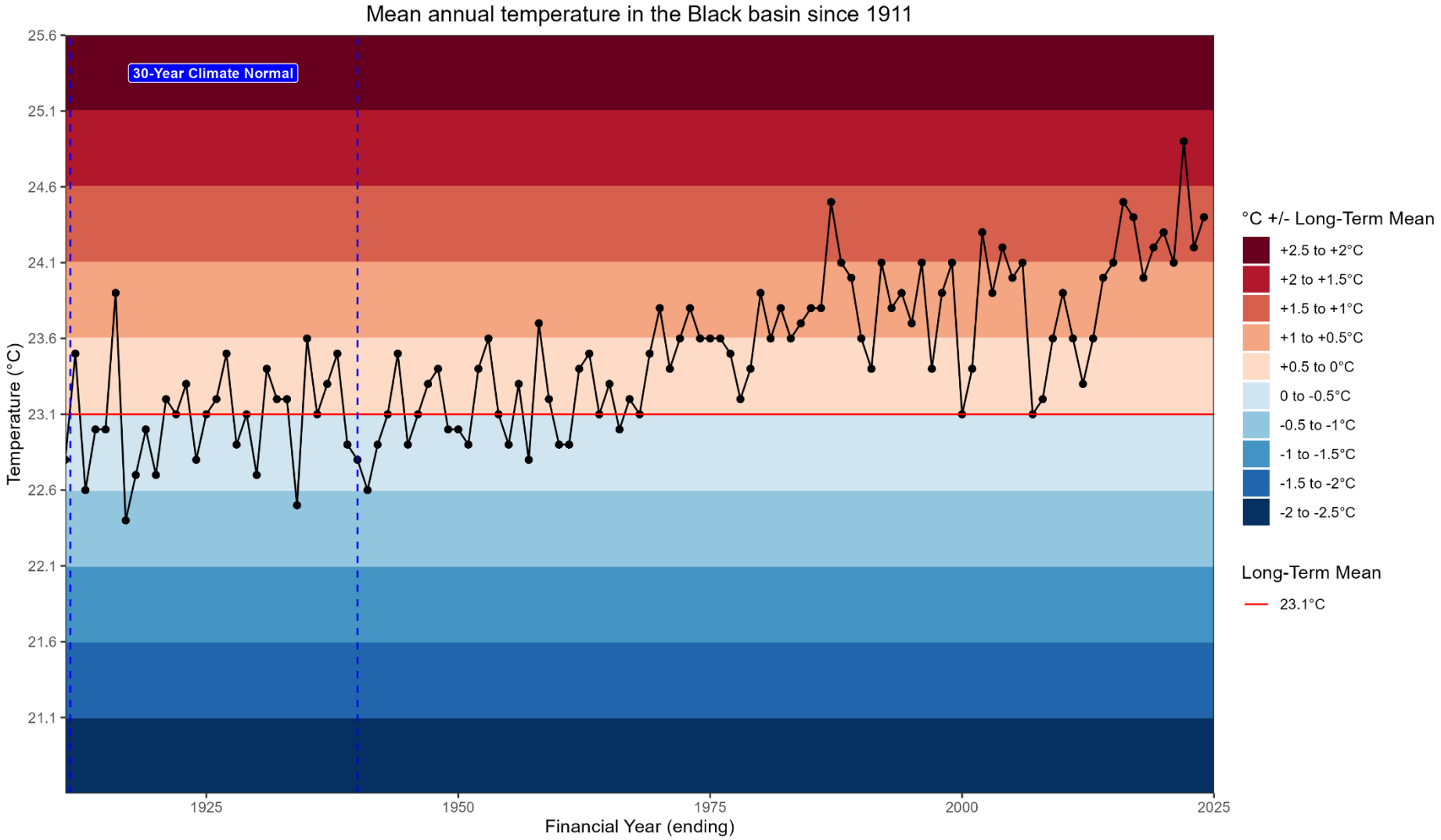

Figure 29. Black Basin long-term annual air temperature trends.

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

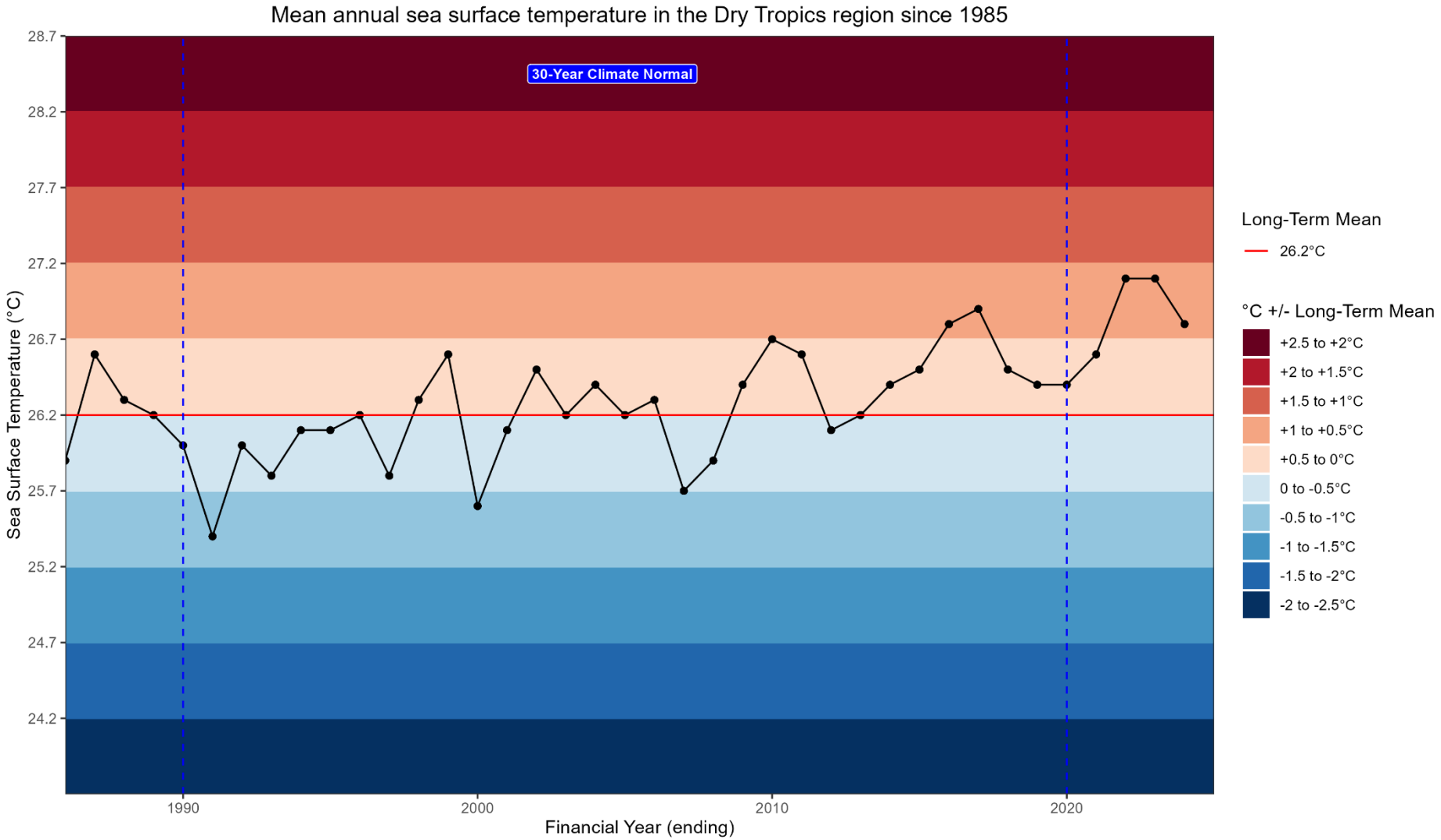

Figure 30. Black Basin long-term annual sea surface temperature trends.

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

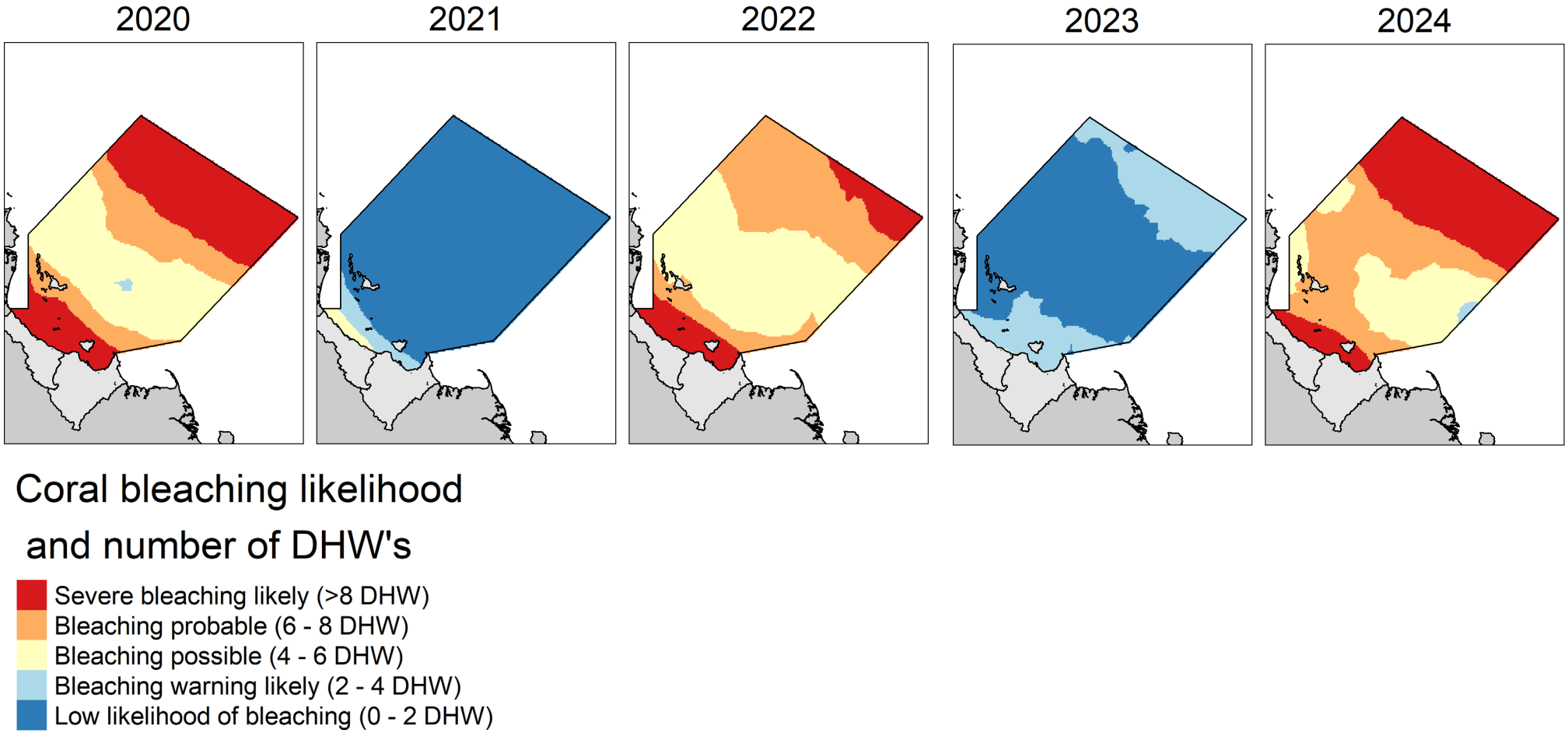

Figure 31. Dry Tropics Marine Region 5-year Historic Degree Heating Week Map.

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

Table 81. 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	-	-	-	0.02	0.38	79	11	0.02	0.03	0.46
Aplin's Weir	66	12	0.025	0.02	0.38	ND	ND	ND	0.03	0.46
Gleesons Weir	11	11	0.015	0.02	0.38	ND	ND	ND	0.05	0.46
Blacks Weir	11	11	0.015	0.02	0.38	11	11	0.01	0.03	0.46
Bohle Mid-Field	12	11	4.399	0.08	0.38	12	11	5	0.05	0.46
Bohle Far-Field	12	11	0.257	0.08	0.38	12	11	2.3	0.05	0.46
Black River	74	12	0.021	0.02	0.05	11	11	0.023	0.02	0.03
Althaus Ck	5	5	0.012	0.02	0.05	5	5	0.023	0.02	0.03
Bluewater Ck	11	11	0.027	0.02	0.05	11	11	0.013	0.02	0.03
Sleeper Log Ck	11	11	0.004	0.02	0.05	11	11	0.02	0.02	0.03
Leichhardt Ck	11	11	0.006	0.02	0.05	11	11	0.015	0.02	0.03
Saltwater Ck	10	10	0.005	0.02	0.05	10	10	0.01	0.02	0.03
Rollingstone Ck	11	11	0.016	0.02	0.05	11	11	0.01	0.02	0.03
Ollera Ck	9	9	0.009	0.02	0.05	9	9	0.011	0.02	0.03
Crystal Ck	11	11	0.013	0.02	0.05	11	11	0.008	0.02	0.03
Paluma Lake	-	-	-	0.02	0.05	12	10	0.01	0.03	0.06

Key: ■ = Mean/Median meets the guideline value | ■ = Mean/Median does not meet the guideline value | ND = No Data | - = Not Applicable (data available but not usable).

Appendix I. Freshwater Water Quality Nutrients Scores Historic Comparison

Table 82. Townsville Dry Tropics freshwater water quality historic nutrient indicator scores.

Basin	Sub Basin	Watercourse	DIN					TP				
			23-24	22-23	21–22	20–21	19–20	23-24	22-23	21–22	20–21	19–20
Ross	Upper Ross	Ross Lake	-	-	90	90	68	90	73	61	90	61
	Lower Ross	Aplin's Weir	60	62	61	59	66	ND	ND	ND	ND	ND
		Gleesons Weir	90	59	90	62	74	ND	ND	ND	ND	ND
		Blacks Weir	64	63	59	61	59	90	90	90	90	70
			71	61	70	60	66	90	90	90	90	70
	Bohle River	Bohle Mid-Field	0	0	36	43	0	0	0	0	0	0
		Bohle Far-Field	25	0	60	66	29	0	0	0	0	0
			12	0	48	54	15	0	0	0	0	0
			47	37	66	68	49	45	40	37	60	33
Black	Black River	Black River	59	63	63	61	78	42	39	61	54	9
	Bluewater Ck	Althaus Ck	68	90	90	67	74	42	18	48	90	90
		Bluewater Ck	46	73	66	63	90	76	90	90	73	66
		Sleeper Log Ck	90	90	71	74	62	61	77	90	90	90
			68	84	75	68	75	60	61	76	84	82
	Rollingstone Ck	Leichhardt Ck	90	90	90	74	90	73	90	90	76	55
		Saltwater Ck	90	90	90	70	90	90	90	90	90	90
		Rollingstone Ck	61	61	62	0	64	90	90	90	90	90
			80	80	80	48	81	84	90	90	85	78
	Crystal Ck	Ollera Ck	90	90	71	66	63	90	90	90	90	90
		Crystal Ck	90	90	69	90	90	90	90	90	90	90
			90	90	70	78	76	90	90	90	90	90
	Paluma Lake	Paluma Lake	-	-	-	63	90	90	90	90	90	90
			76	82	74	63	79	74	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 | - = 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 83. 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	79	11	8	10	35	79	11	100.45	110	120	90	70
Aplin's Weir	11	11	4.3	10	35	11	11	81.188	110	120	90	70
Gleesons Weir	11	11	3.7	10	35	11	11	81.272	110	120	90	70
Blacks Weir	11	11	3.4	10	35	11	11	77.467	110	120	90	70
Bohle Mid-Field	12	11	9.9	22	35	12	11	64.57	110	120	85	70
Bohle Far-Field	12	11	6.4	22	35	12	11	48.38	110	120	85	70
Black River	11	11	1.01	5	10	11	11	98.9	105	120	90	70
Althaus Ck	5	5	5.21	5	10	5	5	97.4	105	120	90	70
Bluewater Ck	11	11	1.6	5	10	11	11	93.8	105	120	90	70
Sleeper Log Ck	11	11	7.47	5	10	11	11	92.8	105	120	90	70
Leichhardt Ck	11	11	2.79	5	10	11	11	90.2	105	120	90	70
Saltwater Ck	10	10	2.605	5	10	10	10	97.4	105	120	90	70
Rollingstone Ck	11	11	0.63	5	10	11	11	86.2	105	120	90	70
Ollera Ck	9	9	0.54	5	10	9	9	72.9	105	120	90	70
Crystal Ck	11	11	0.74	5	10	11	11	99.2	105	120	90	70
Paluma Lake	12	10	1.8	10	20	12	10	87.666	110	120	90	70

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

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

Table 84. Townsville Dry Tropics freshwater water quality historic physical-chemical indicator scores.

Basin	Sub Basin	Watercourse	Turbidity					High DO					Low DO				
			23-24	22-23	21–22	20–21	19–20	23-24	22-23	21–22	20–21	19–20	23-24	22-23	21–22	20–21	19–20
Ross	Upper Ross	Ross Lake	72	90	90	90	90	90	90	90	90	90	90	90	90	90	90
	Lower Ross	Aplin's Weir	90	90	90	90	90	90	90	80	90	90	34	46	55	74	90
		Gleesons Weir	78	90	90	90	90	90	90	90	90	90	34	67	11	50	73
		Blacks Weir	90	90	90	90	90	90	90	90	90	90	22	44	19	26	56
			86	90	90	90	90	90	90	90	90	90	30	53	28	50	73
	Bohle River	Bohle Mid-Field	90	62	67	90	90	90	90	90	90	90	0	50	26	0	0
		Bohle Far-Field	77	63	66	90	90	90	90	90	90	90	0	0	40	37	0
			83	63	66	90	90	90	90	90	90	90	0	25	33	18	0
			82	81	82	90	90	90	90	88	90	90	30	49	40	52	51
Black	Black River	Black River	90	72	90	69	90	64	64	47	53	62	90	90	90	90	90
	Bluewater Ck	Althaus Ck	58	0	0	12	90	73	51	90	69	4	90	90	90	90	81
		Bluewater Ck	90	70	90	90	90	90	90	79	90	90	90	62	66	77	11
		Sleeper Log Ck	30	13	0	90	70	90	90	90	90	90	90	72	20	76	32
			59	28	30	64	83	84	77	86	90	90	90	75	59	81	41
	Rollingstone Ck	Leichhardt Ck	90	68	90	90	90	90	90	90	90	90	61	62	61	61	27
		Saltwater Ck	90	57	75	90	90	90	90	90	90	90	90	90	90	66	90
		Rollingstone Ck	90	90	90	90	90	90	90	90	90	90	49	51	40	74	51
			90	72	90	90	90	90	90	90	90	90	66	67	63	67	56
	Crystal Ck	Ollera Ck	90	90	90	90	90	90	90	90	90	90	8	0	0	59	0
		Crystal Ck	90	90	90	90	90	90	90	90	90	90	90	90	90	73	75
			90	90	90	90	90	90	90	90	90	90	49	45	45	66	37
	Paluma Lake	Paluma Lake	90	90	90	90	90	90	90	90	90	90	53	52	55	90	69
			80	64	70	80	88	85	83	85	85	79	71	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 | - = Not Applicable (data available but not usable) | X = Data was not updated this year.

Appendix L. Freshwater Water Quality 2022–2023 Boxplots

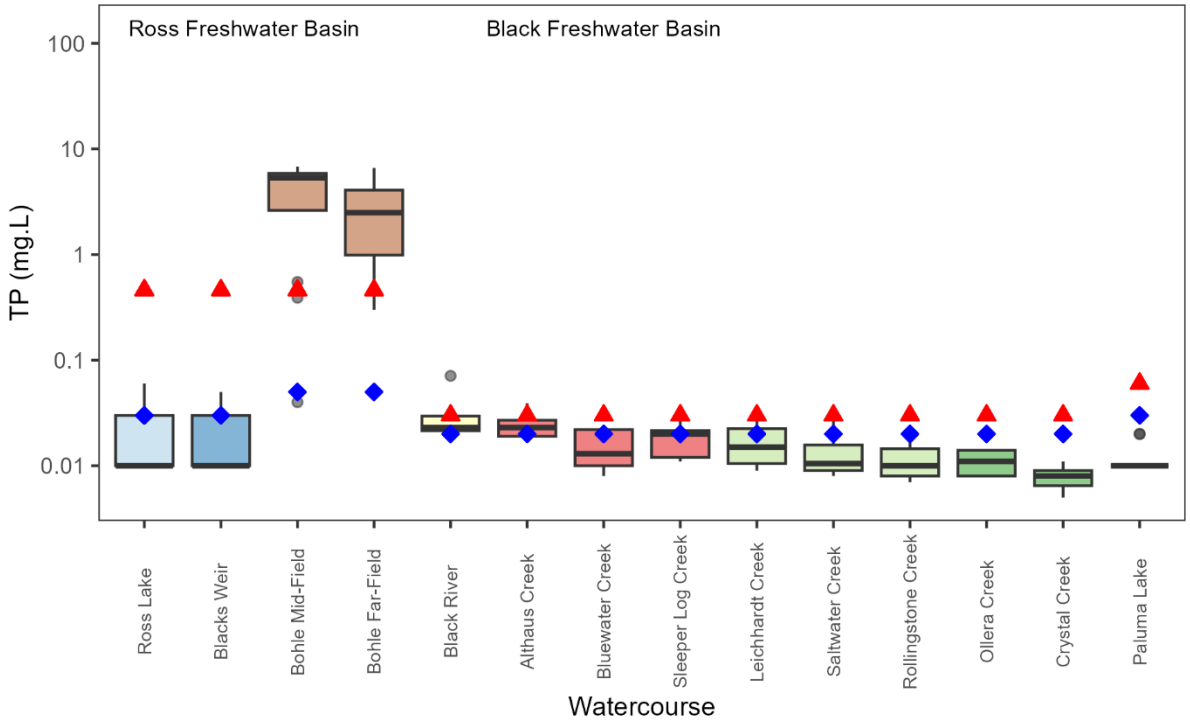

Figure 33. Total Phosphorus (TP) (mg/l) boxplot: red triangles indicate the scaling factor, blue diamonds indicate the water quality objective.

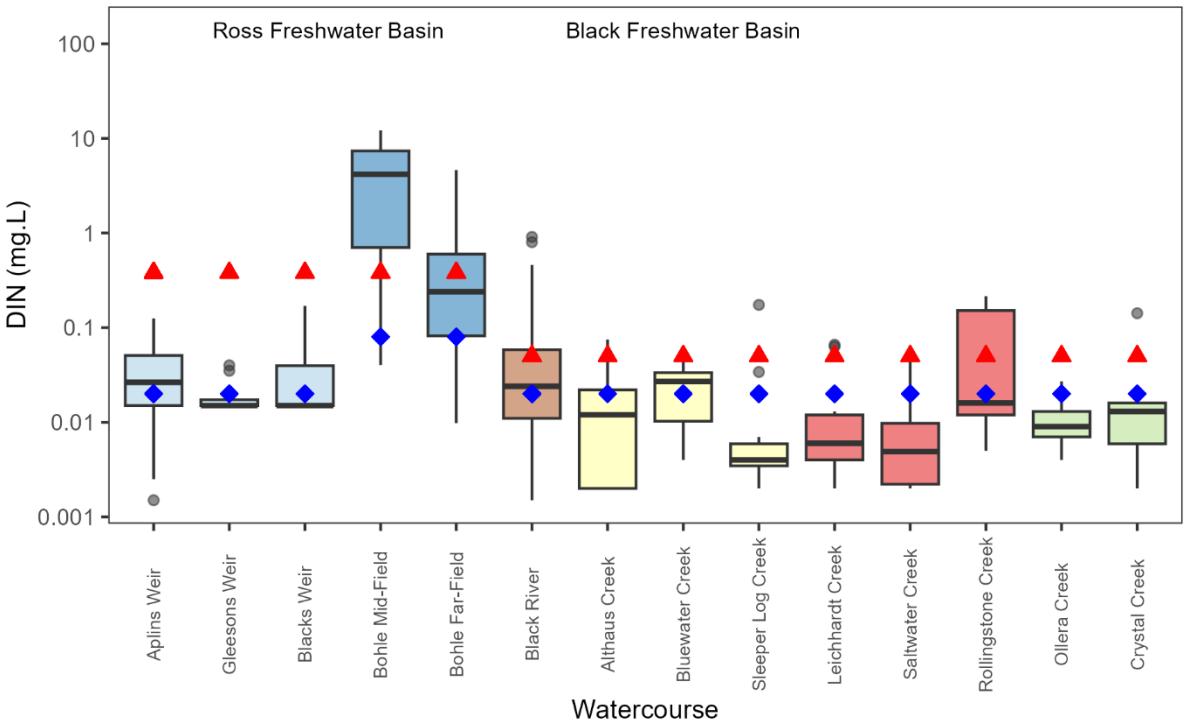

Figure 32. Dissolved Inorganic Nitrogen (DIN) (mg/L) Boxplot: red triangles indicate the scaling factor, blue diamonds indicate the water quality objective.

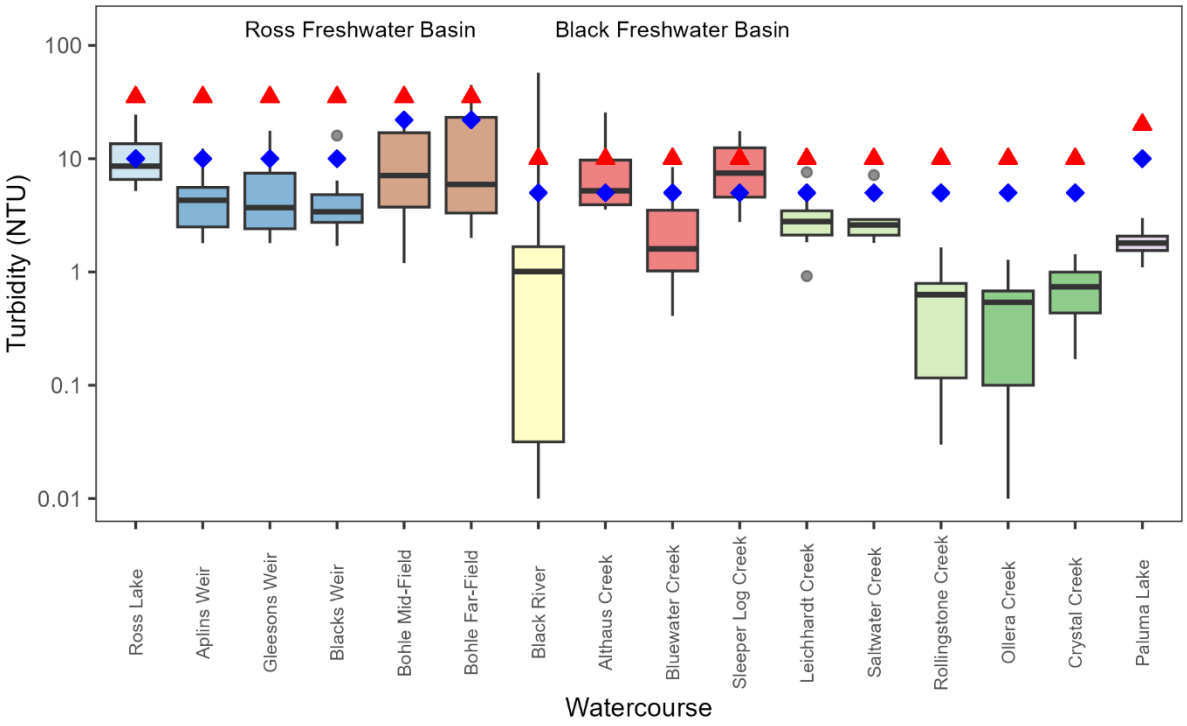

Figure 35. Turbidity (NTU) boxplot: red triangles indicate the scaling factor, blue diamonds indicate the water quality objective.

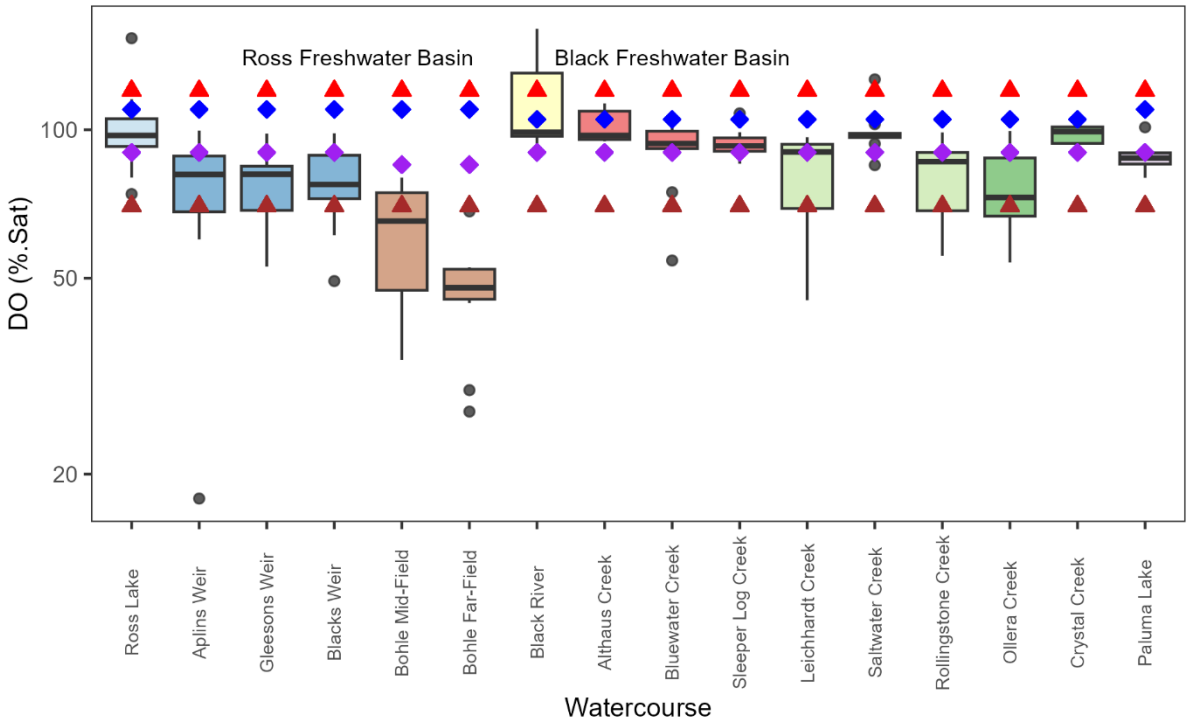

Figure 34. Dissolved Oxygen (DO) (% Saturation) boxplot: red triangles indicate the high DO scaling factor, blue diamonds indicate the high DO water quality objective, purple diamonds indicate the low DO water quality objective, and brown triangles indicate the low DO scaling factor.

Appendix M. Freshwater Water Quality Line Plots

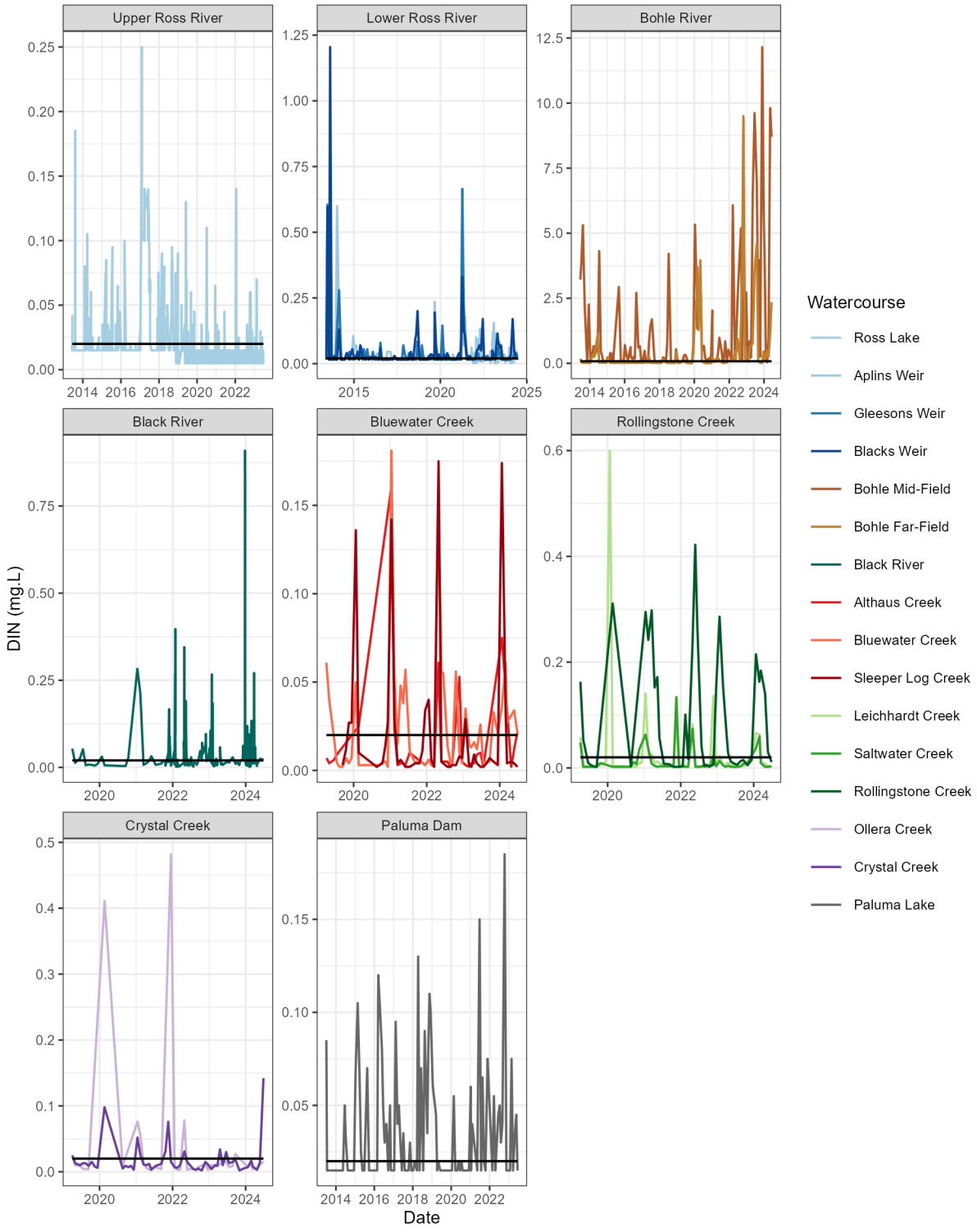

Figure 36. Historical concentrations of dissolved inorganic nitrogen (DIN) in the freshwater sub basins. Black line indicates the water quality objective.

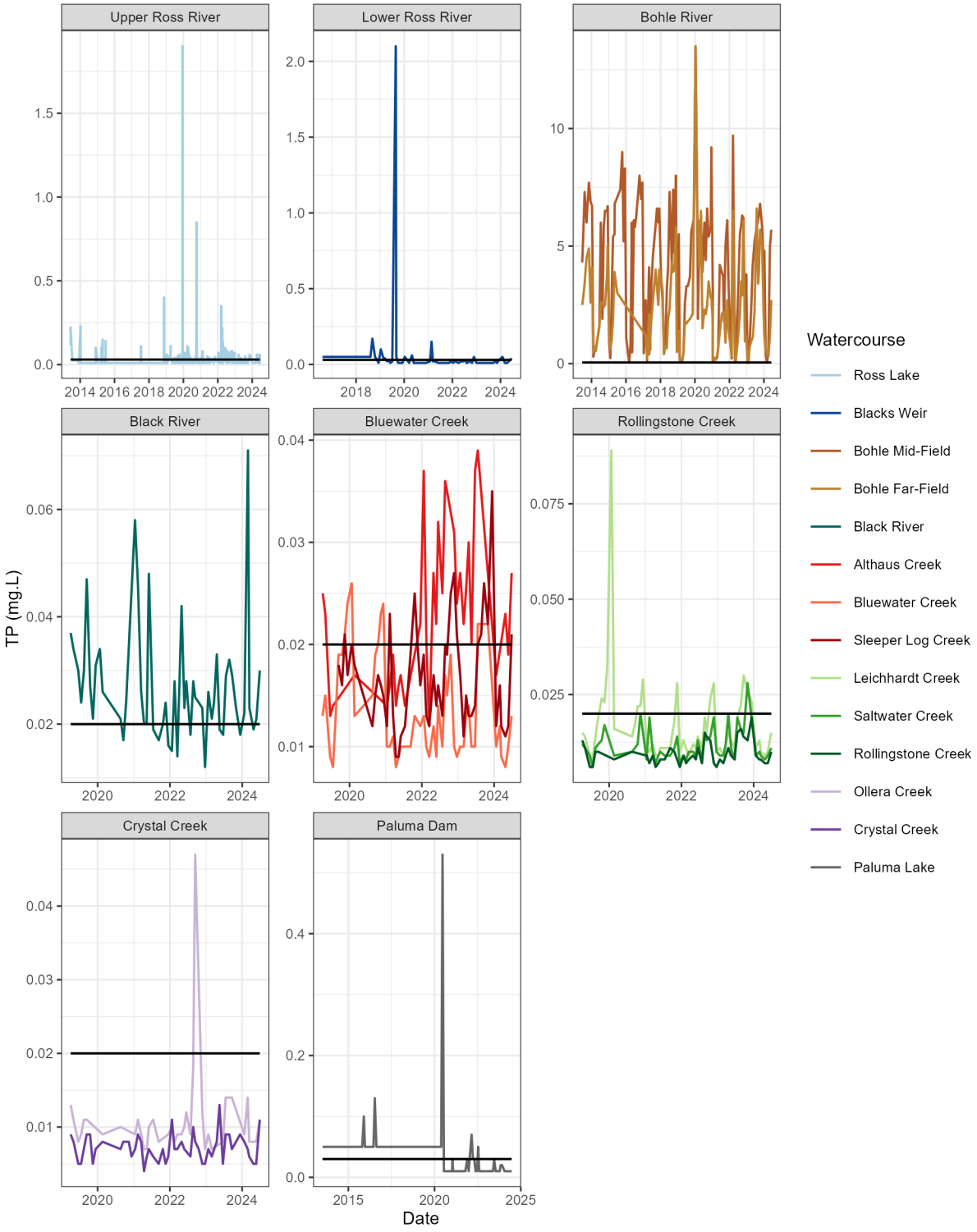

Figure 37. Historical data for total phosphorus in the freshwater sub basins. Black line indicates the water quality objective.

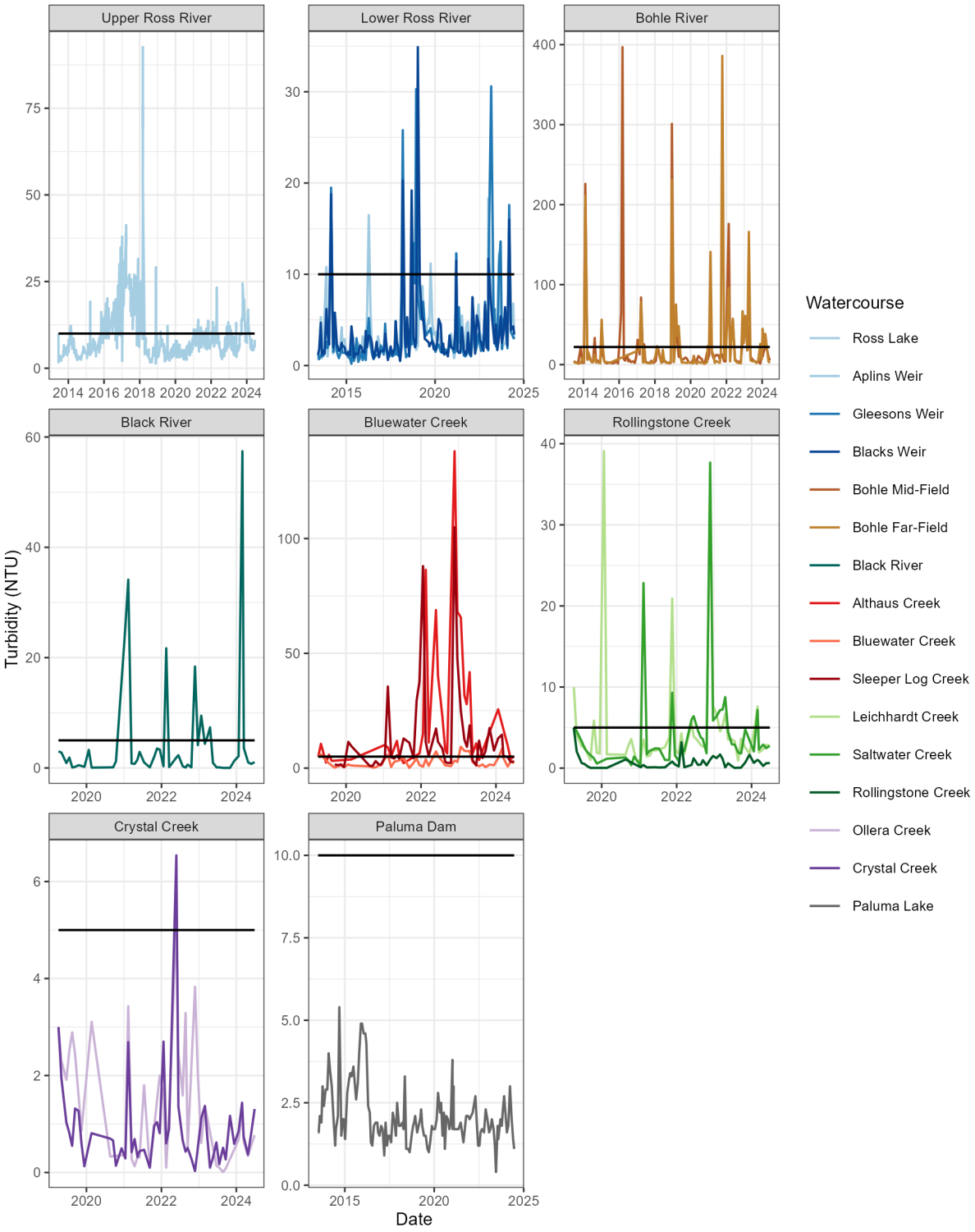

Figure 38. Historical turbidity in the freshwater sub basins. Black lines indicates the water quality objectives.

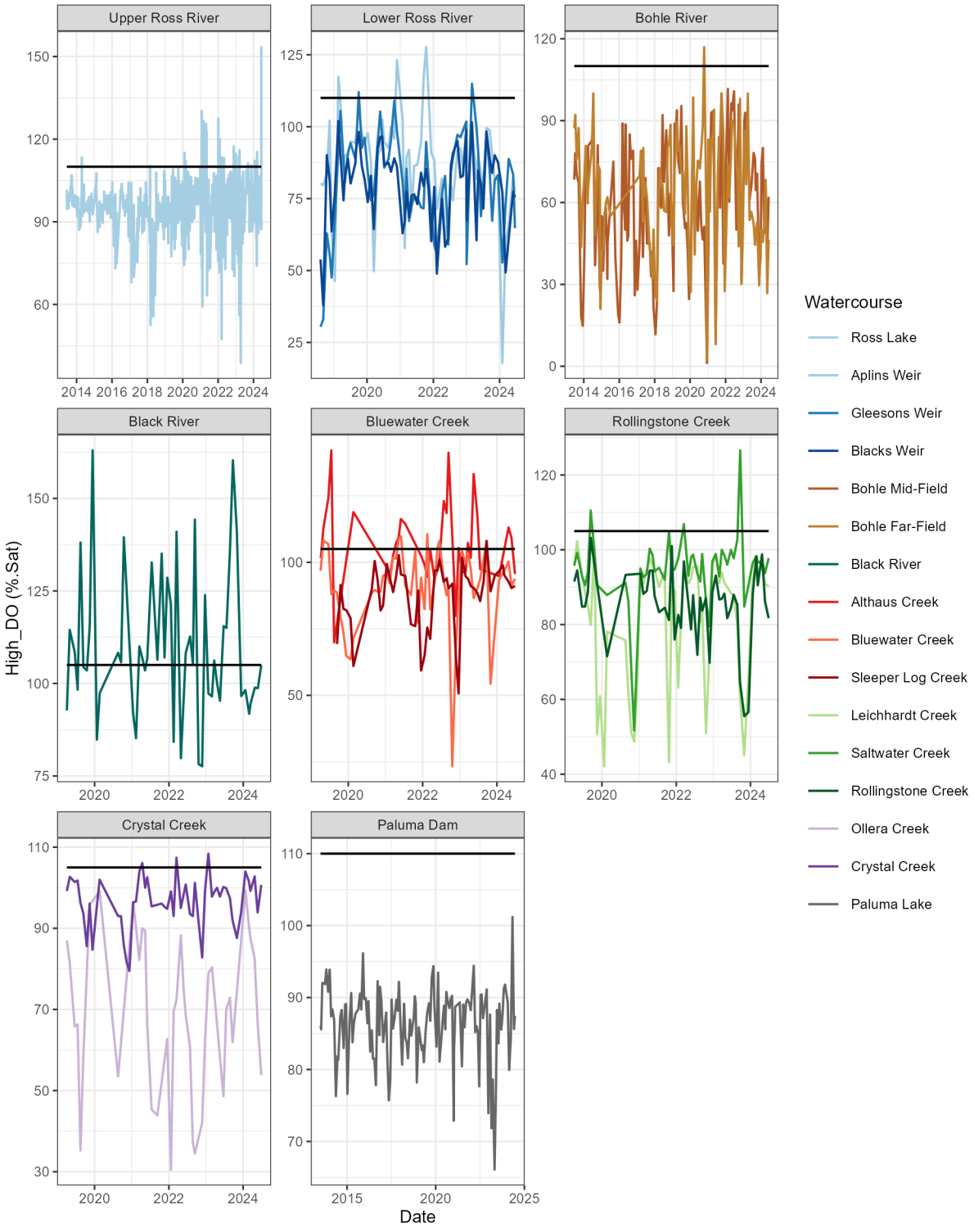

Figure 39. Historical dissolved oxygen in the freshwater sub basins. Black lines indicate the water quality objective (High DO).

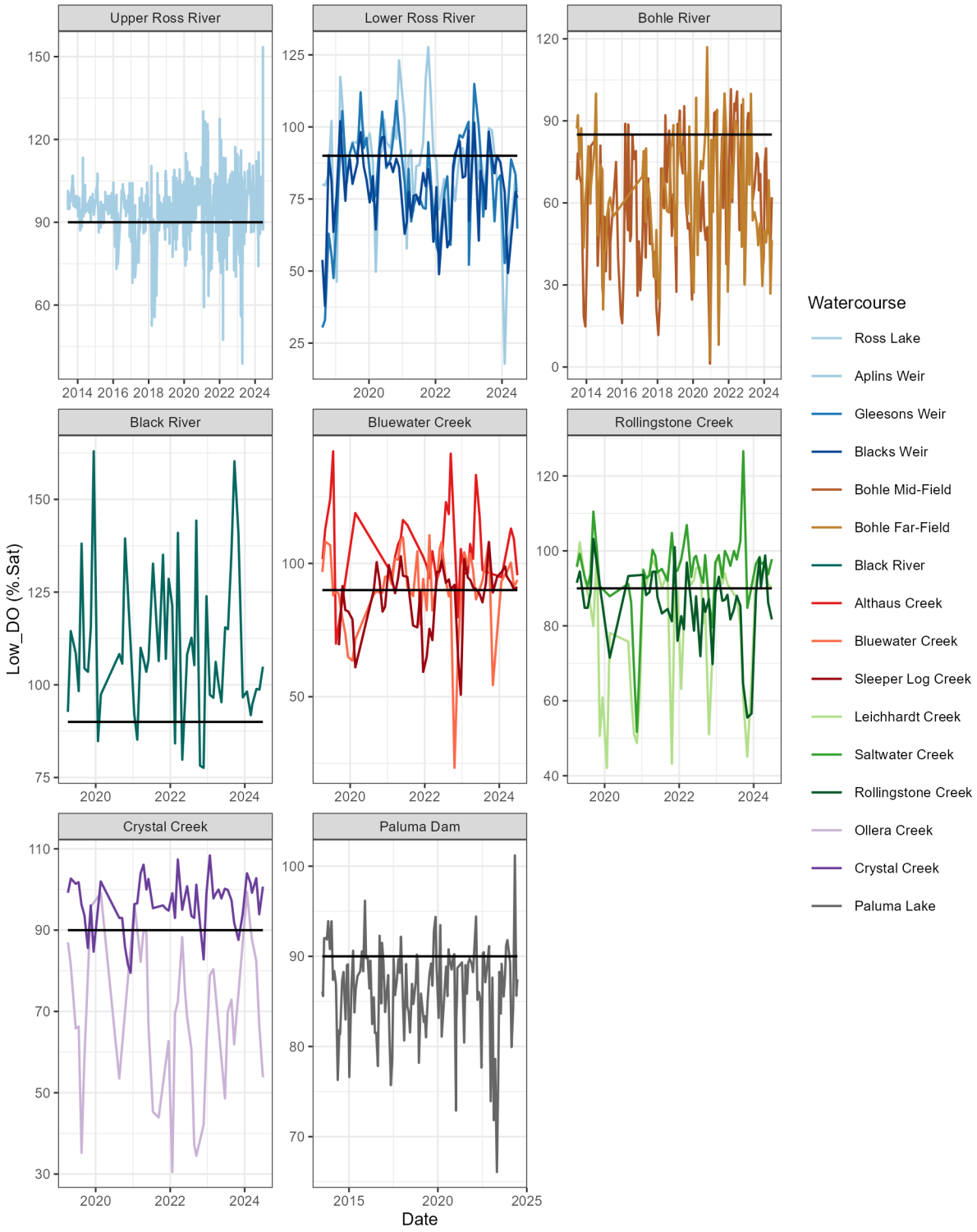

Figure 40. Historical dissolved oxygen in the freshwater sub basins. Black lines indicate the water quality objective (Low DO).

Appendix N. Freshwater Pesticides Sampling Locations

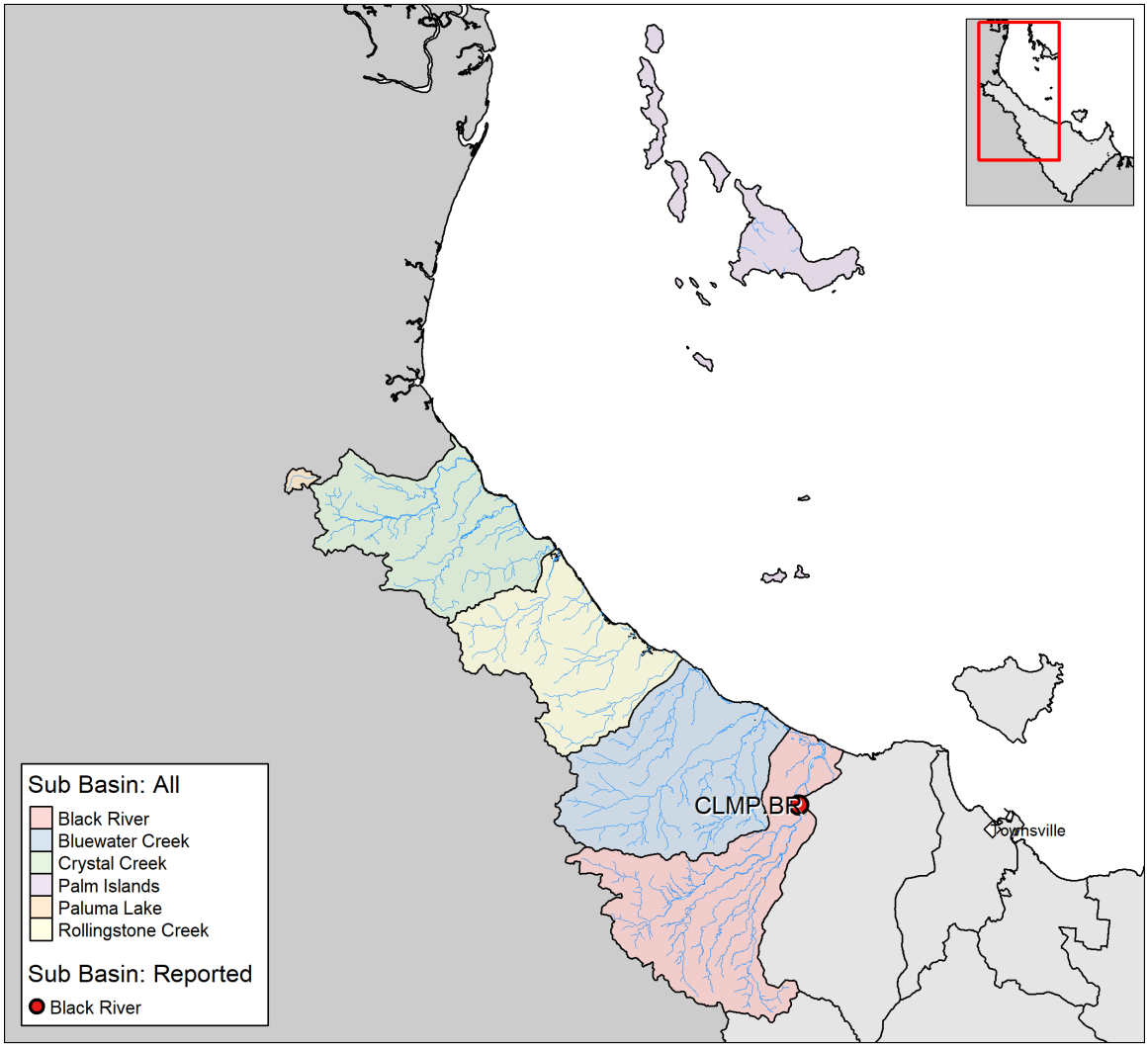

Figure 41. Black Freshwater Basin pesticide site locations. The red box in the inset map defines the extent of the Black Basin.

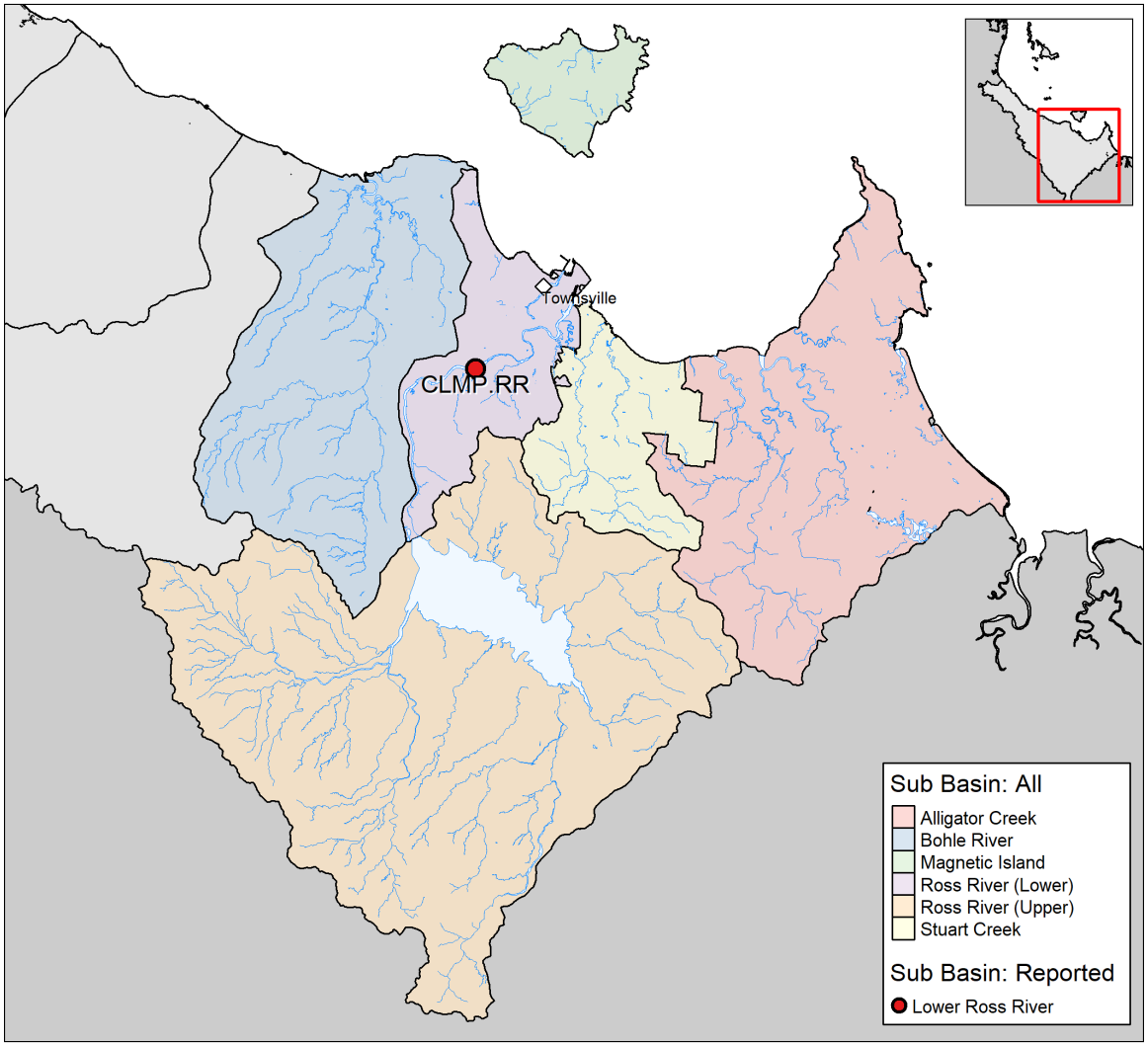

Figure 42. Ross Freshwater Basin pesticide site locations. The red box in the inset map defines the extent of the Ross Basin.

Appendix O. Freshwater Pesticides Historical Species Affected

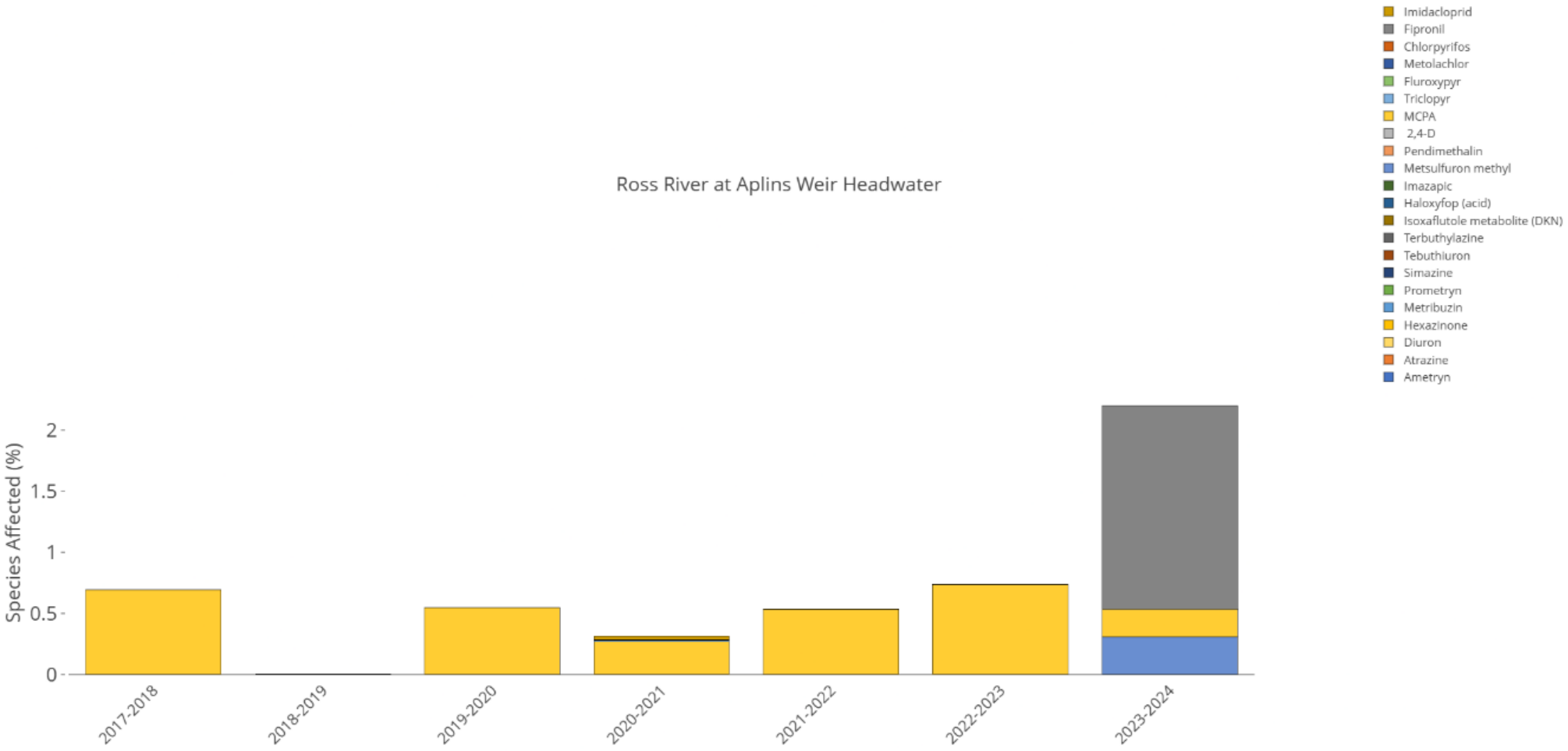

Figure 43. Historic pesticide proportions at the Ross River at Aplins Weir Headwater CLMP monitoring site.

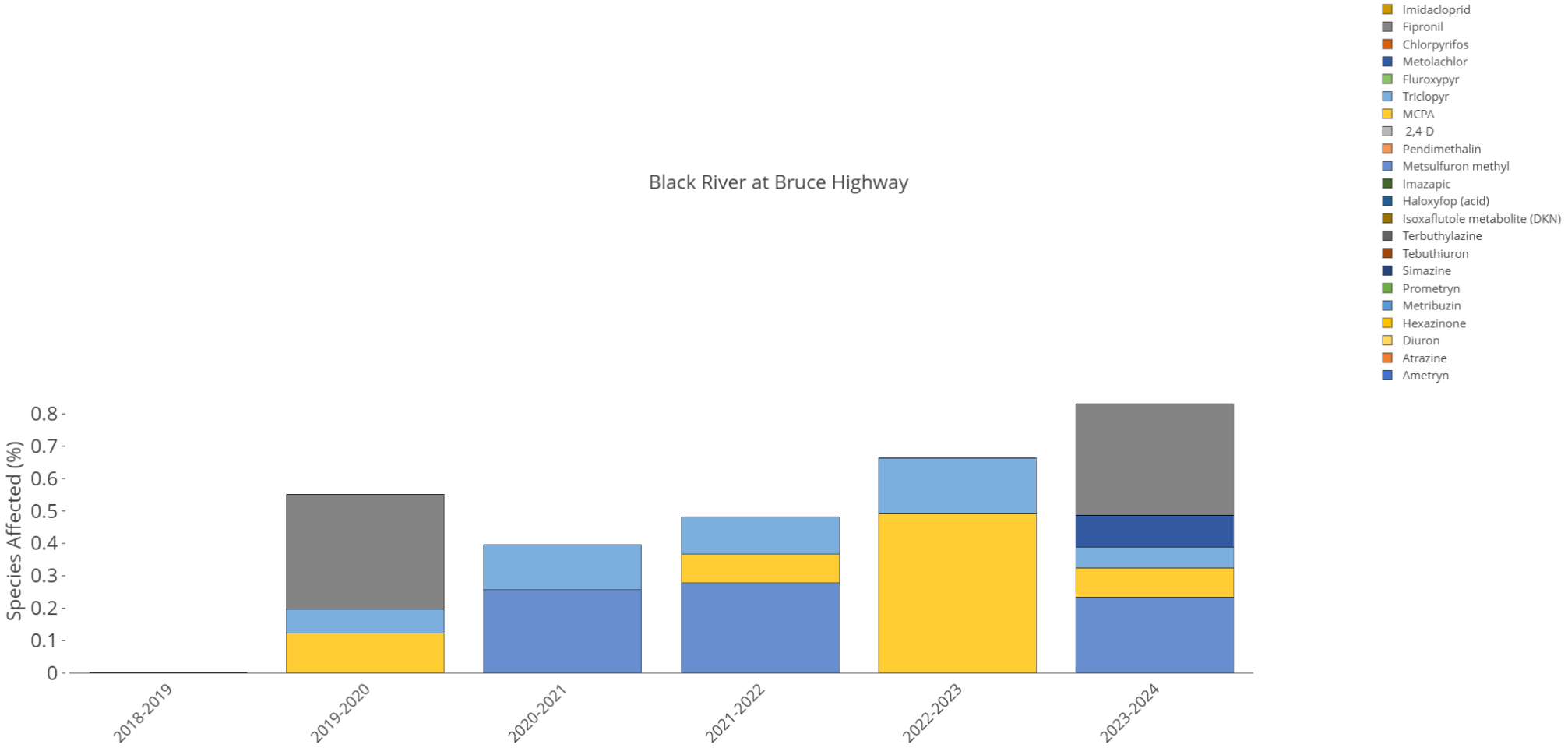

Figure 44. Historic pesticide proportions at the Black River CLMP monitoring site.

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

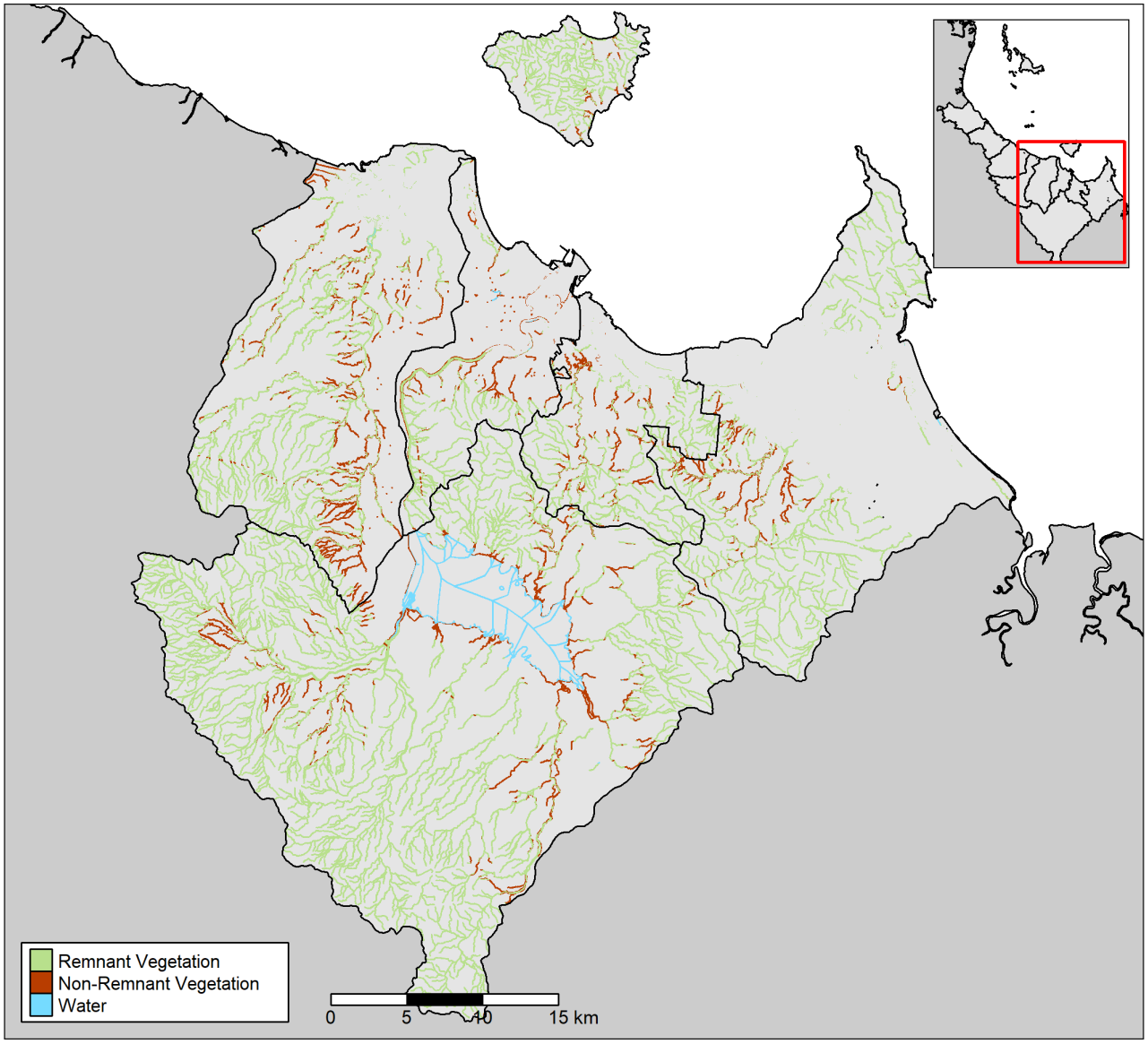

Figure 45. Freshwater riparian extent assessed for vegetation in the Ross Basin of the Dry Tropics region.

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

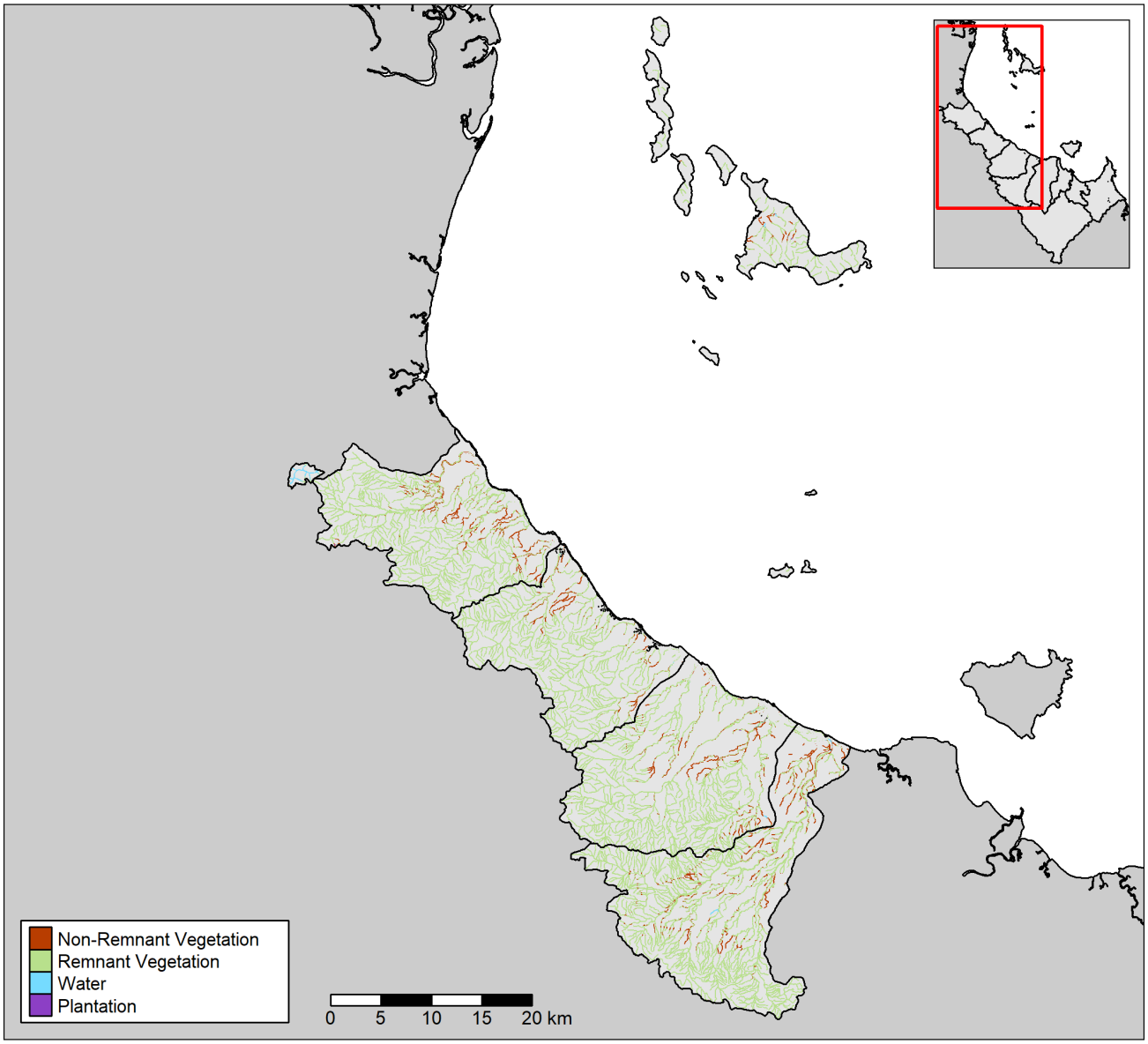

Figure 46. Freshwater riparian extent assessed for vegetation in the Black Basin of the Dry Tropics region.

Appendix R. Freshwater Riparian Extent Historical Scores

Table 85. Townsville Dry Tropics freshwater riparian extent historic scores.

Basin/Sub Basin	Extent Change: 19-21 Report Card Year: 23-24	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 Ck	X	57	X	X	ND
Bohle River	X	60	X	X	ND
Magnetic Island	X	80	X	X	ND
Ross River (Lower)	X	80	X	X	ND
Ross River (Upper)	X	52	X	X	ND
Stuart Ck	X	35	X	X	ND
Ross freshwater	X	54	X	X	44
Black River	X	81	X	X	ND
Bluewater Ck	X	81	X	X	ND
Crystal Ck	X	81	X	X	ND
Palm Islands	X	80	X	X	ND
Paluma Lake	X	80	X	X	ND
Rollingstone Ck	X	81	X	X	ND
Black freshwater	X	81	X	X	56

Appendix S. Ross Freshwater Riparian Vegetation Change Over Time

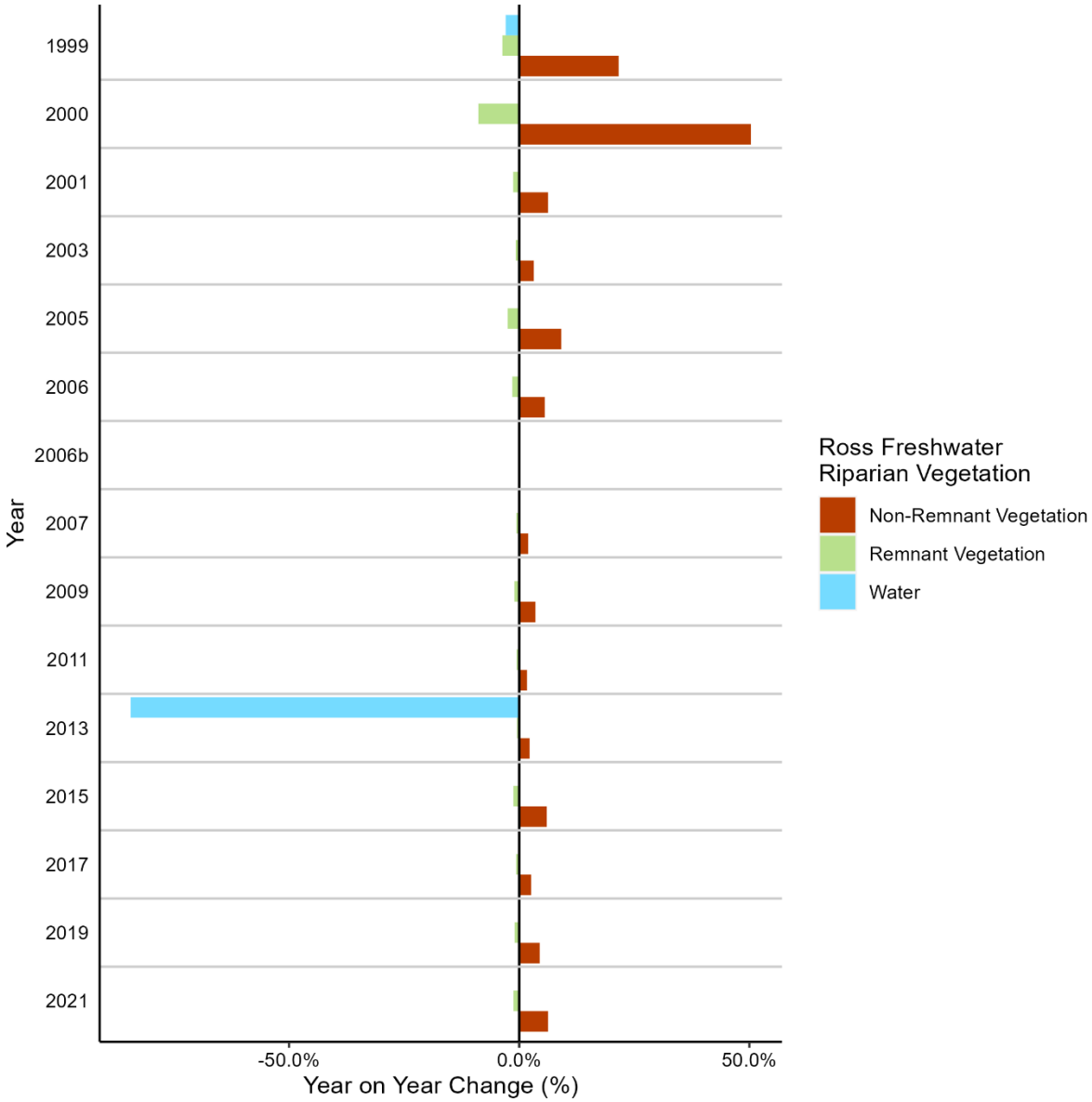

Figure 47. Ross Freshwater riparian vegetation change over time.

Appendix T. Black Freshwater Riparian Vegetation Change Over Time

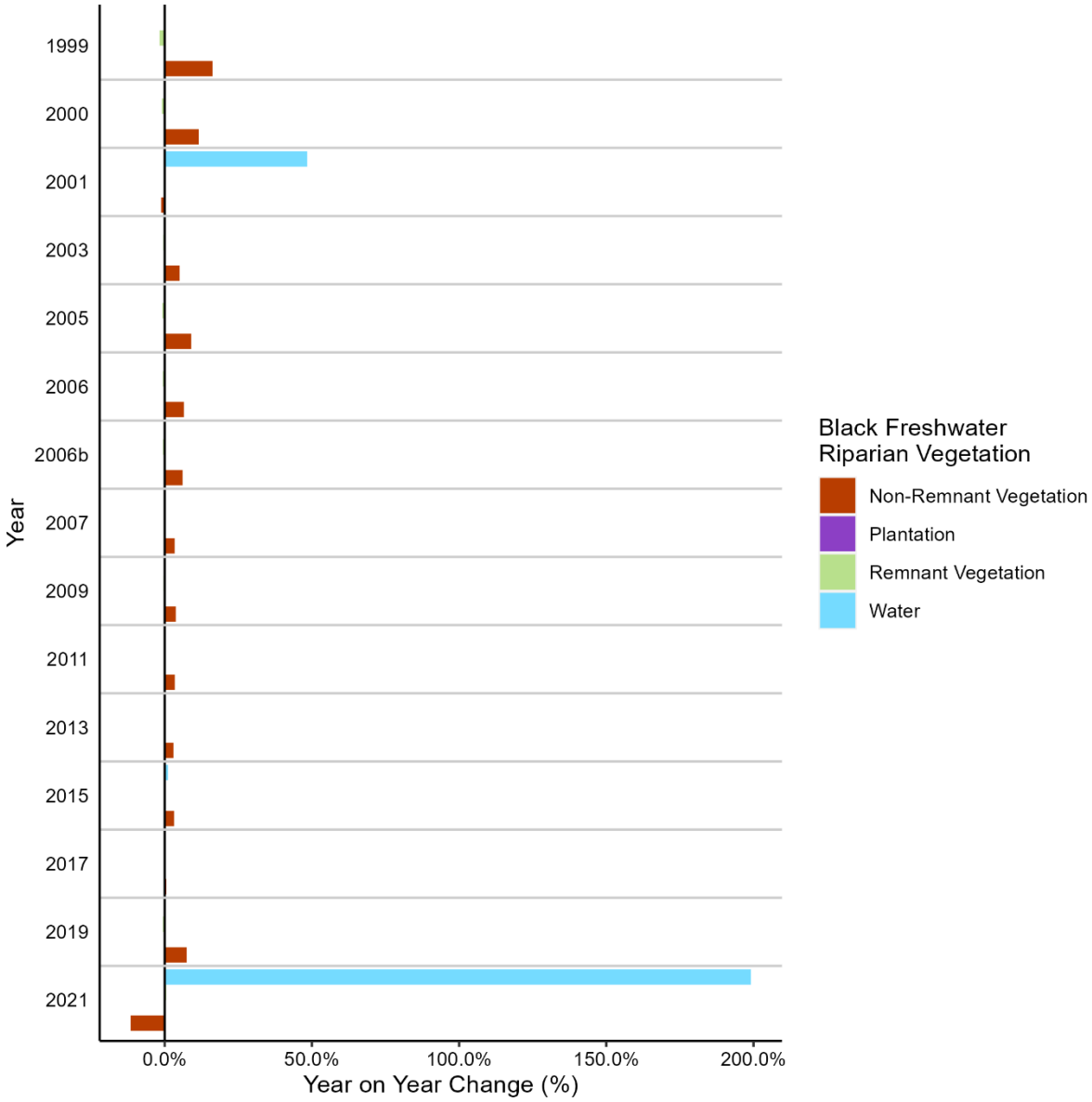

Figure 48. Black Freshwater riparian vegetation change over time.

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

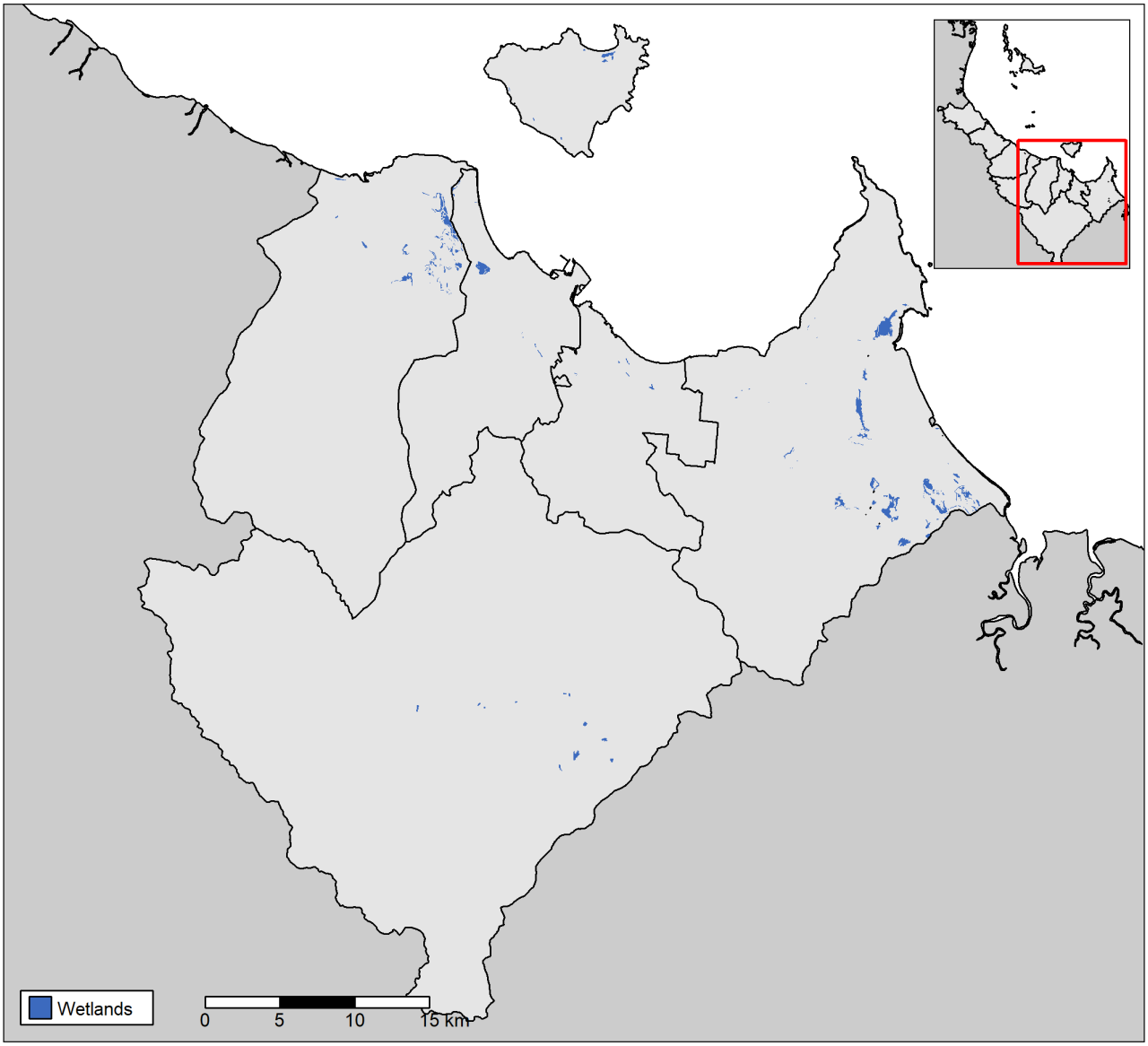

Figure 49. Freshwater wetlands assessed in the Ross freshwater environment of the Dry Tropics region.

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

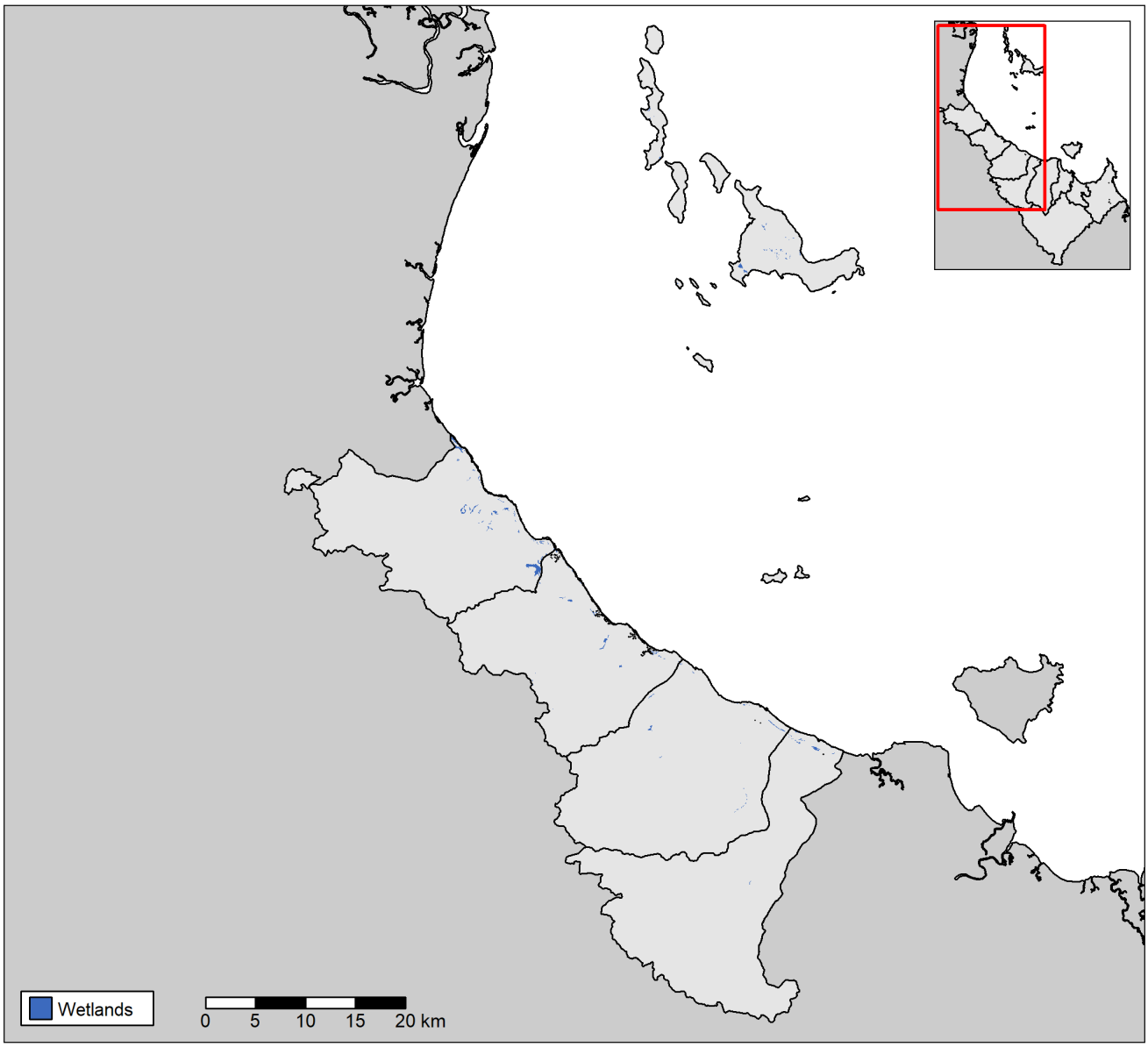

Figure 50. Freshwater wetlands assessed in the Black freshwater environment of the Dry Tropics region.

Appendix W. Ross Freshwater Wetland Vegetation Change Over Time

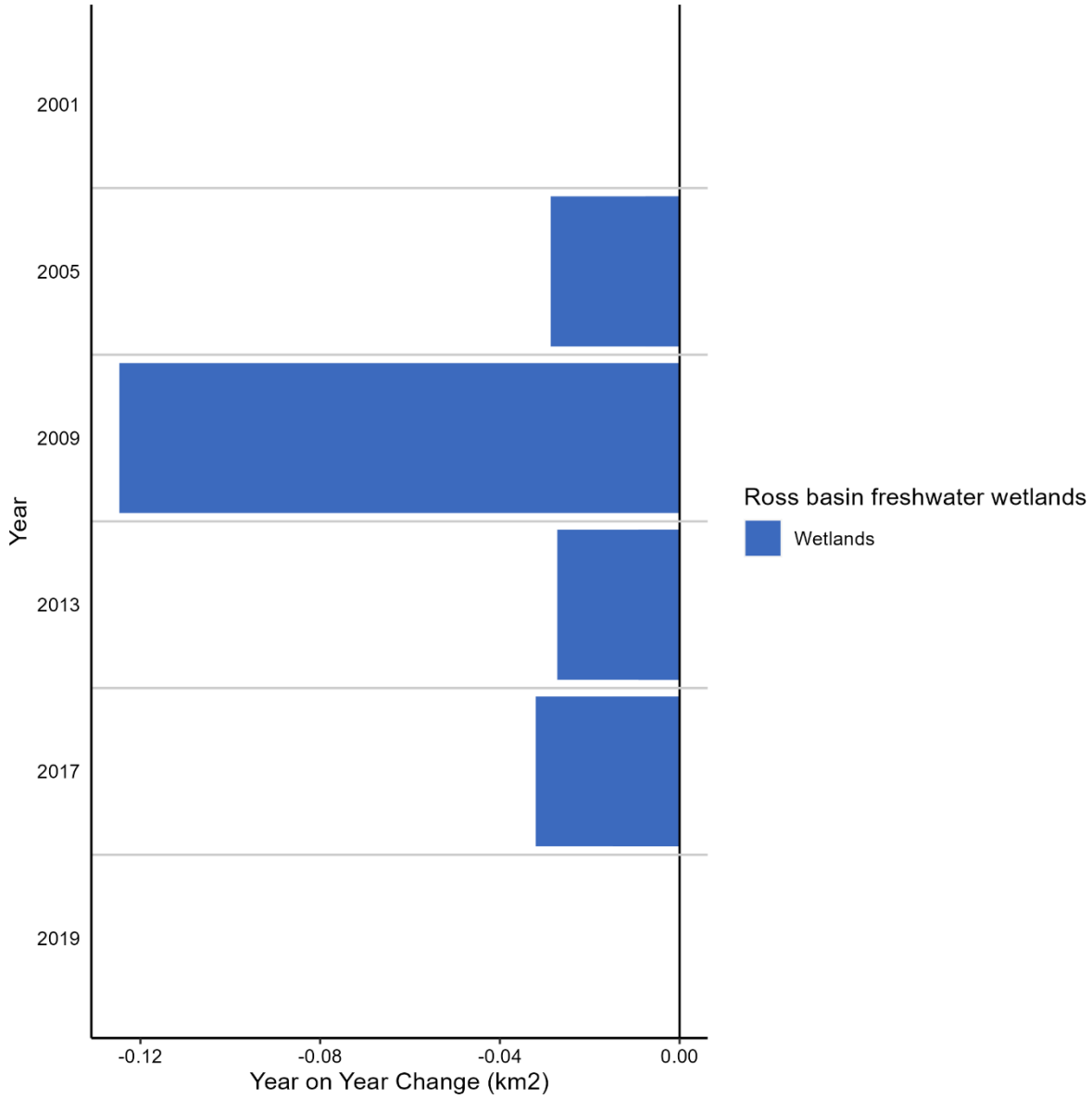

Figure 51. Ross freshwater wetland vegetation change over time.

Appendix X. Black Freshwater Wetland Vegetation Change Over Time

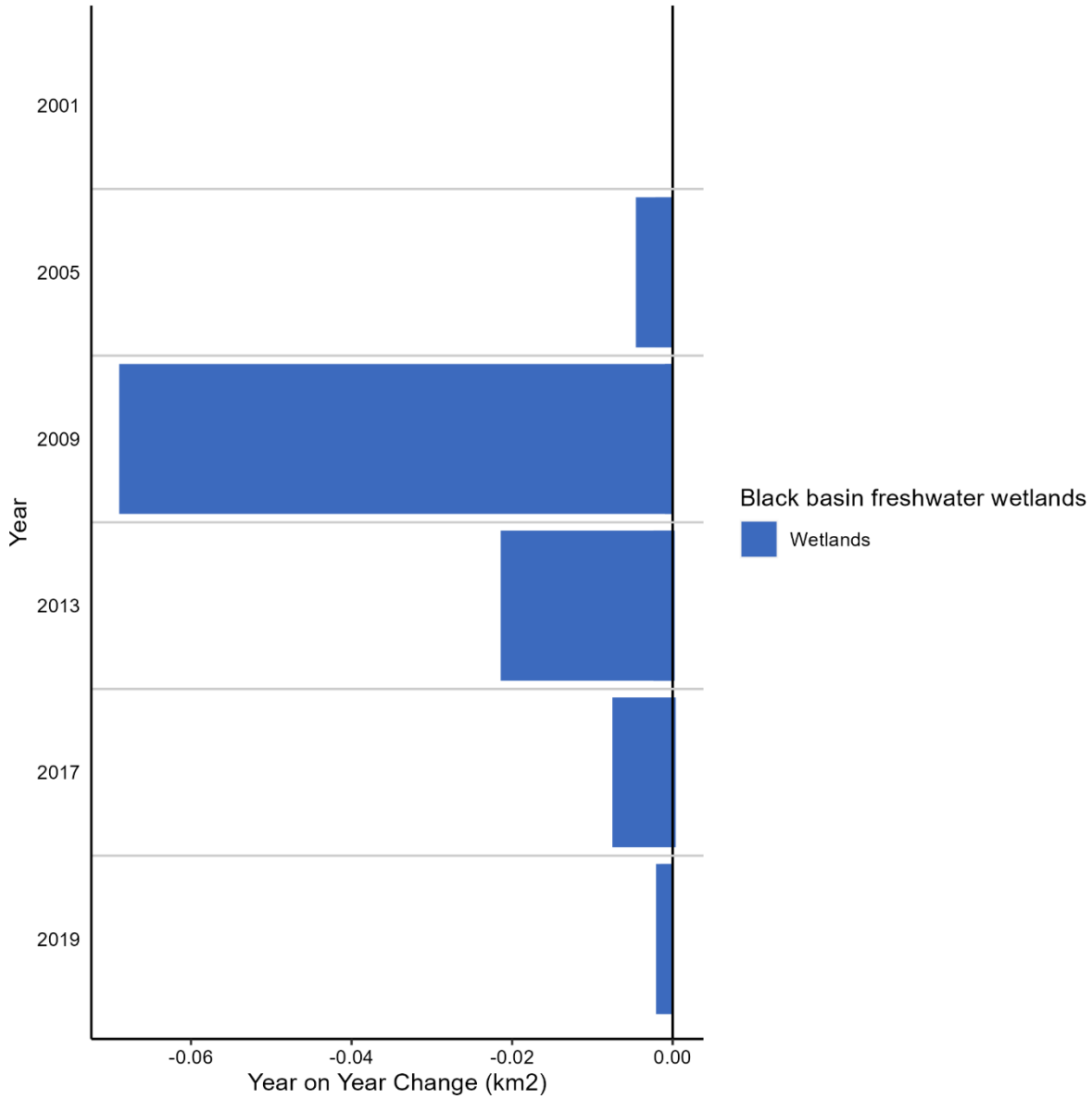

Figure 52. Black freshwater wetland vegetation change over time.

Appendix Y. Effect of the New Wetland Vegetation Dataset

Table 86. 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 Ck	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 Ck	11.1	10.1	1
Ross freshwater	**879.0**	**667.7**	**211.3**
Black River	33.5	13.6	19.9
Bluewater Ck	45.1	43.6	1.5
Crystal Ck	219.1	213.8	5.3
Palm Islands	61.9	47.4	14.5
Paluma Lake	-	-	-
Rollingstone Ck	76.9	77.3	-0.4
Black freshwater	**436.6**	**395.6**	**41**

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

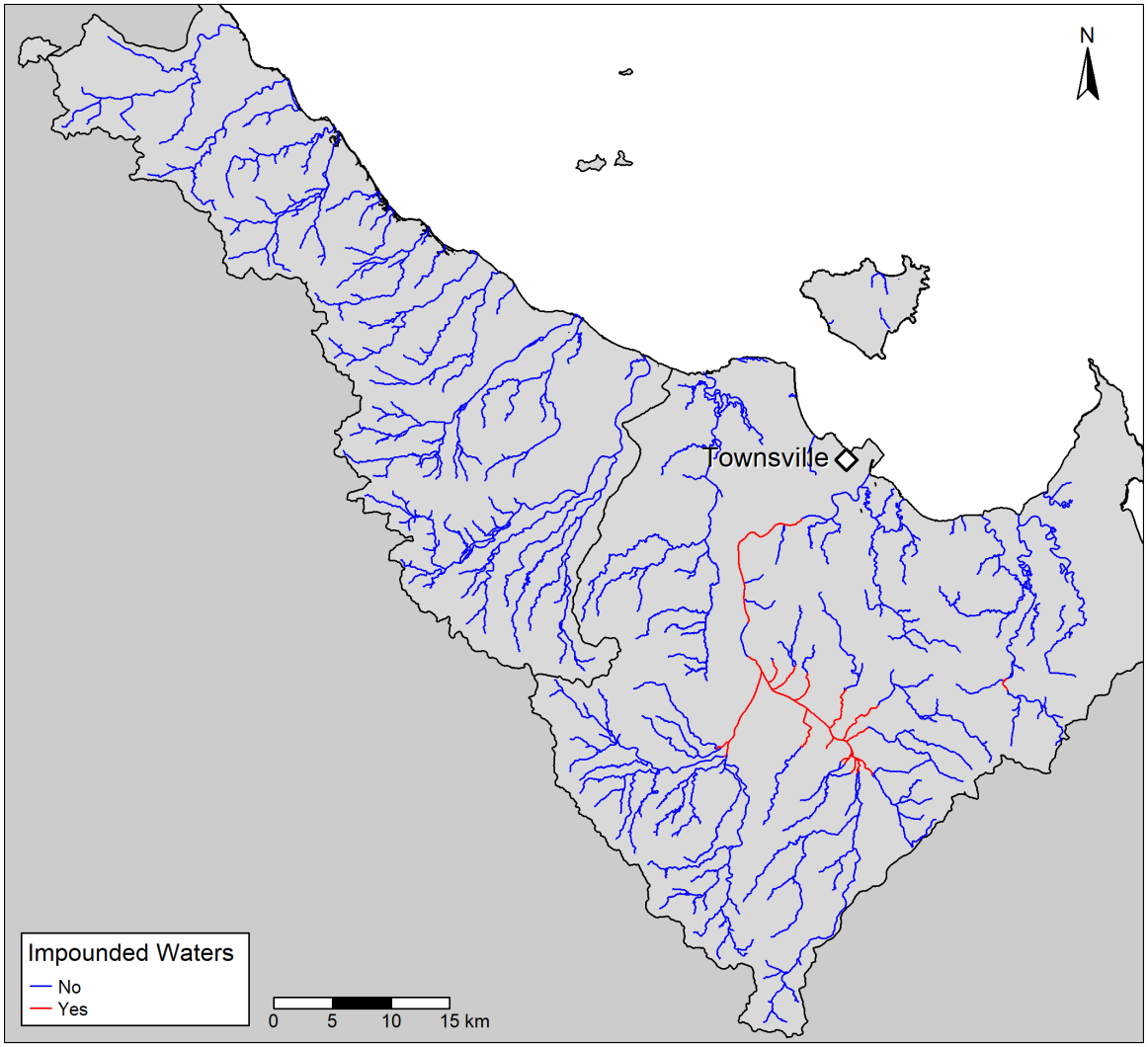

Figure 53. Impounded and non-impounded waters in the Dry Tropics region.

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

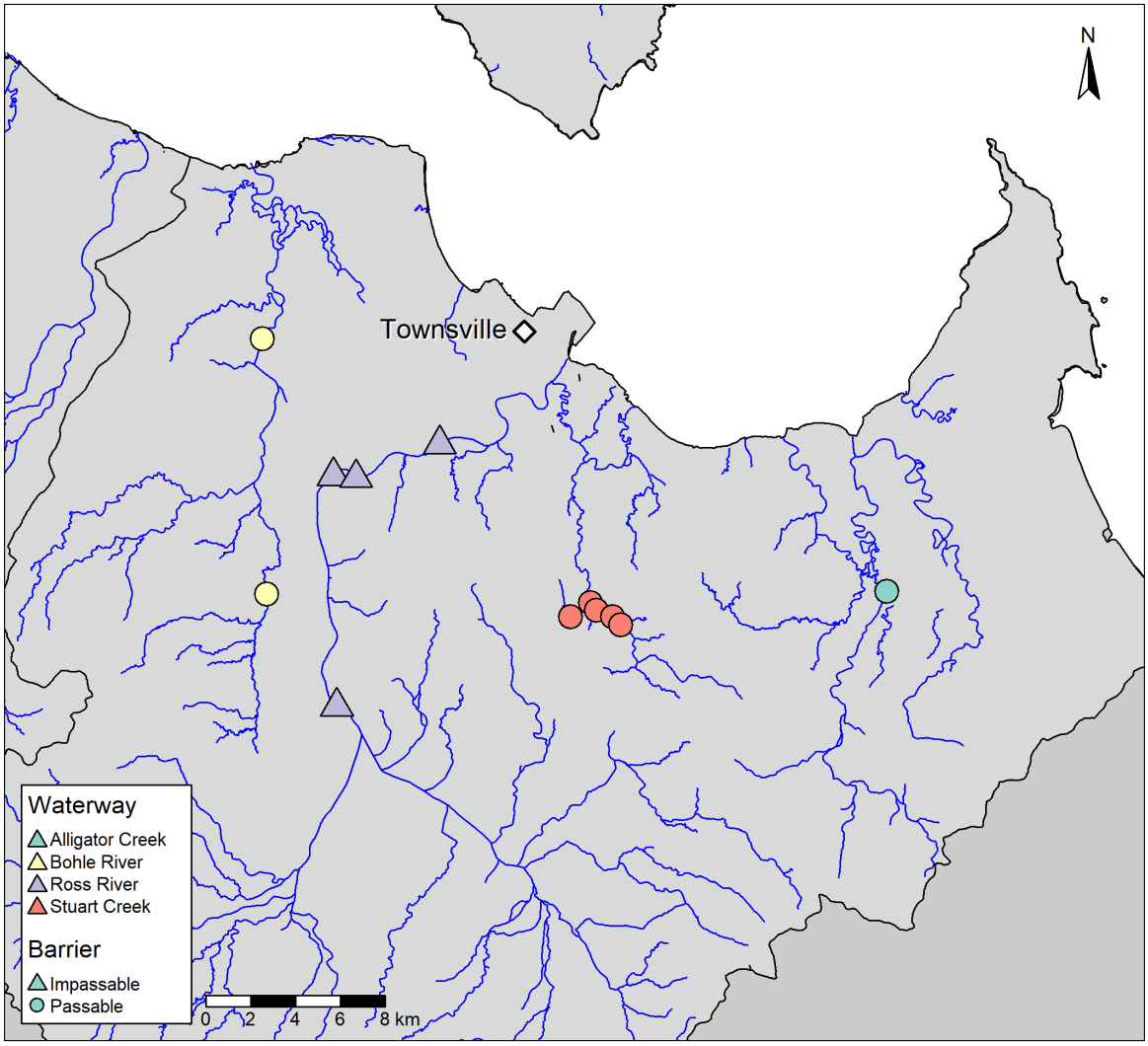

Figure 54. Fish barriers located on major and high importance waterways in the Dry Tropics region.

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

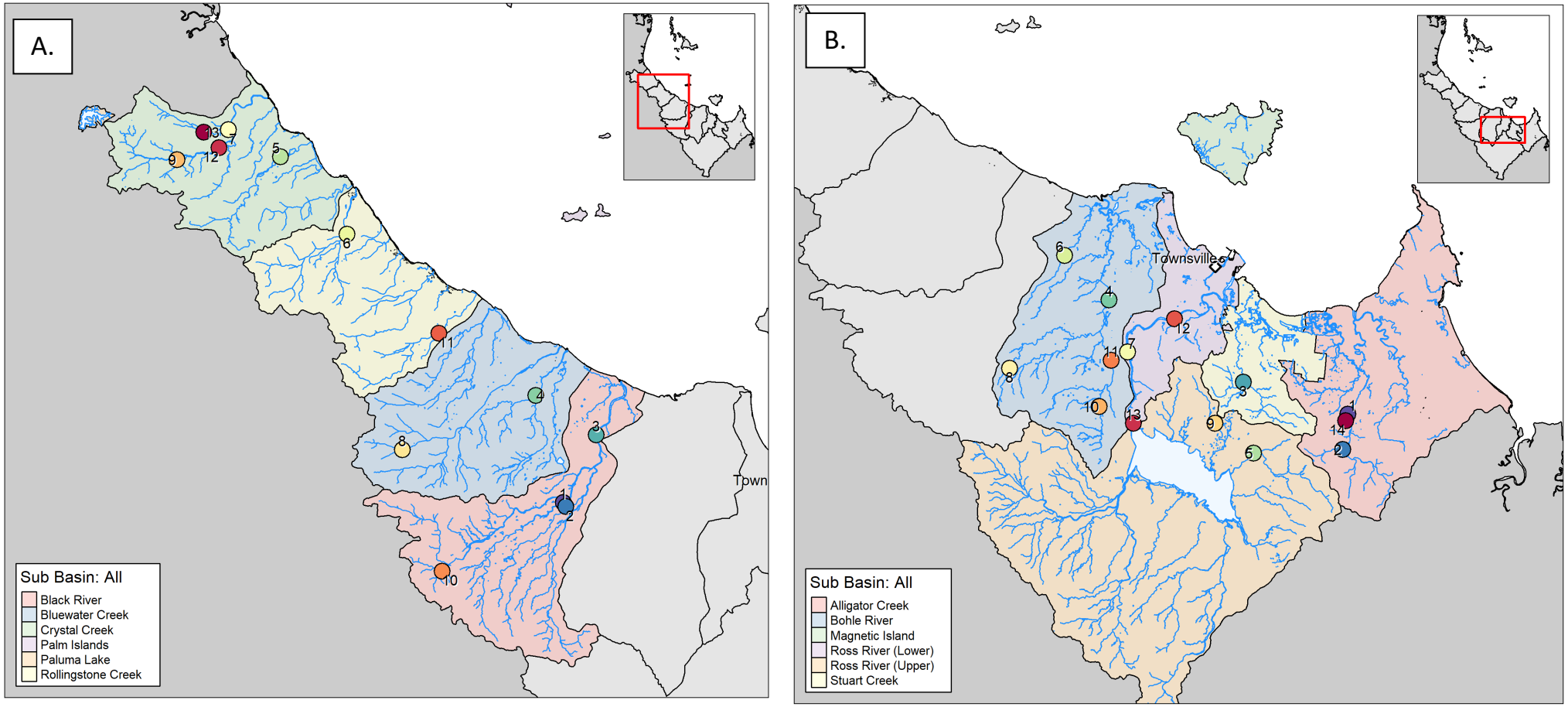

Figure 55. 2022-2023 freshwater fish sampling locations in the Townsville Dry Tropics Region. (A. = Black Basin, B. = Ross Basin). For Site ID's refer to Table 85 below.

Table 87. List of Site Names and Site Numbers for the 2022-2023 fish monitoring locations.

Basin	Site	Site Number
Ross	Alligator Ck Road, Alligator Ck	1
	Alligator Ck 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 Ck	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 Ck	9
	Page Road, Hervey Range	10
	Setter Road, Bluewater	11
	Spiegelhauer Road, Mutarnee	12
	Volk Road, Mutarnee	13

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

Table 88. 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 DD. Presence/Absence of Fish Species in Waterways Across the Ross Freshwater Basin and Black Freshwater Basin

Table 89. 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
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	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
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
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
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
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
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
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
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
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
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
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
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

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

Table 90. 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
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
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	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
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	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
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	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
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	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
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	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	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	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 EE. Distribution of Fish Data Across All Monitoring Sites in The Ross Freshwater Basin and Black Freshwater Basin

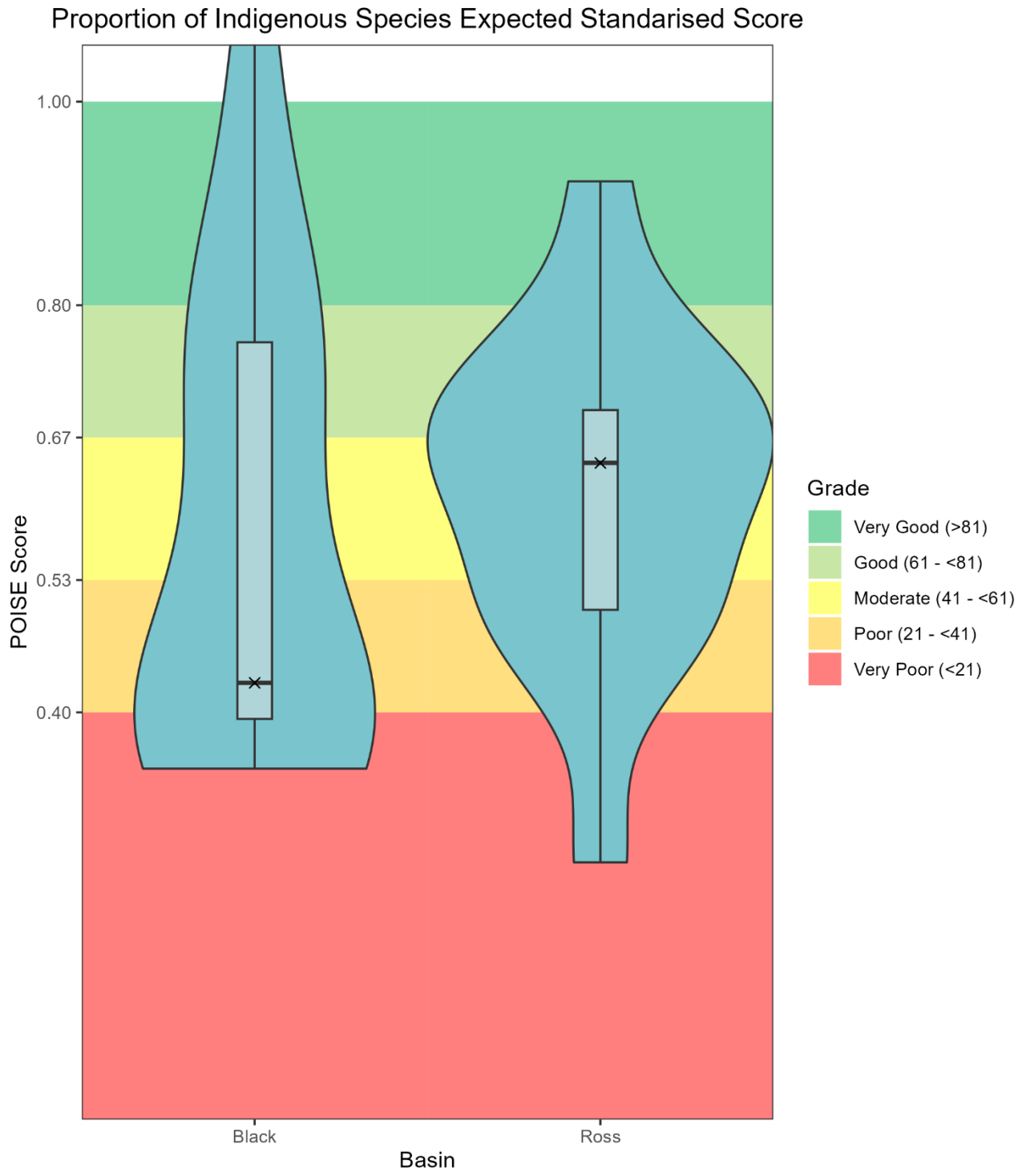

Figure 56. POISE scores for sites in each basin of the Townsville Dry Tropics region.

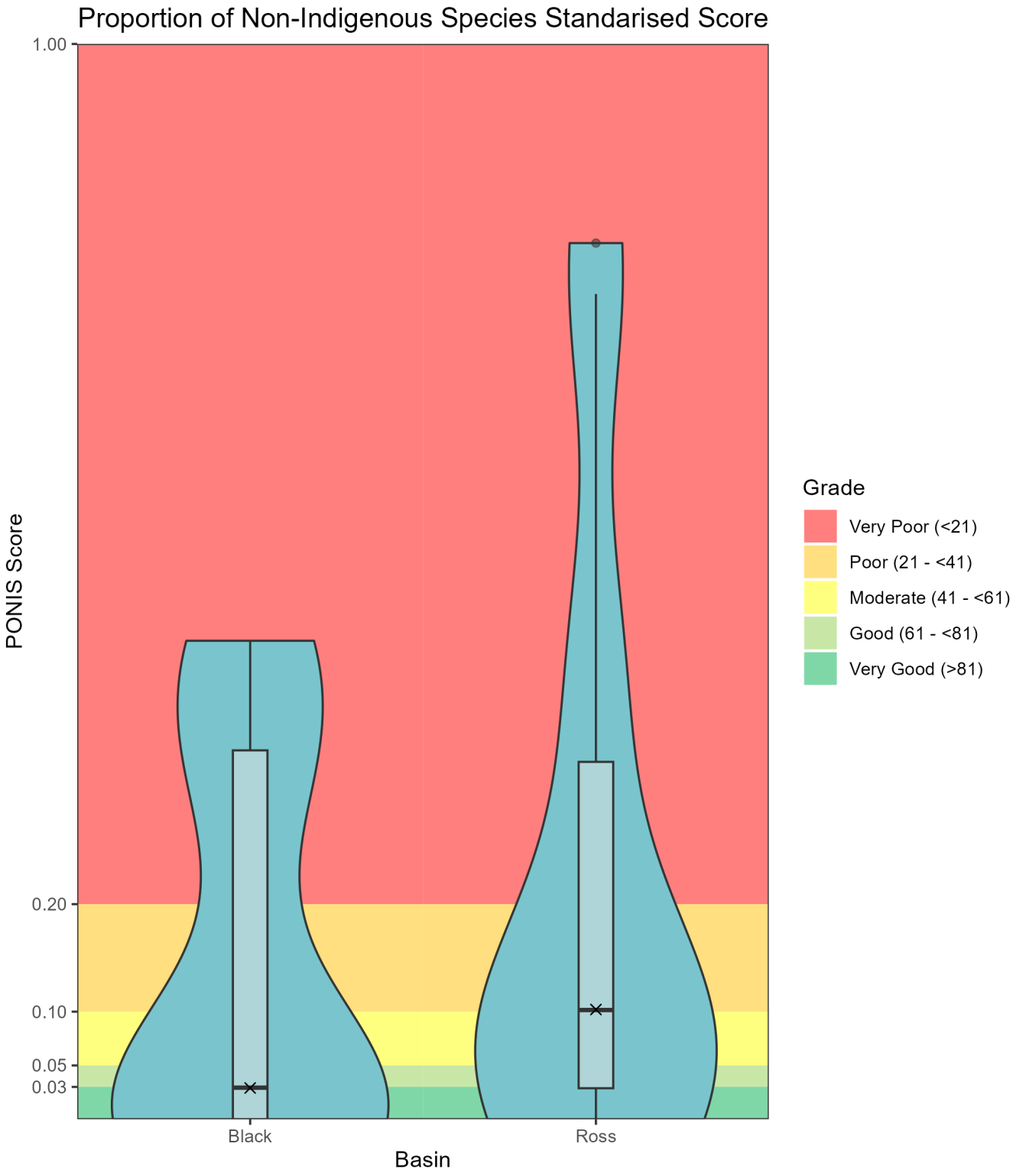

Figure 57. PONIS scores for sites in each basin of the Townsville Dry Tropics region.

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

Table 91. 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	12	11	0.006	0.07	0.09	12	11	0.05	0.05	0.09
Louisa Ck	36	11	0.162	0.07	0.09	36	11	0.11	0.05	0.09
Ross Ck	6	3	0.05	0.07	0.09	8	4	0.003	0.05	0.09
Ross River	3	3	0.017	0.07	0.09	4	4	0.002	0.05	0.09
Sandfly Ck	22	10	0.022	0.07	0.09	22	10	0.042	0.05	0.09
Alligator Ck	10	9	0.003	0.07	0.09	10	9	0.03	0.05	0.09
Althaus Ck	11	11	0.017	0.02	0.09	11	11	0.021	0.025	0.04
Bluewater Ck	10	10	0.032	0.02	0.09	10	10	0.016	0.025	0.04
Sleeper Log Ck	8	8	0.019	0.02	0.09	8	8	0.021	0.025	0.04
Camp Oven Ck	33	11	0.019	0.02	0.09	33	11	0.002	0.025	0.04
Saltwater Ck	44	12	0.029	0.02	0.09	44	12	0.002	0.025	0.04
Rollingstone Ck	11	11	0.058	0.02	0.09	11	11	0.013	0.025	0.04
Crystal Ck	11	11	0.048	0.02	0.09	11	11	0.019	0.025	0.04

Key: ■ = Mean/Median meets the guideline value | ■ = Mean/Median does not meet the guideline value | ND = No Data | - = Not Applicable (data available but not usable).

Appendix GG. Estuarine Water Quality Nutrients Scores Historic Comparison

Table 92. Townsville Dry Tropics estuarine water quality historic nutrient indicator scores.

Basin	Sub Basin	Watercourse	DIN					TP				
			23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20
Ross Estuarine	Bohle	Bohle River	90	90	90	90	90	61	90	90	90	90
		Louisa Ck	0	67	79	75	74	0	0	79	75	74
			45	78	85	83	82	30	45	85	83	82
	Lower Ross	Ross Ck	90	90	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	90	90	90	90
	Stuart	Sandfly Ck	90	90	76	90	90	70	90	76	90	90
	Alligator	Alligator	90	90	90	90	90	74	90	90	90	90
			75	86	85	88	88	64	75	85	88	88
Black Estuarine	Bluewater Ck	Althaus Ck	62	49	90	69	90	74	56	90	69	90
		Bluewater Ck	50	65	63	53	70	72	90	63	53	70
		Sleeper Log Ck	62	61	90	90	ND	77	90	90	90	ND
			58	58	81	71	80	74	78	81	71	80
	Rollingstone Ck	Camp Oven Ck	62	80	80	90	ND	90	90	80	90	ND
		Saltwater Ck	52	78	70	90	66	90	90	70	90	66
		Rollingstone Ck	27	34	61	36	49	90	90	61	36	49
			47	64	71	72	58	90	90	71	72	58
	Crystal Ck	Crystal Ck	36	56	65	27	58	71	90	65	27	58
			50	60	72	57	65	80	85	72	57	65

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 | - = Not Applicable (data available but not usable) | X = Data was not updated this year.

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

Table 93. 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	12	11	18.6	20	45	12	11	88.62	105	120	85	70
Louisa Ck	36	11	15.9	20	45	36	11	64.975	105	120	85	70
Ross Ck	8	4	2.93	20	45	8	4	85.079	105	120	85	70
Ross River	4	4	6.46	20	45	4	4	78.236	105	120	85	70
Sandfly Ck	22	10	27.575	20	45	22	10	87.432	105	120	85	70
Alligator Ck	10	9	21	20	45	10	9	87.75	105	120	85	70
Althaus Ck	11	11	12.87	8	15	11	11	96.7	105	120	85	70
Bluewater Ck	10	10	11.727	8	15	10	10	92.975	105	120	85	70
Sleeper Log Ck	8	8	10.935	8	15	8	8	89.5	105	120	85	70
Camp Oven Ck	33	11	5.65	8	15	33	11	70.6	105	120	85	70
Saltwater Ck	44	12	4.212	8	15	44	12	95.334	105	120	85	70
Rollingstone Ck	11	11	7.91	8	15	11	11	96.5	105	120	85	70
Crystal Ck	11	11	11.21	8	15	11	11	97.8	105	120	85	70

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

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

Table 94. Townsville Dry Tropics estuarine water quality historic physical-chemical indicator scores.

Basin	Sub Basin	Watercourse	Turbidity					High DO					Low DO				
			23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20
Ross Estuarine	Bohle	Bohle River	62	67	66	90	90	90	90	90	90	90	66	90	90	90	90
		Louisa Ck	67	65	66	68	90	90	90	90	25	90	0	0	24	21	90
			64	66	66	79	90	90	90	90	57	90	33	45	41	56	90
	Lower Ross	Ross Ck	90	90	90	90	90	90	90	90	90	90	61	90	90	90	ND
		Ross River	90	75	90	90	90	90	90	90	70	90	33	90	90	90	ND
			90	82	90	90	90	90	90	90	80	90	47	90	90	90	ND
	Stuart	Sandfly Ck	42	34	76	33	52	90	90	90	90	90	68	90	90	90	90
	Alligator	Alligator	58	48	90	69	90	90	90	90	90	90	65	90	90	90	90
			68	63	81	68	81	90	90	90	79	90	49	75	90	81	90
Black Estuarine	Bluewater Ck	Althaus Ck	18	0	0	0	3	90	80	33	90	68	90	90	28	90	90
		Bluewater Ck	28	63	90	90	7	90	90	76	90	73	70	73	0	90	90
		Sleeper Log Ck	35	59	63	84	ND	90	90	90	90	90	90	90	90	90	ND
			27	40	51	58	5	90	86	66	90	77	83	84	39	90	90
	Rollingstone Ck	Camp Oven Ck	90	55	42	63	ND	90	90	90	53	90	2	42	54	65	ND
		Saltwater Ck	75	69	83	86	90	90	90	77	90	90	90	90	75	90	90
		Rollingstone Ck	62	80	69	65	73	76	90	90	90	90	90	77	64	90	90
			75	68	65	71	82	85	90	86	78	90	60	70	64	81	90
	Crystal Ck	Crystal Ck	32	43	7	68	90	90	90	90	90	90	90	90	69	90	34
			48	53	41	66	59	88	88	81	86	86	74	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 | - = Not Applicable (data available but not usable) | X = Data was not updated this year.

Appendix JJ. Estuarine Water Quality 2022–2023 Boxplots

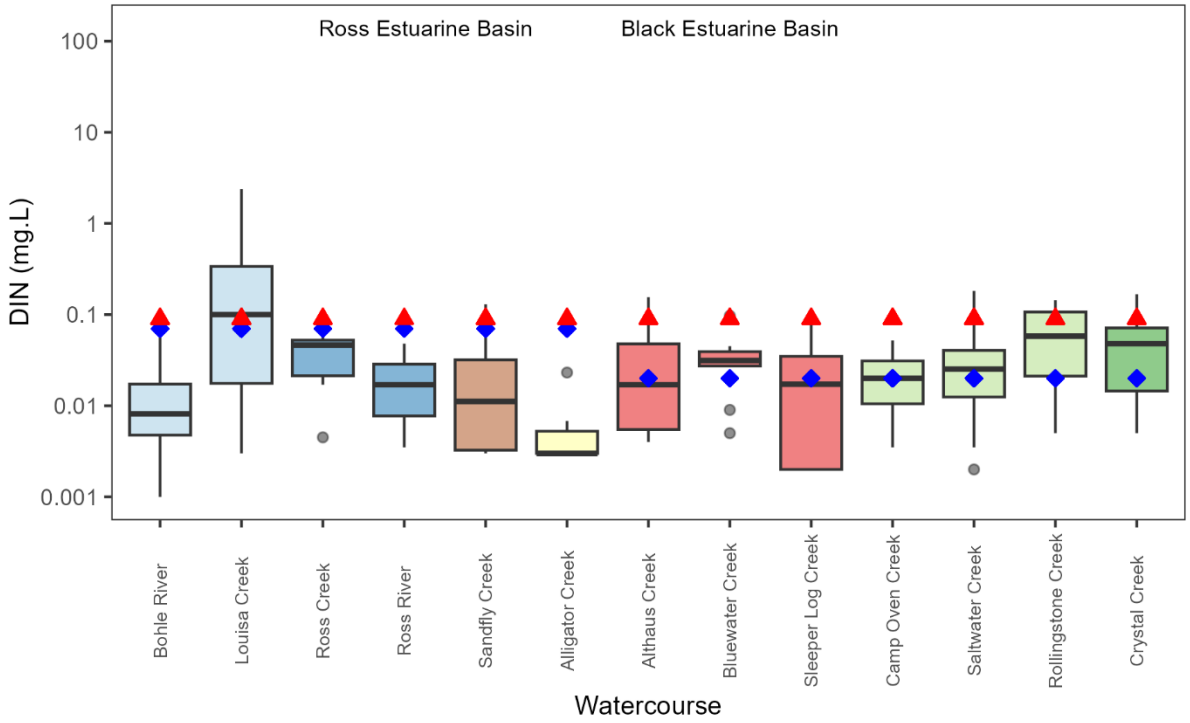

Figure 59. Dissolved Inorganic Nitrogen (DIN) (mg/L) Boxplot: red triangles indicate the scaling factor; blue diamonds indicate the water quality objective.

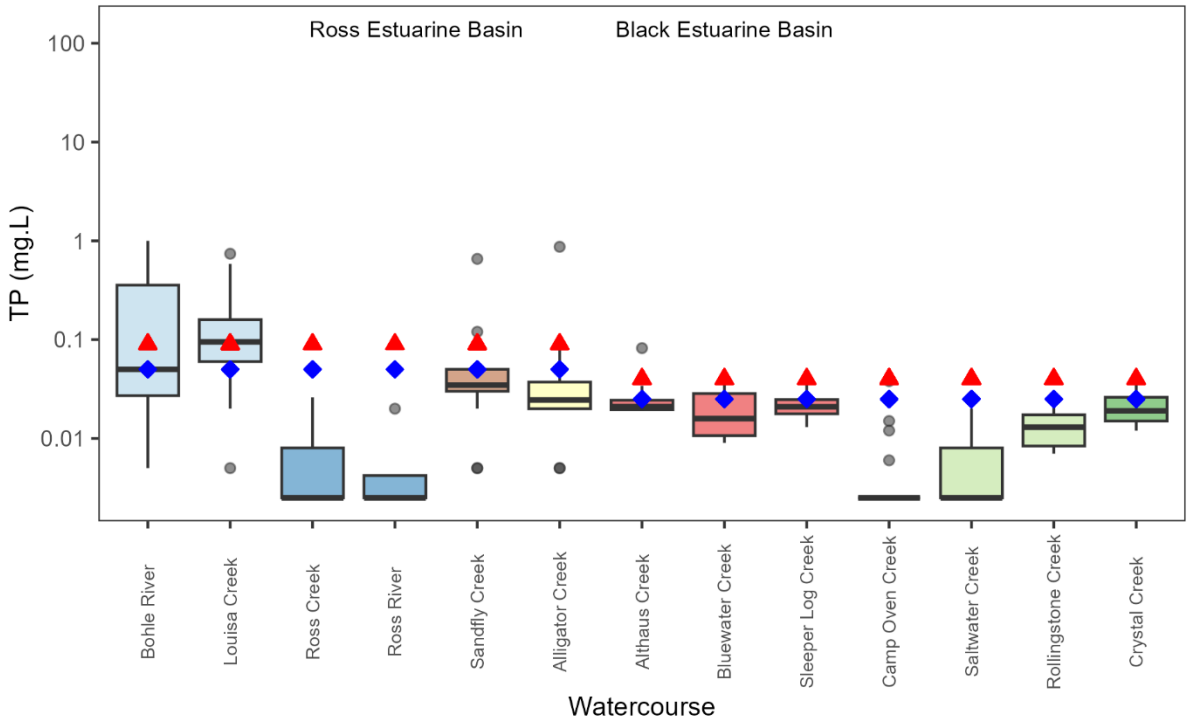

Figure 58. Total Phosphorus (TP) (mg/L) Boxplot: red triangles indicate the scaling factor; blue diamonds indicate the water quality objective.

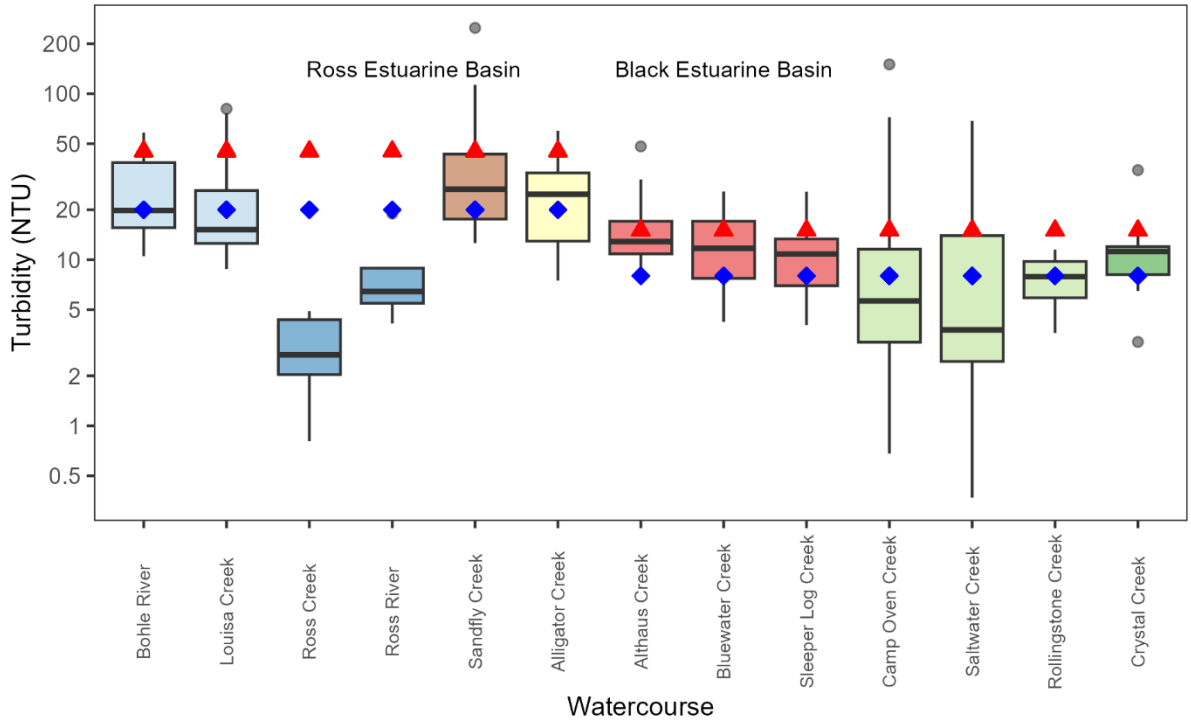

Figure 61. Turbidity (NTU) Boxplot: red triangles indicate the scaling factor; blue diamonds indicate the water quality objective.

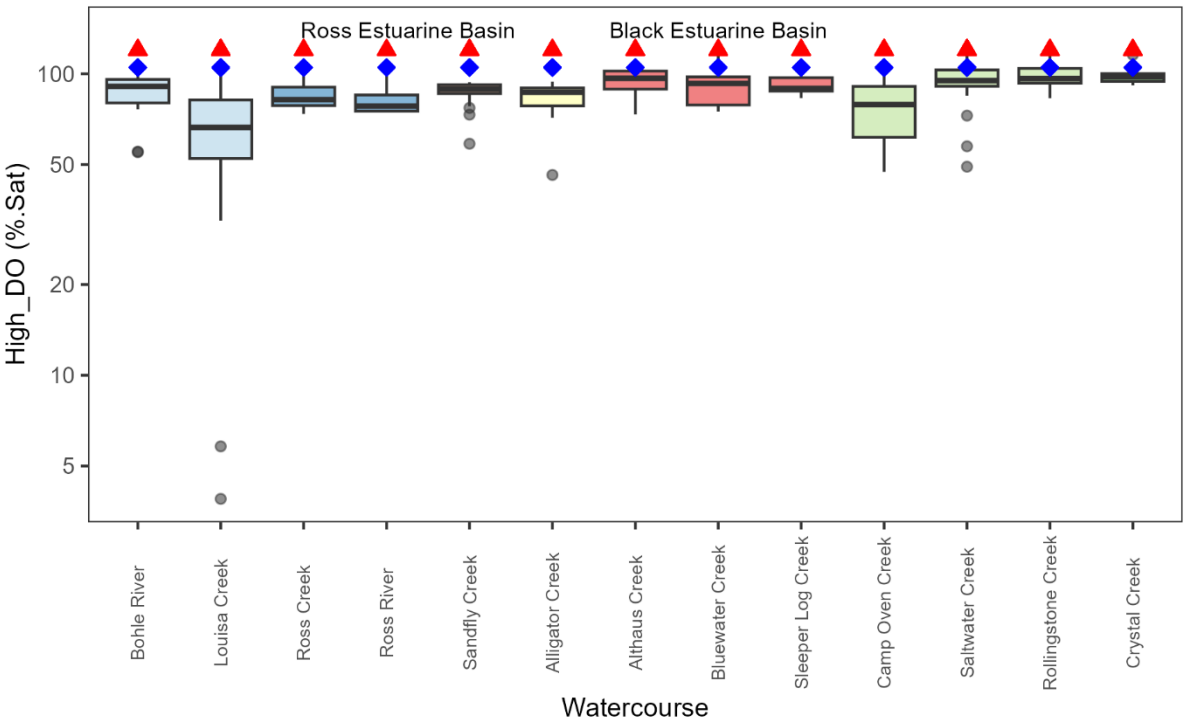

Figure 60. Dissolved Oxygen (DO) (% Saturation) boxplot: red triangles indicate the high DO scaling factor, blue diamonds indicate the high DO water quality objective, purple diamonds indicate the low DO water quality objective, and brown triangles indicate the low DO scaling factor.

Appendix KK. Estuarine Water Quality Line Plots

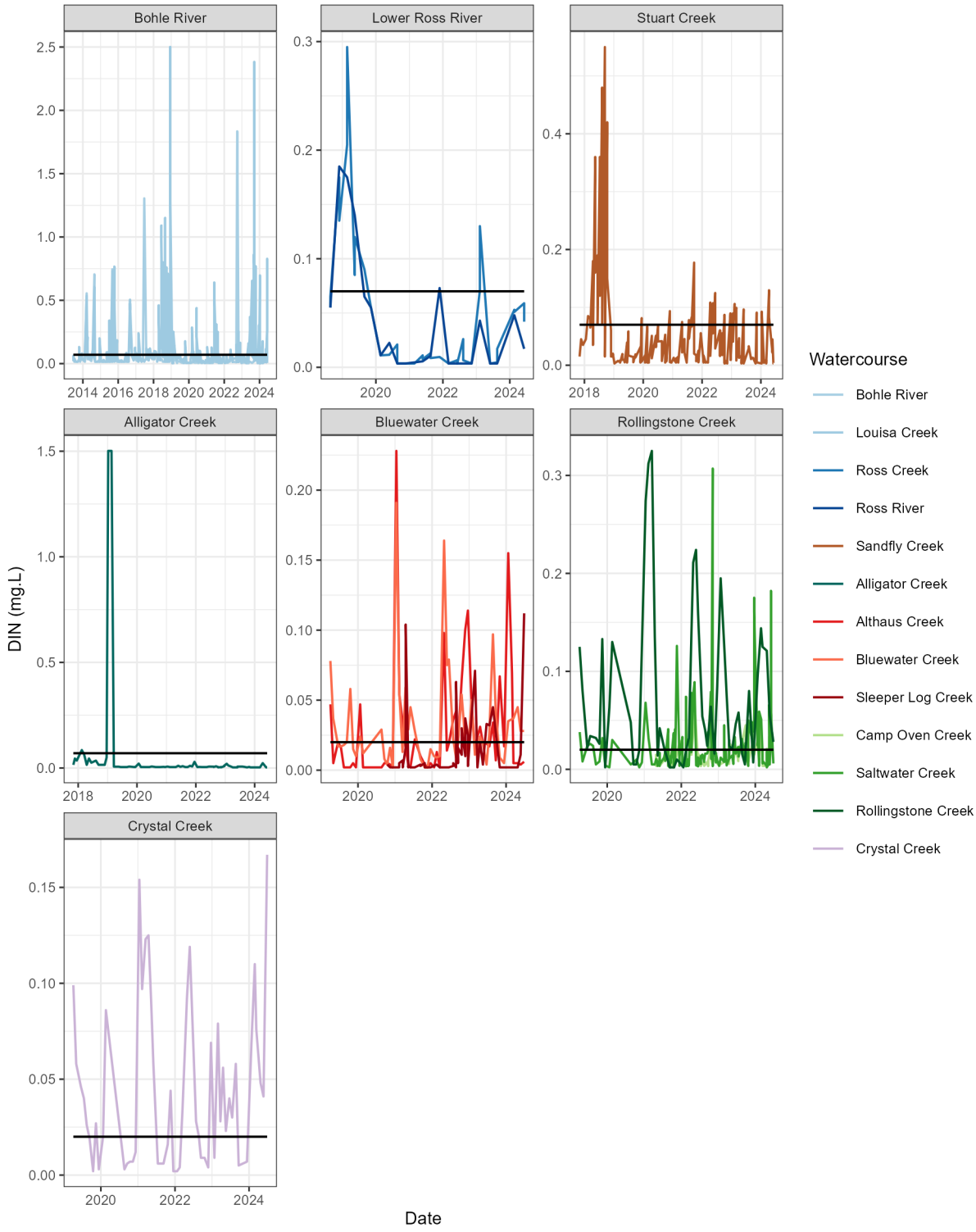

Figure 62. Historical concentrations of dissolved inorganic nitrogen (DIN) in the freshwater sub basins. Black line indicates the water quality objective.

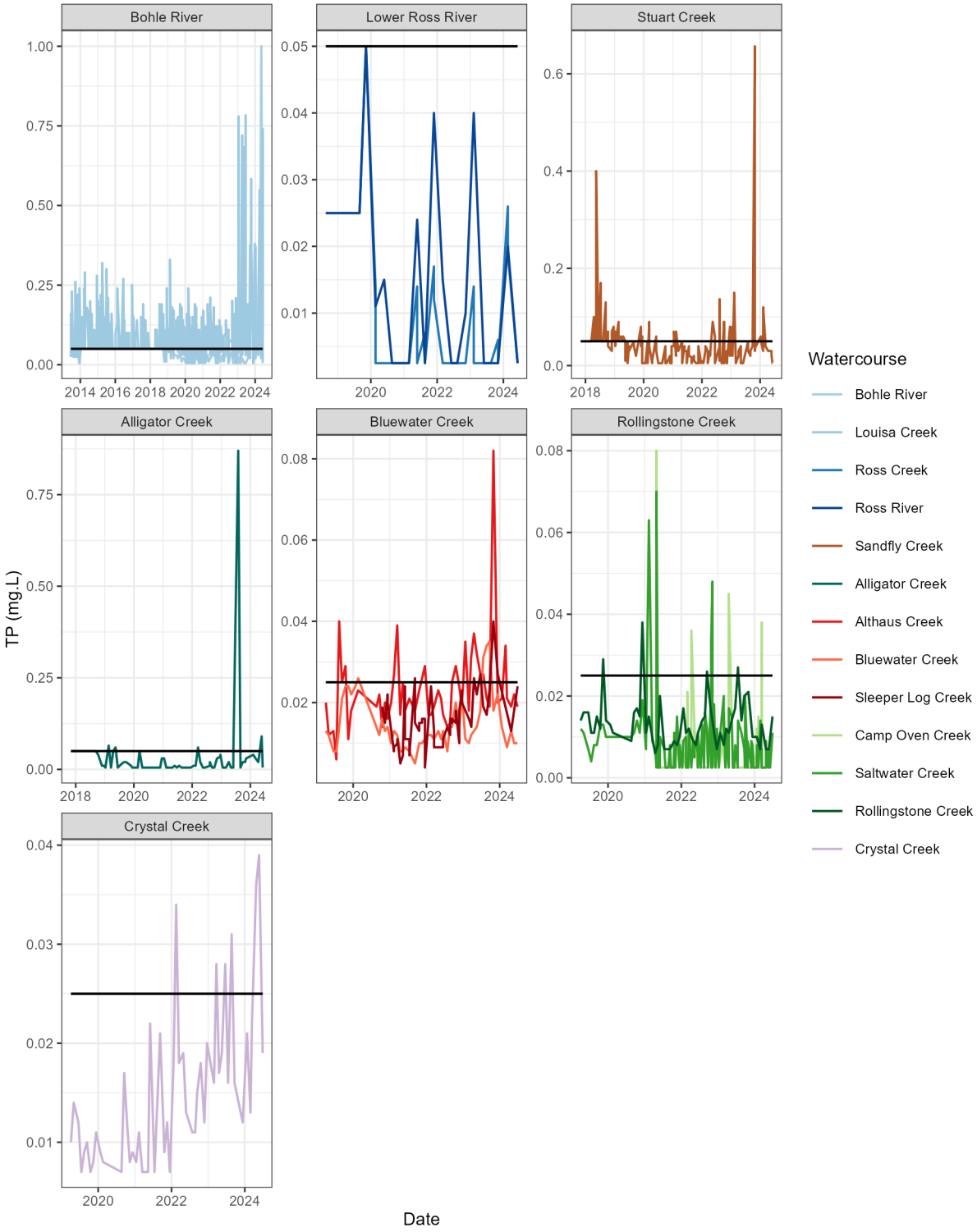

Figure 63. Historical concentrations of Total Phosphorus (TP) in the freshwater sub basins. Black line indicates the water quality objective.

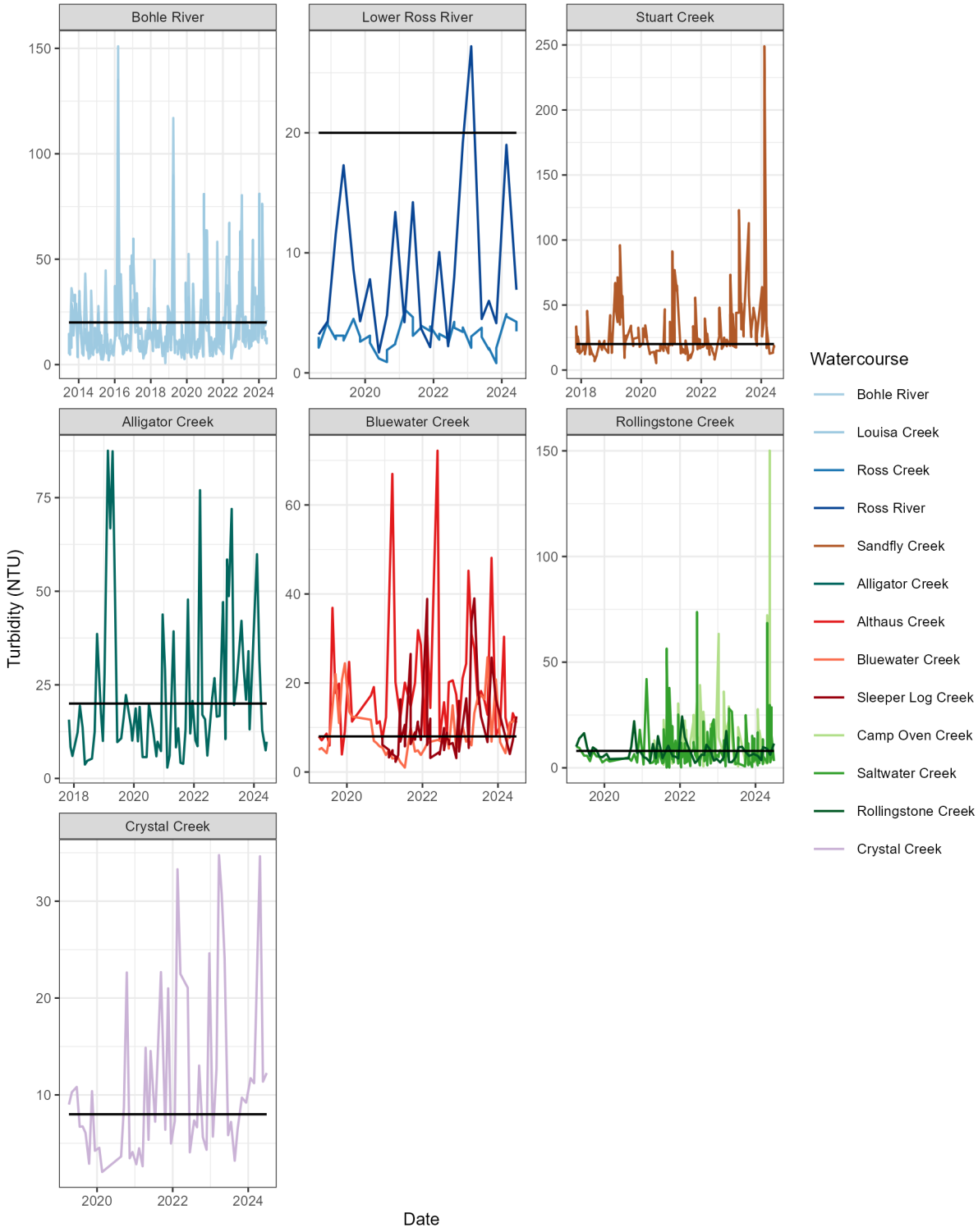

Figure 64. Historical concentrations of turbidity (NTU) in the freshwater sub basins. Black line indicates the water quality objective.

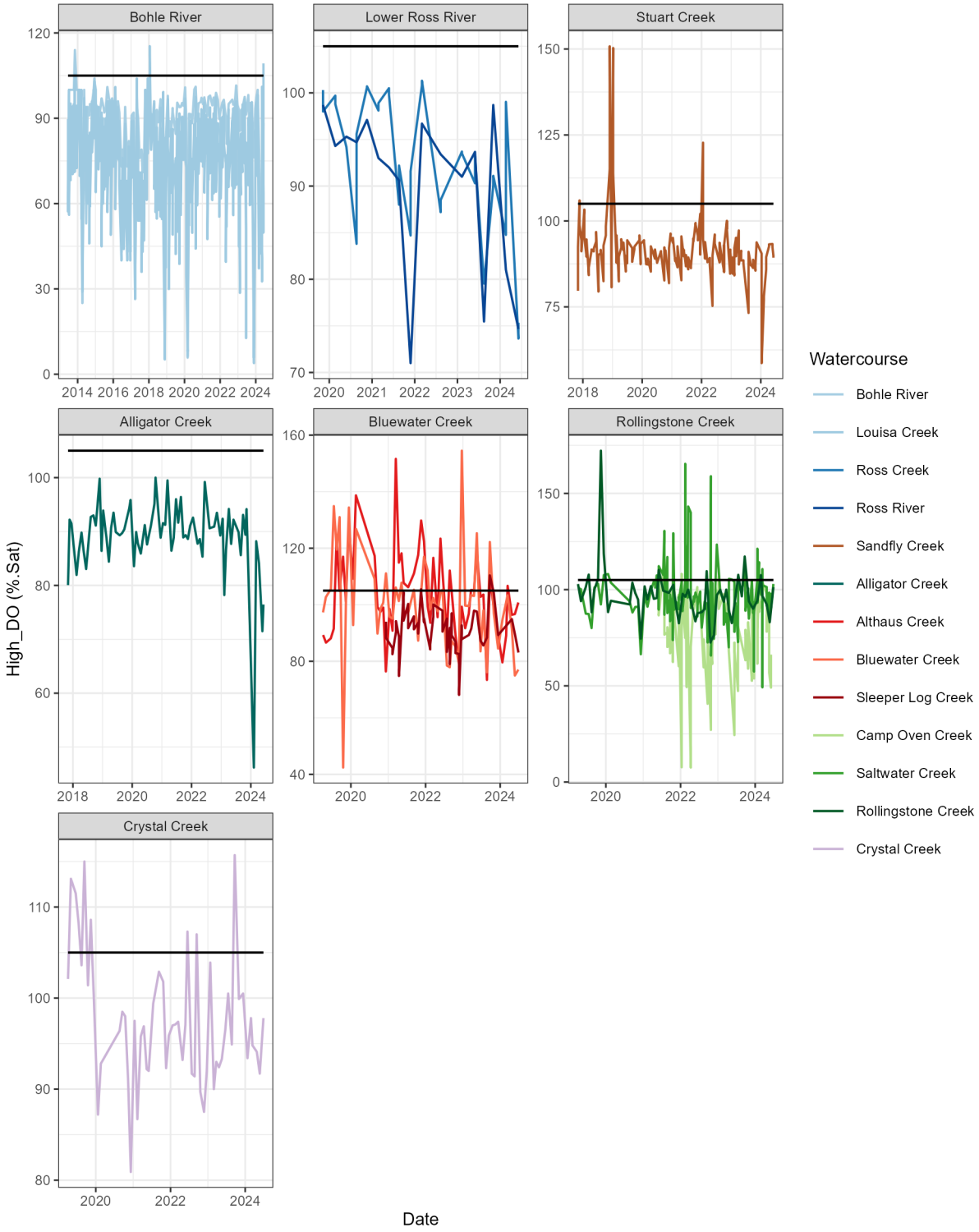

Figure 65. Historical dissolved oxygen in the freshwater sub basins. Black lines indicate the water quality objective (High DO).

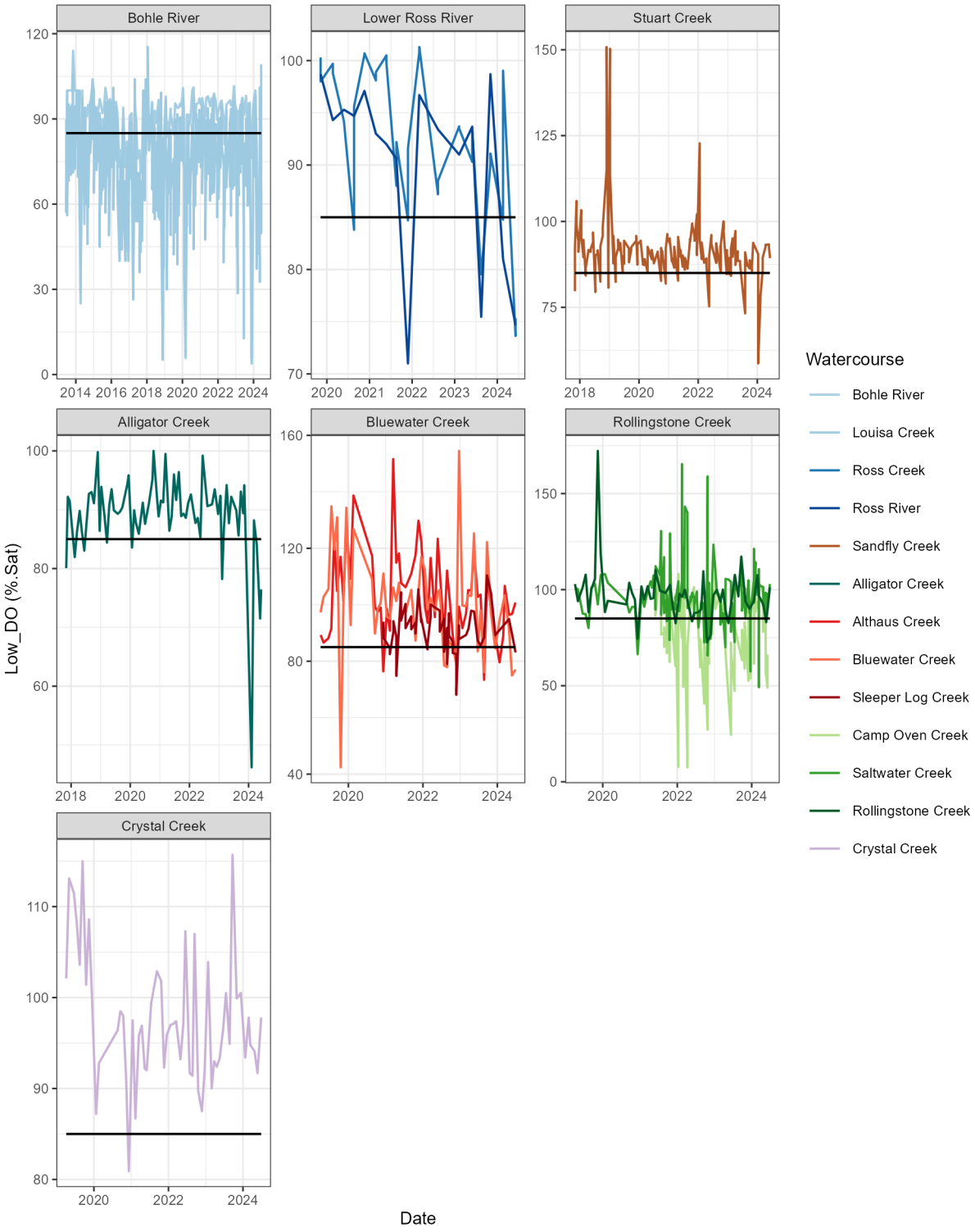

Figure 66. Historical dissolved oxygen in the freshwater sub basins. Black lines indicate the water quality objective (Low DO).

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

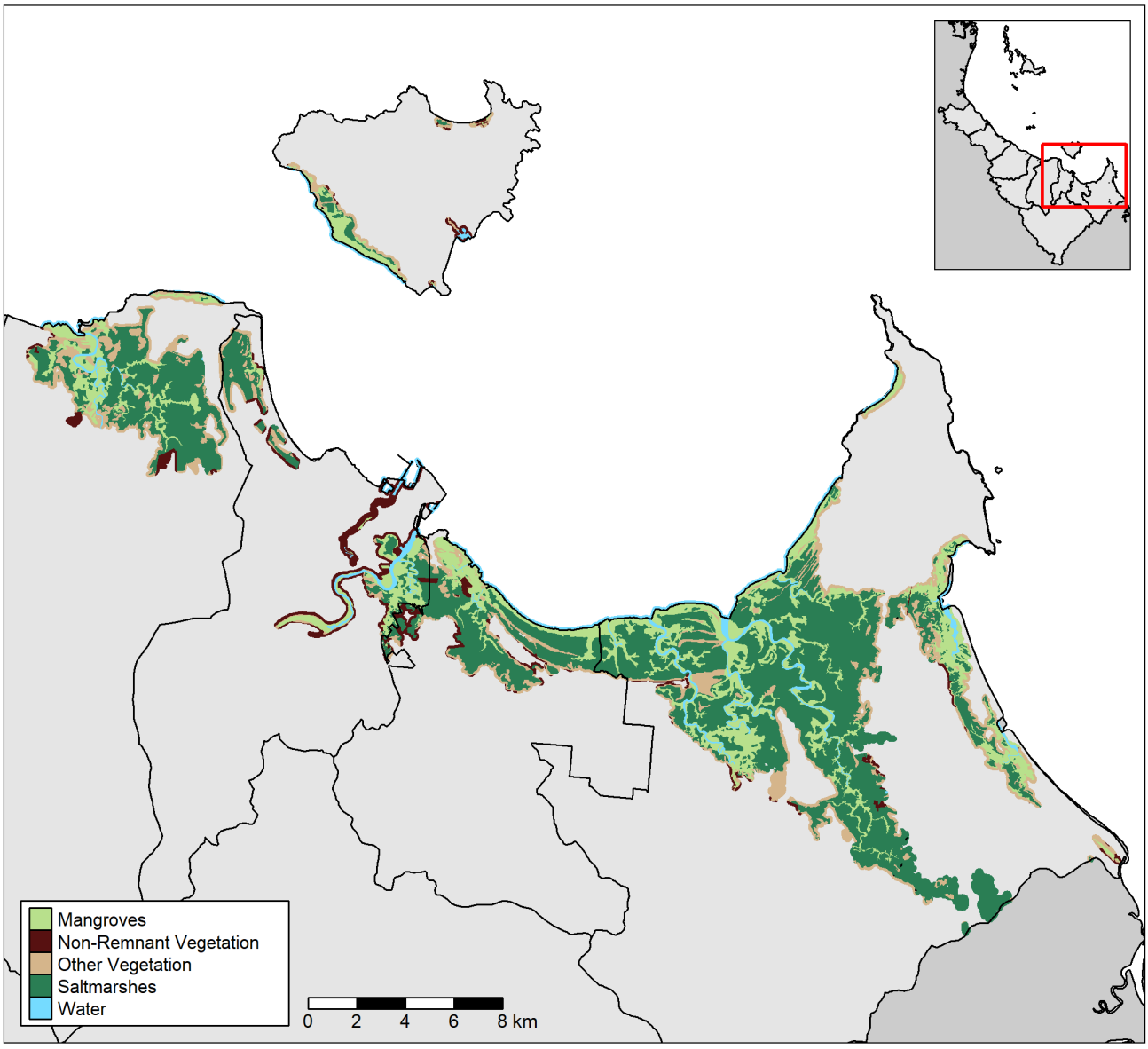

Figure 67. Total area in the Ross Basin of the Dry Tropics region that was assessed for changes in Mangrove and Saltmarsh extent.

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

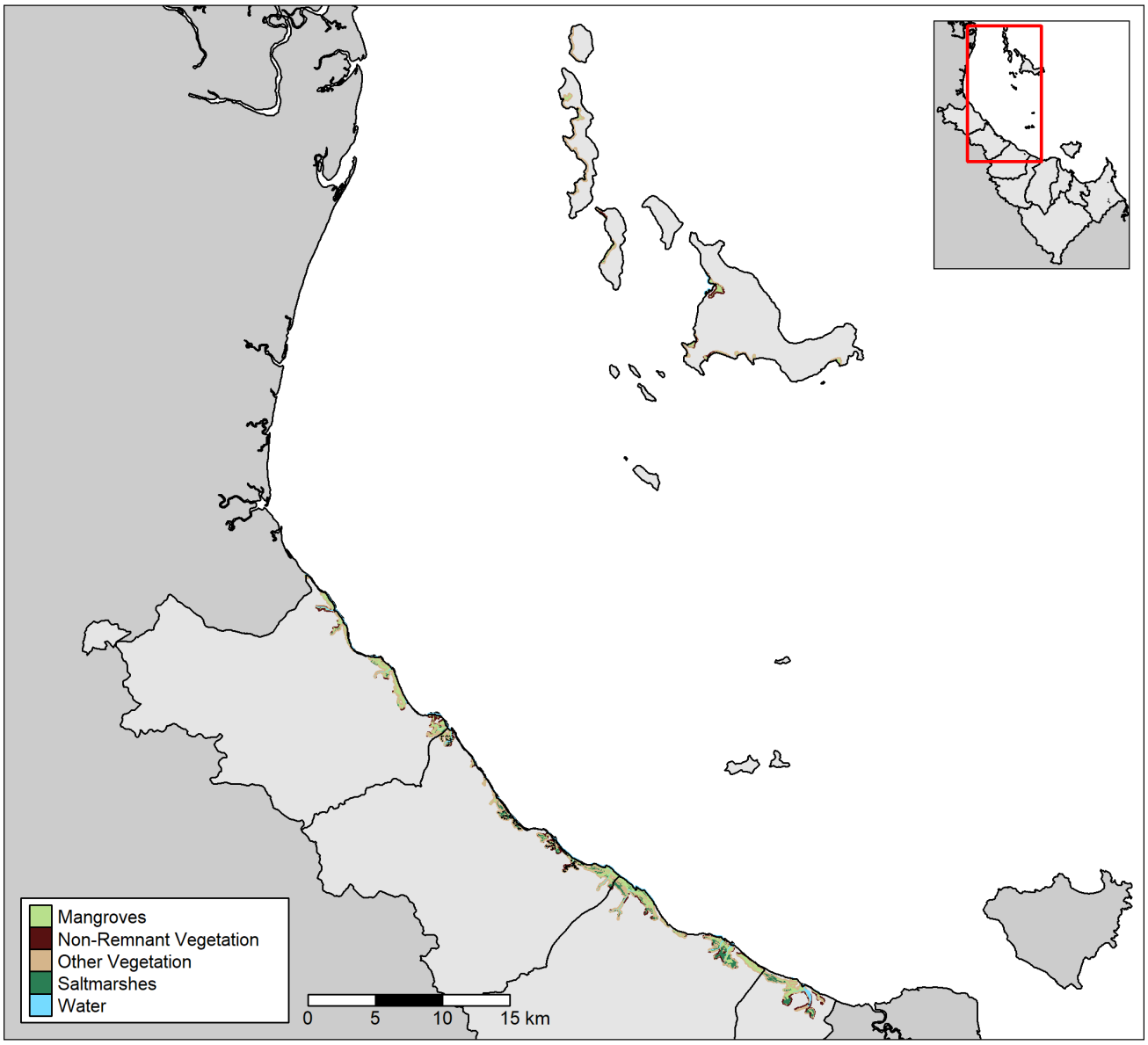

Figure 68. Total area in the Black Basin of the Dry Tropics region that was assessed for changes in Mangrove and Saltmarsh extent.

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

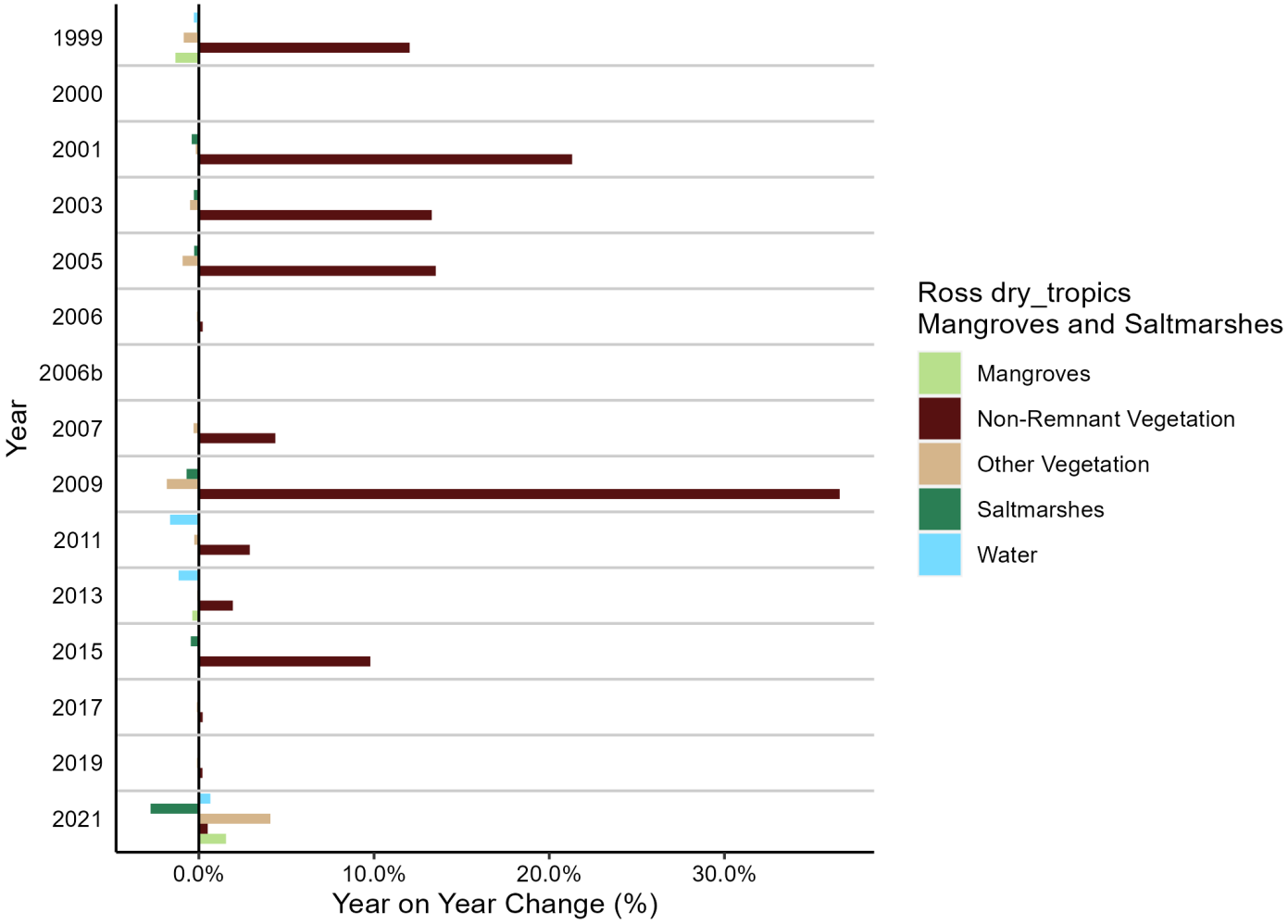

Figure 69. Ross Estuarine Area Mangrove and Saltmarsh Vegetation Change.

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

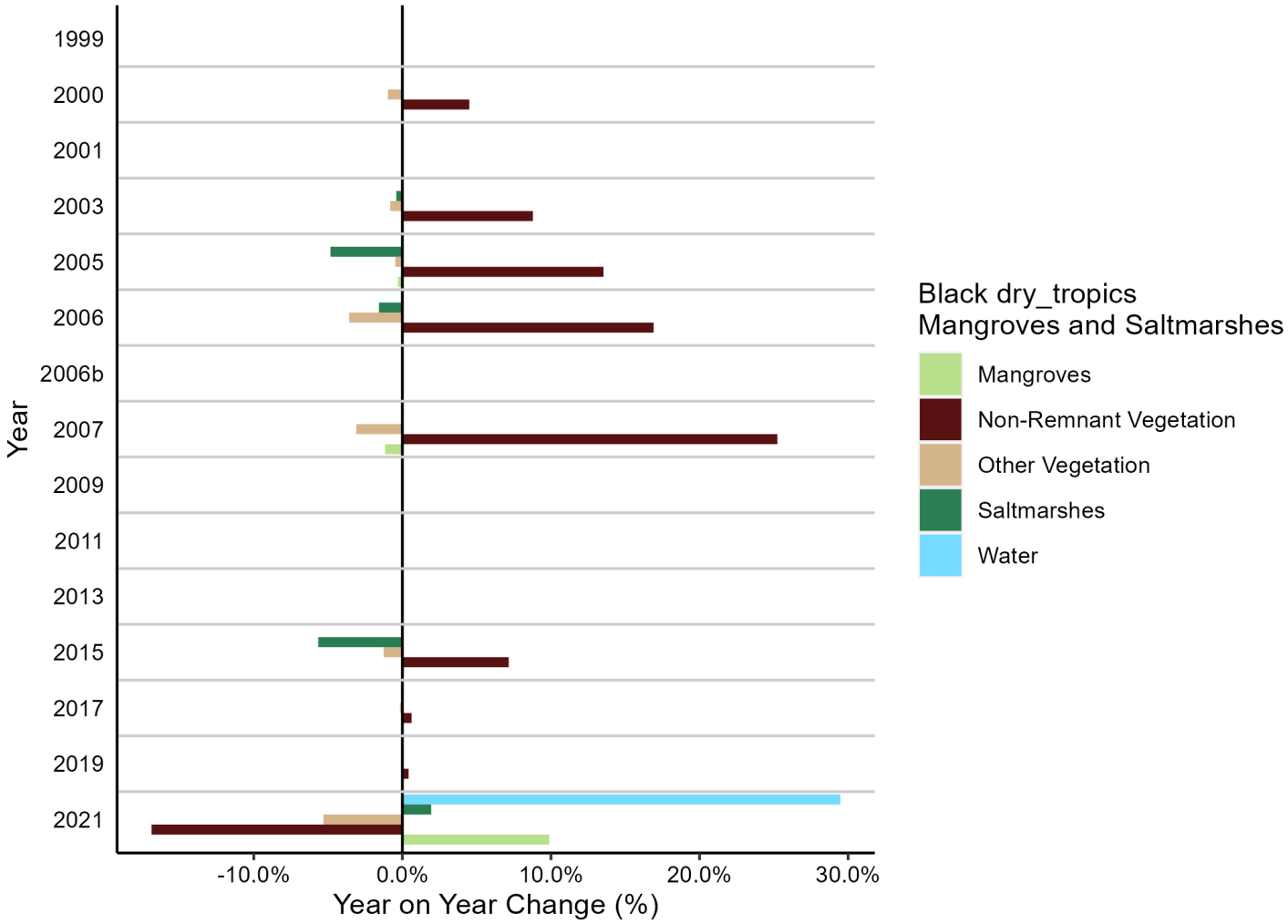

Figure 70. Black Estuarine Area Mangrove and Saltmarsh Vegetation Change.

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

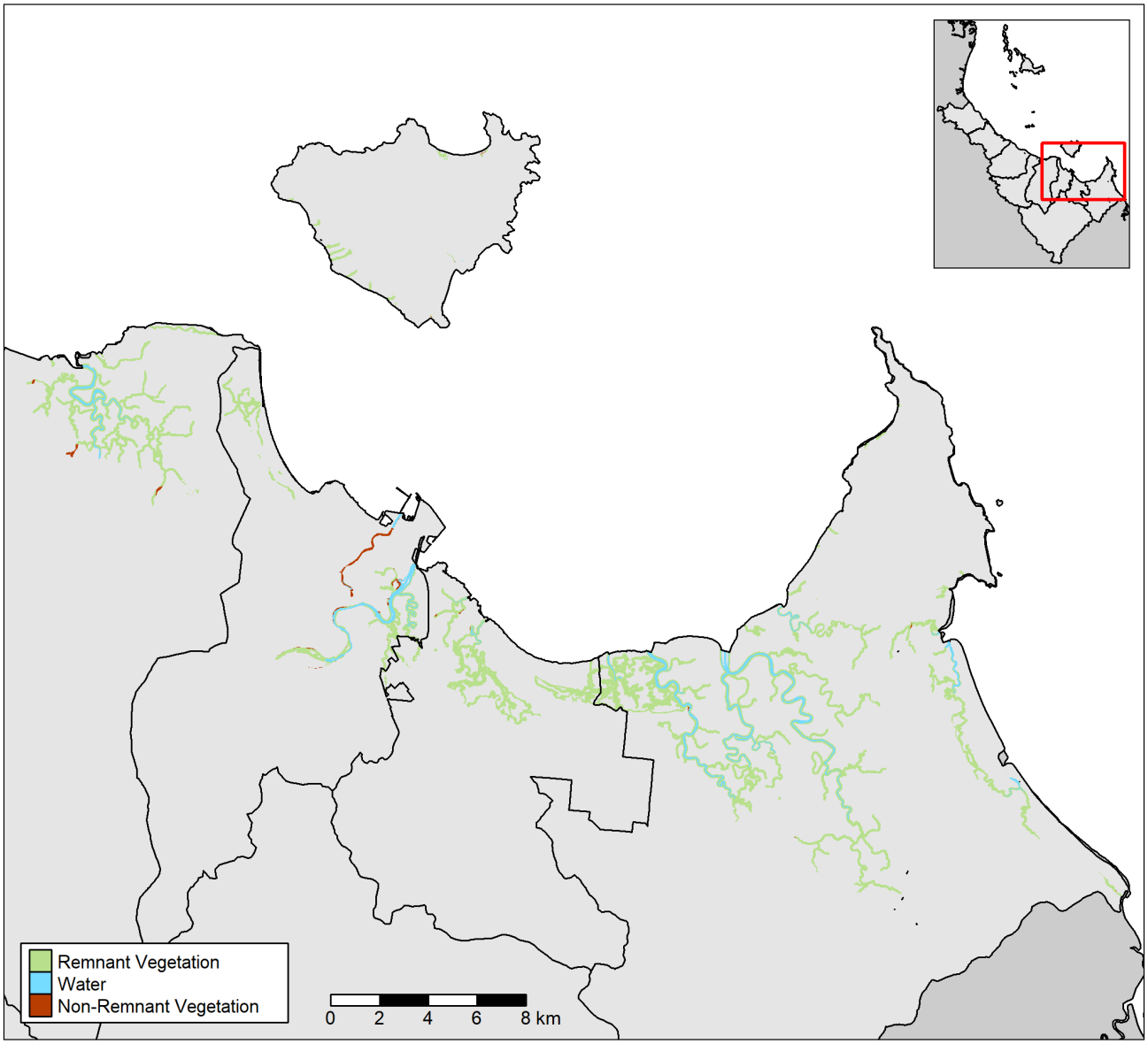

Figure 71. Ross Estuarine Riparian Vegetation Change.

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

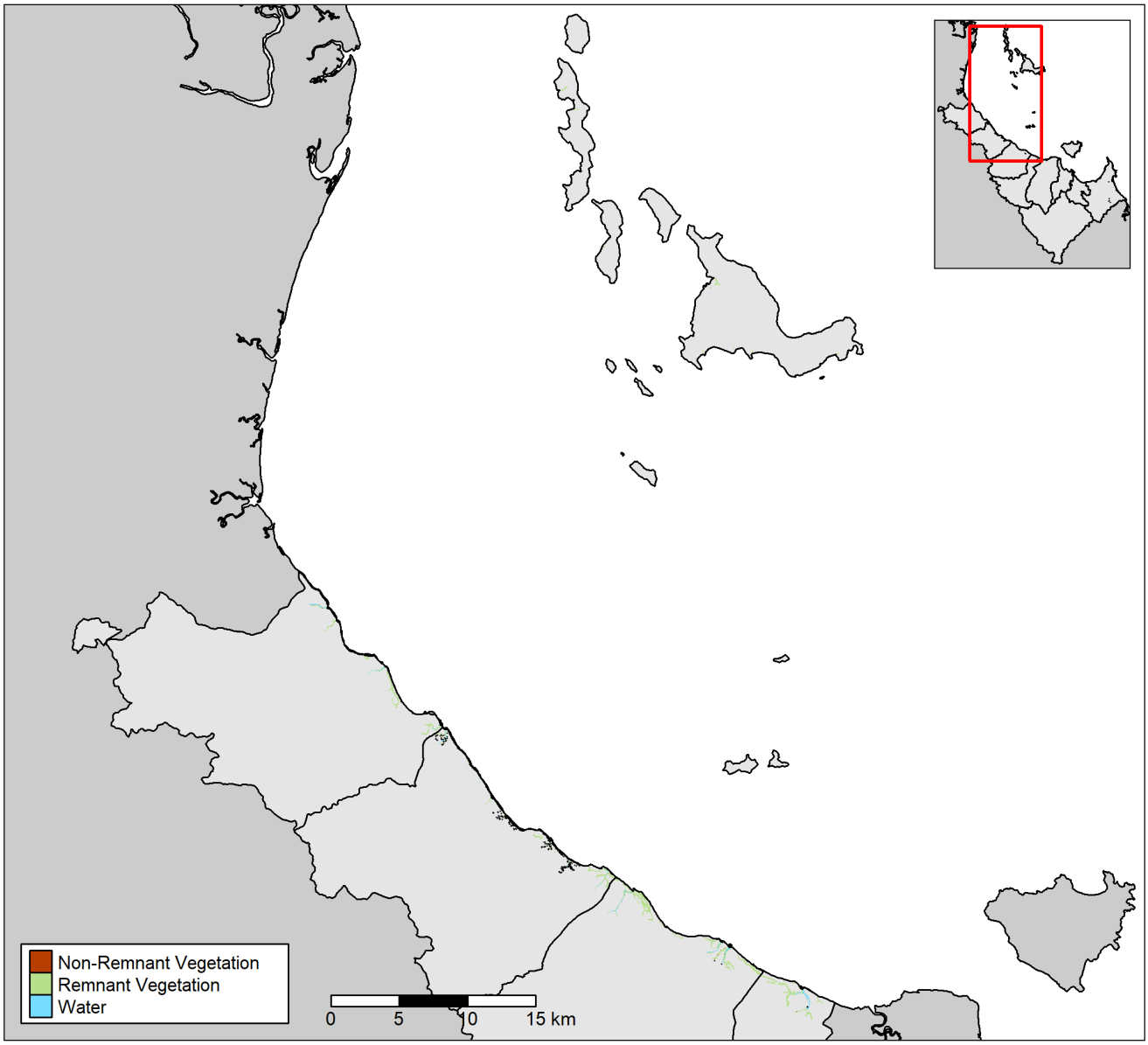

Figure 72. Black Estuarine Riparian Vegetation Change.

Appendix RR. Ross Estuarine Riparian Vegetation Change Over Time

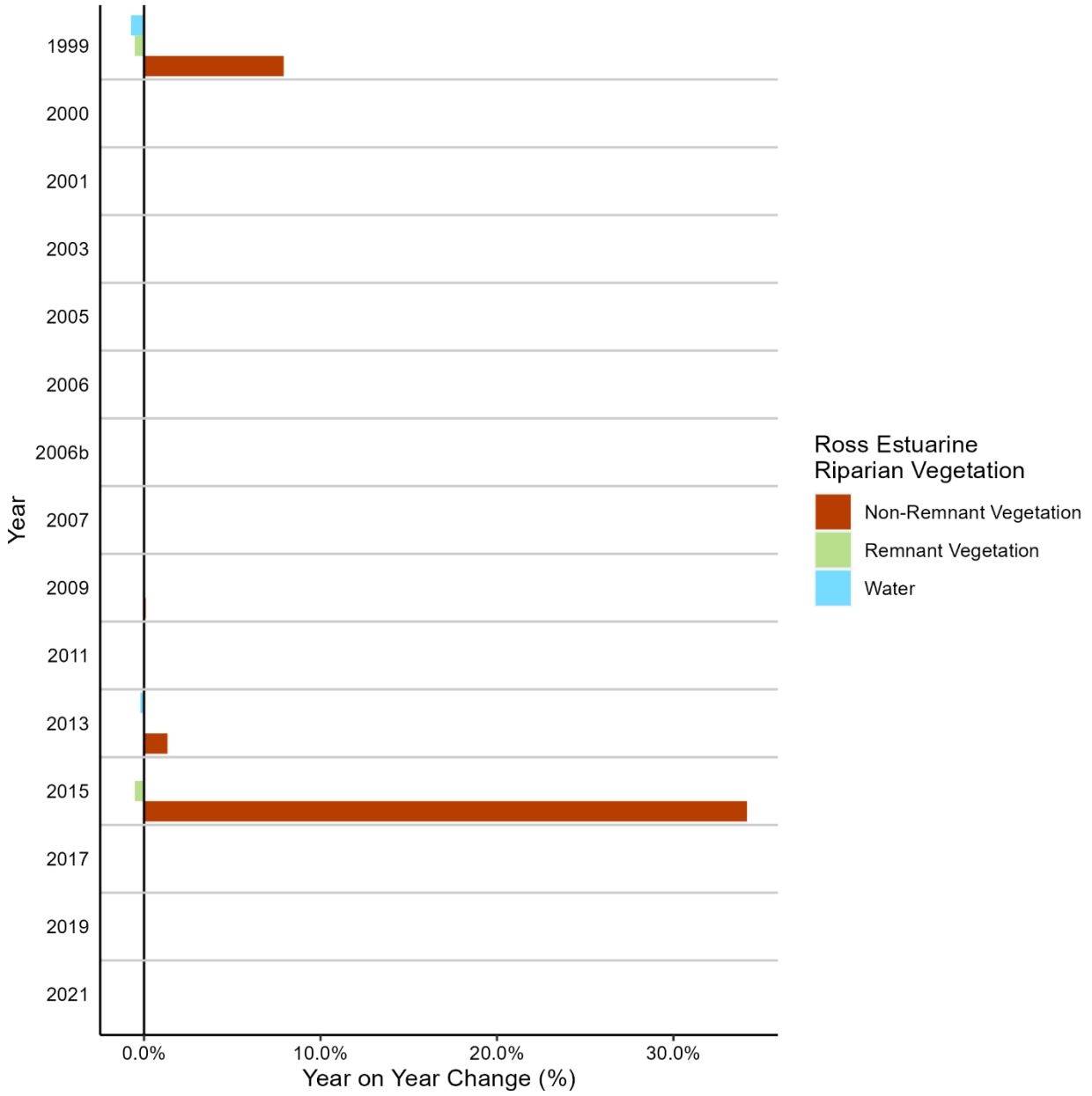

Figure 73. Ross Estuarine riparian vegetation change over time.

Appendix SS. Black Estuarine Riparian Vegetation Change Over Time

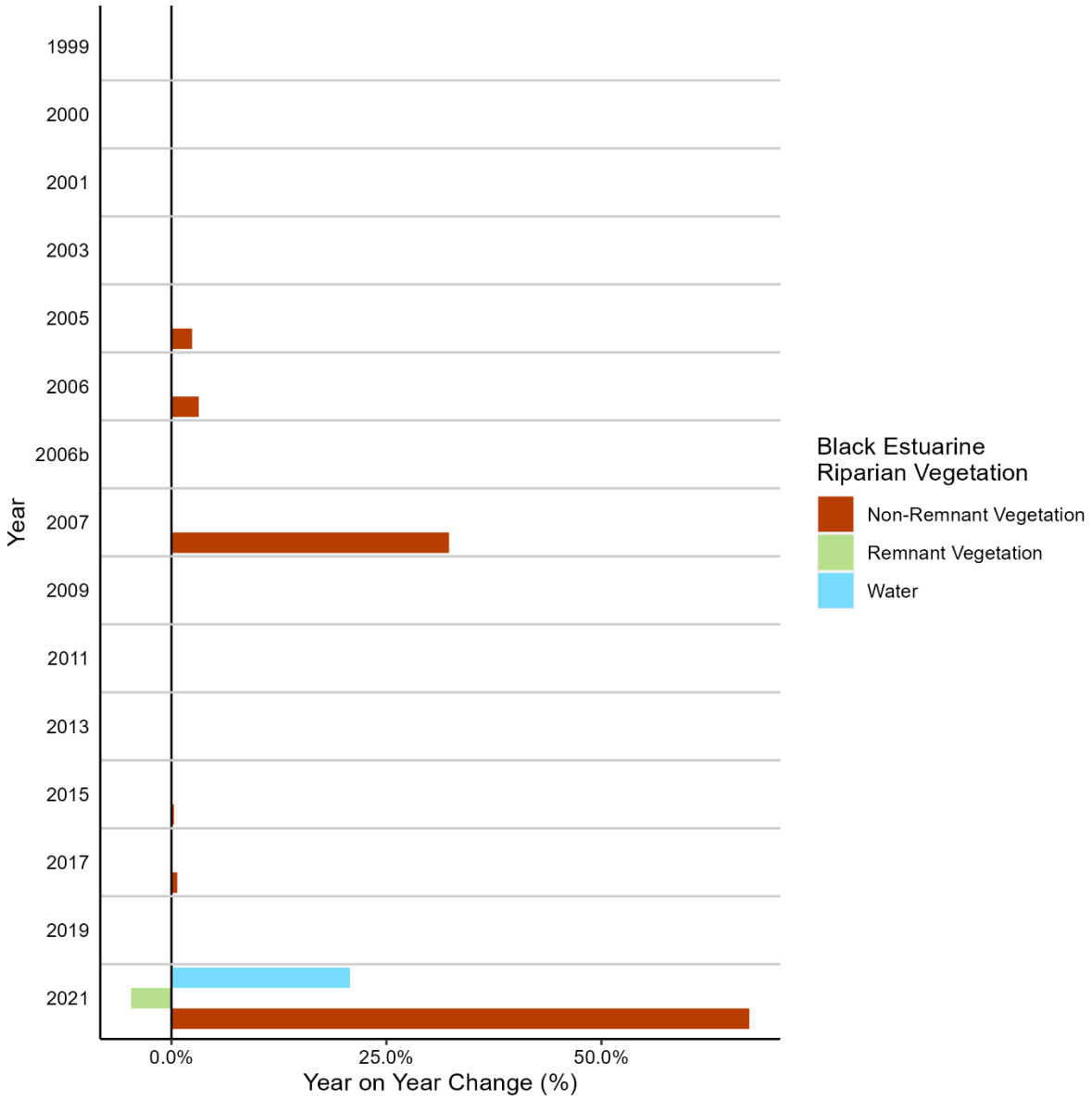

Figure 74. Black Estuarine riparian vegetation change over time.

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

Table 95. 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	6	2	0.001	0.009	ND	ND	ND	ND	ND	ND	ND	ND	12	4	0.0025	0.03
E.C.OPZ	35	10	0.0015	0.009	ND	ND	ND	ND	ND	ND	ND	ND	37	10	0.01	0.03
O.C.IPZ	2	2	0.001	0.009	ND	ND	ND	ND	ND	ND	ND	ND	4	4	0.0025	0.03
O.C.OPZ	4	2	0.001	0.002	ND	ND	ND	ND	ND	ND	ND	ND	8	4	0.0025	0.02
Mag. Is.	9	7	0.0011	0.001	9	7	0.0351	0.021	9	7	0.0035	0.0028	ND	ND	ND	ND
E.C.W	16	8	0.001	0.003	ND	ND	ND	ND	ND	ND	ND	ND	16	8	0.0025	0.02
O.C.W	9	7	0.0008	0.002	9	7	0.0289	0.02	9	7	0.003	0.0028	ND	ND	ND	ND
Mid	9	7	0.0013	0.002	9	7	0.0268	0.02	9	7	0.002	0.0028	ND	ND	ND	ND

Key: = Mean/Median meets the guideline value | = Mean/Median does not meet the guideline value | ND = No Data | - = Not Applicable (data available but not usable).

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

Table 96. Townsville Dry Tropics inshore marine environment historic nutrient indicator scores.

Zone	Sub Zone	Area	NOX					PN					PP					TP				
			23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20
Cleveland Bay	Enclosed Coastal	E.C.IPZ	100	100	100	100	100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	100	100	100	100	100
		E.C.OPZ	100	100	100	94	94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	100	100	100	16	16
			100	100	100	97	97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	100	100	100	58	58
	Open Coastal	O.C.IPZ	100	100	100	100	100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	100	100	100	100	100
		O.C.OPZ	100	-	100	100	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	100	100	100	100	100
			100	100	100	100	100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	100	100	100	100	100
	Magnetic Island	Mag. Is.	57	19	23	0	4	15	8	3	23	13	41	40	36	55	29	ND	ND	ND	ND	ND
			89	79	80	73	74	15	8	3	23	13	41	40	36	55	29	100	100	100	79	79
Halifax Bay	Enclosed Coastal	E.C.W	100	100	100	100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	100	100	100	100	ND
	Open Coastal	O.C.W	100	100	97	75	36	28	32	18	33	0	56	63	76	38	66	ND	ND	ND	ND	ND
	Midshelf	Midshelf	85	100	55	94	19	35	25	32	27	0	79	71	82	73	64	ND	ND	ND	ND	ND
			95	100	84	90	28	32	29	25	30	0	67	67	79	55	65	100	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 | - = Not Applicable (data available but not usable) | X = Data was not updated this year.

Appendix VV. Inshore Marine Water Quality Phys-Chem and Chlorophyll *a*: Sample Frequencies, Means, Medians, and WQOs

Table 97. Number of samples, mean, median, and water quality objective values for physical-chemical properties and Chlorophyll a indicators in the Townsville Dry Tropics Inshore Marine Environment.

Area	Turbidity (NTU)				TSS (mg/L)				Secchi (m)[14]				Chlorophyll a (ug/L)			
	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	4.695	4.9	12	4	10.4167	22	9	3	2.1489	1	ND	ND	ND	ND
E.C.OPZ	37	10	16.9	4.9	37	10	28.7838	15	3	3	2.2867	1	33	10	2.4727	2.6
O.C.IPZ	4	4	3.21	4.9	4	4	7.875	22	3	3	1.98	1	ND	ND	ND	ND
O.C.OPZ	331	12	7.3632	3	8	4	5.375	10	6	3	2.7883	3	ND	ND	ND	ND
Mag. Is.	533	12	2.4003	2.7	9	7	1.9031	3.7	9	7	3.7111	3	375	12	0.5933	0.84
E.C.W	16	8	7.11	6	16	8	13.6562	15	ND	ND	ND	ND	16	8	1	2
O.C.W	288	11	1.1666	1.5	8	6	1.7178	2	9	7	5.1222	10	297	11	0.5674	0.45
Mid	361	12	0.7688	1.5	8	6	0.8709	2	9	7	7.4889	10	370	12	0.5976	0.45

Key: ■ = Mean/Median meets the guideline value | ■ = Mean/Median does not meet the guideline value | ND = No Data | - = Not Applicable (data available but not usable).

[14] 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 WW. Inshore Marine Water Quality Physical-Chemical Properties and Chlorophyll *a* Historic Comparison

Table 98. Townsville Dry Tropics inshore marine environment historic physical-chemical and Chlorophyll a indicator scores.

Zone	Sub Zone	Area	Turbidity					TSS					Secchi					Chlorophyll *a*				
			23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20	23-24	22-23	21-22	20-21	19-20
Cleveland Bay	Enclosed Coastal	E.C.IPZ	63	28	100	89	74	100	85	100	85	100	100	60	92	93	78	ND	ND	ND	ND	ND
		E.C.OPZ	0	0	0	0	0	3	0	3	20	14	100	63	83	100	78	63	90	81	63	100
			31	14	50	44	37	51	43	51	52	57	100	62	87	96	78	63	90	81	63	100
	Open Coastal	O.C.IPZ	84	66	100	100	100	100	44	100	98	100	99	72	100	100	100	ND	ND	ND	ND	ND
		O.C.OPZ	0	30	38	15	63	95	3	54	76	81	54	0	39	56	47	ND	ND	ND	ND	ND
			42	48	69	57	81	97	24	77	87	90	77	36	69	78	73	ND	ND	ND	ND	ND
	Magnetic Island	Mag. Is.	67	89	77	73	78	98	100	85	85	100	73	85	80	83	77	80	84	83	83	80
			43	42	65	58	63	79	46	71	73	79	85	56	78	86	76	72	87	82	73	90
Halifax Bay	Enclosed Coastal	E.C.W	46	88	58	100	ND	66	88	74	84	ND	ND	ND	ND	ND	ND	100	100	100	100	ND
	Open Coastal	O.C.W	75	82	77	73	89	69	86	72	63	92	2	11	6	29	6	40	61	74	69	66
	Midshelf	Midshelf	98	100	100	93	100	100	100	77	92	100	36	41	30	21	1	36	43	53	60	69
			73	90	78	88	94	78	91	74	80	96	19	26	18	25	3	59	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 | - = Not Applicable (data available but not usable) | X = Data was not updated this year.

Appendix XX. Inshore Marine Water Quality 2021–2022 Boxplots

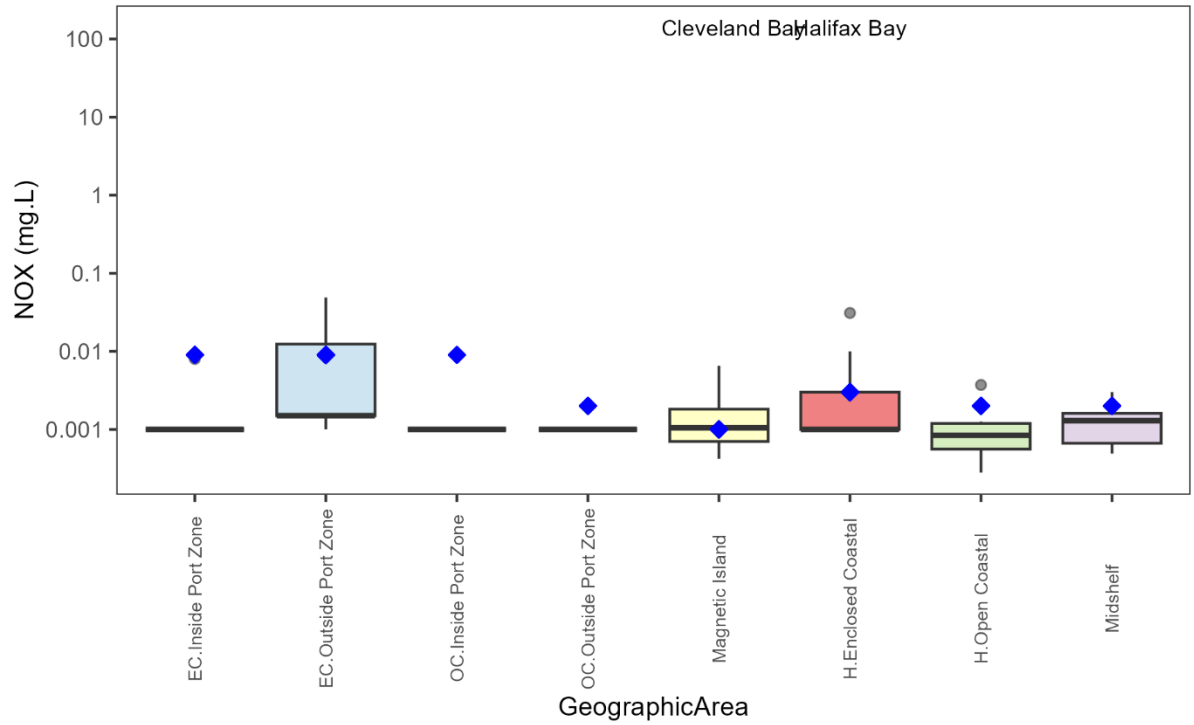

Figure 76. Nitrogen Oxides (NOX) (mg/L) Boxplot: blue diamonds indicate the water quality objective.

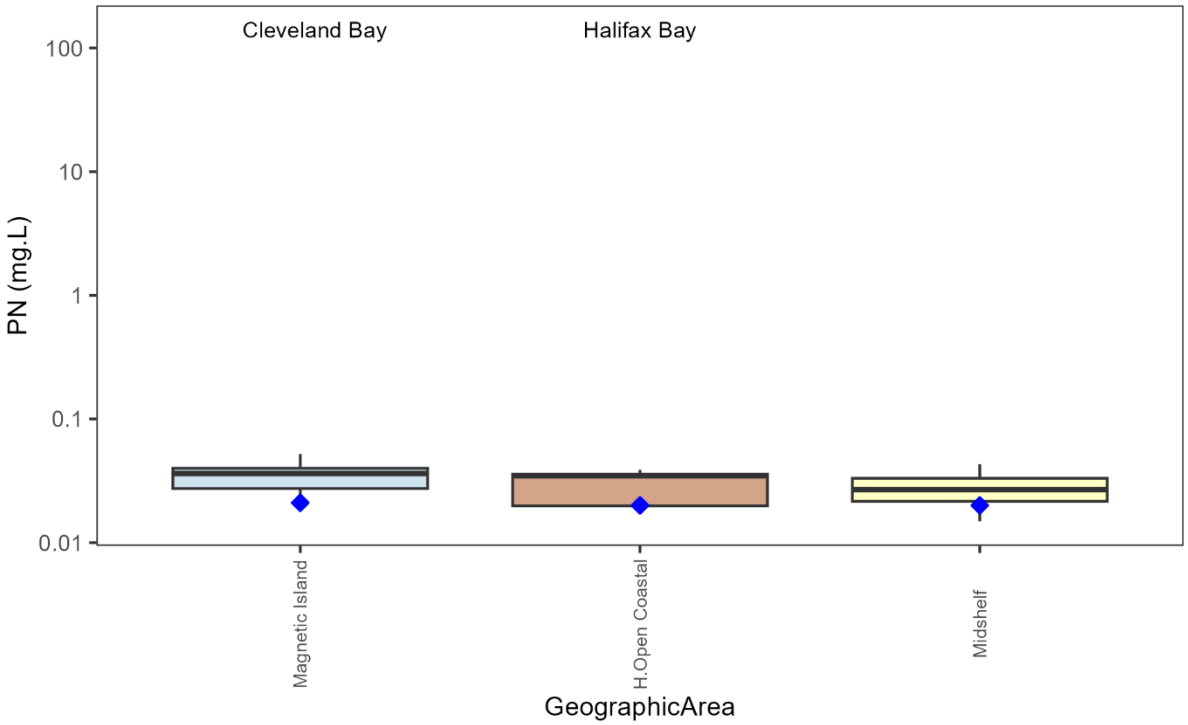

Figure 75. Particulate Nitrogen (PN) (mg/L) Boxplot: blue diamonds indicate the water quality objective.

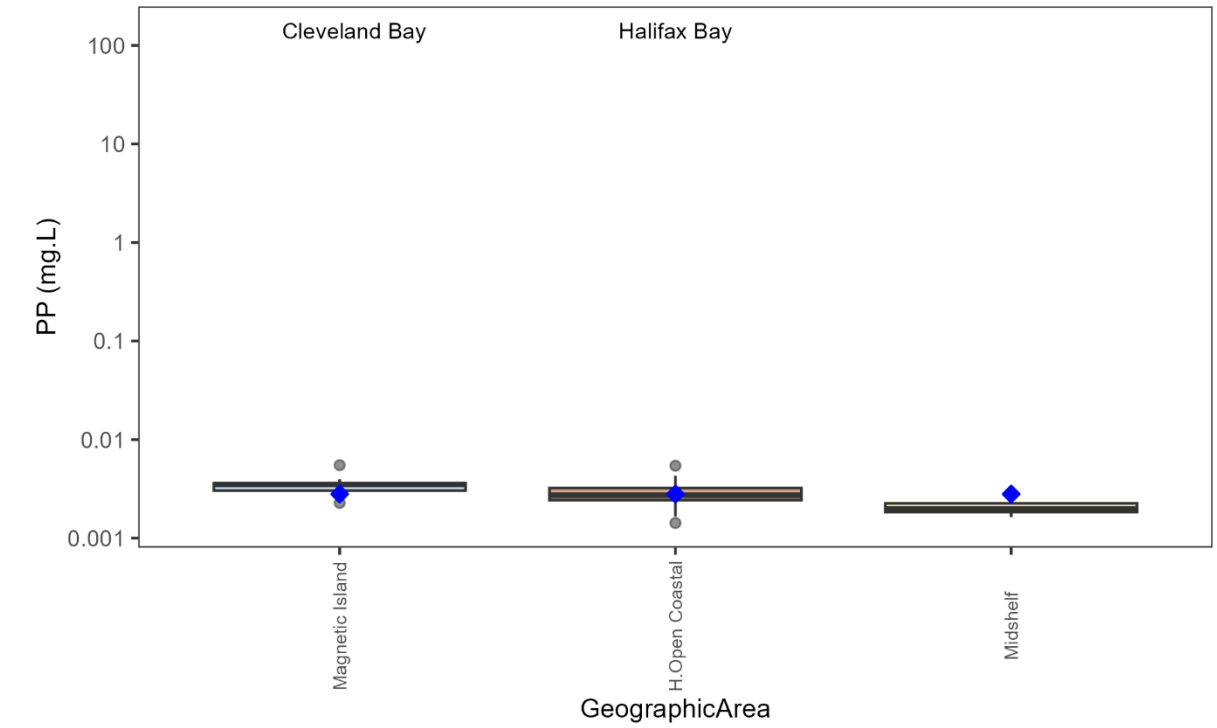

Figure 78. Particulate Phosphorus (PP) (mg/L) Boxplot: blue diamonds indicate the water quality objective.

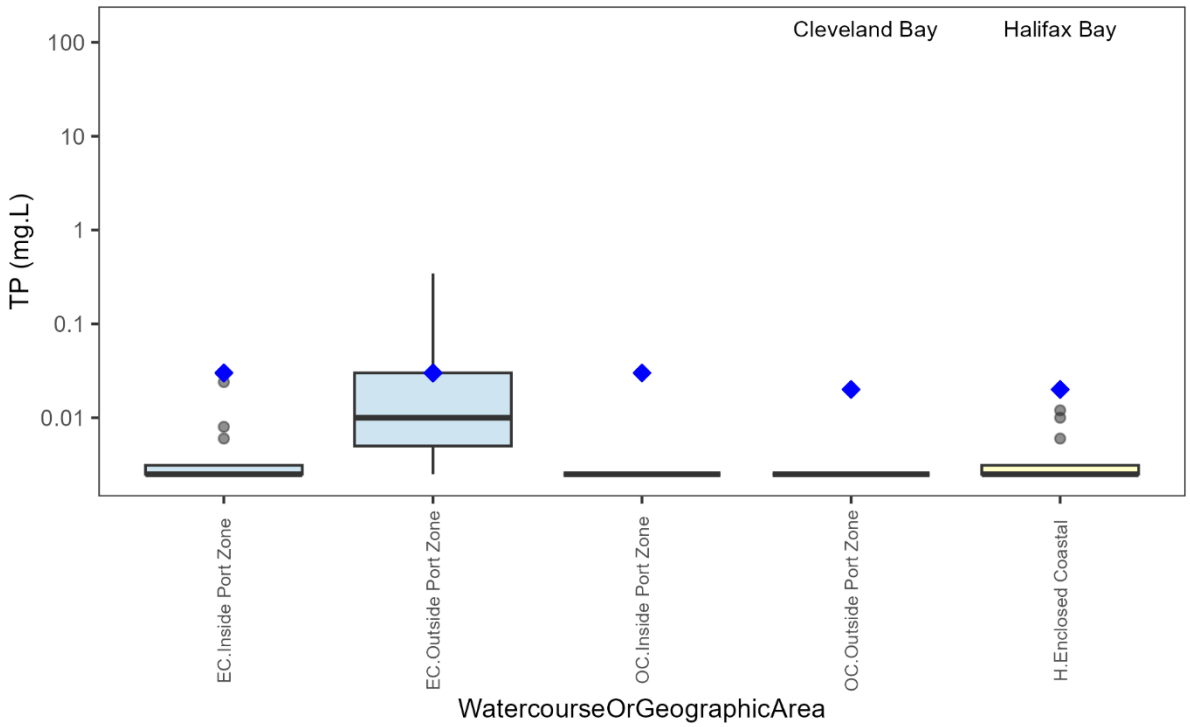

Figure 77. Total Phosphorus (TP) (mg/L) Boxplot: blue diamonds indicate the water quality objective.

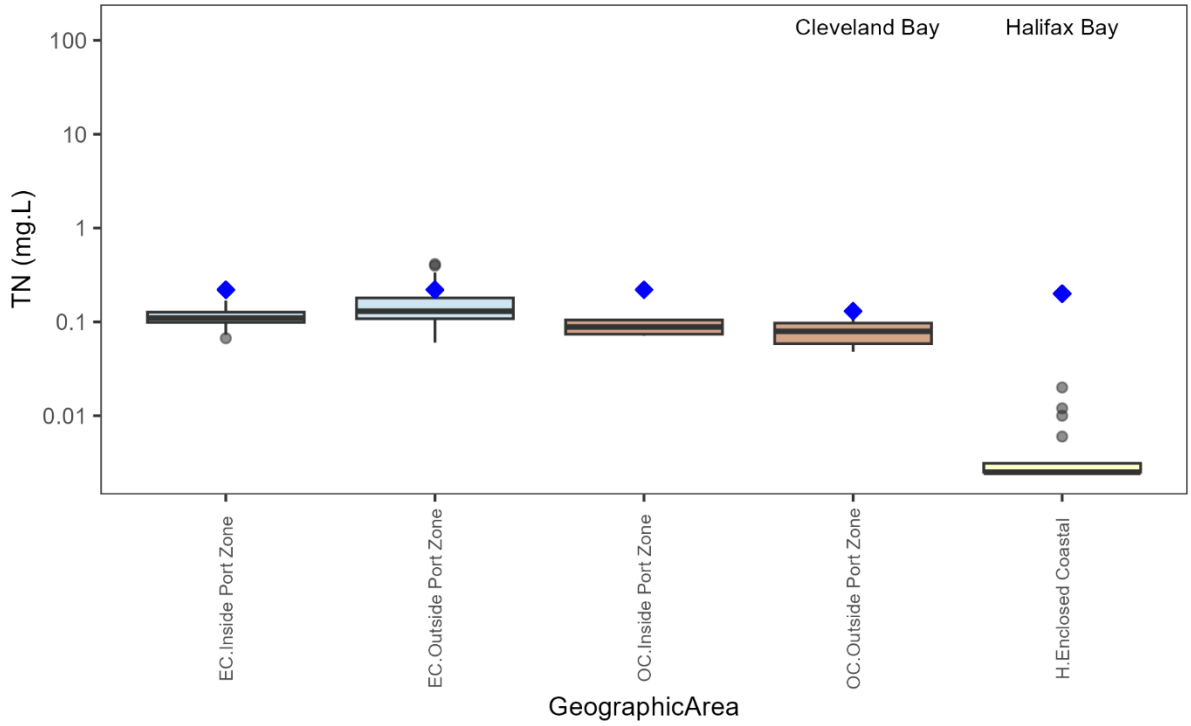

Figure 80. Total Nitrogen (TN) (mg/L) Boxplot: blue diamonds indicate the water quality objective.

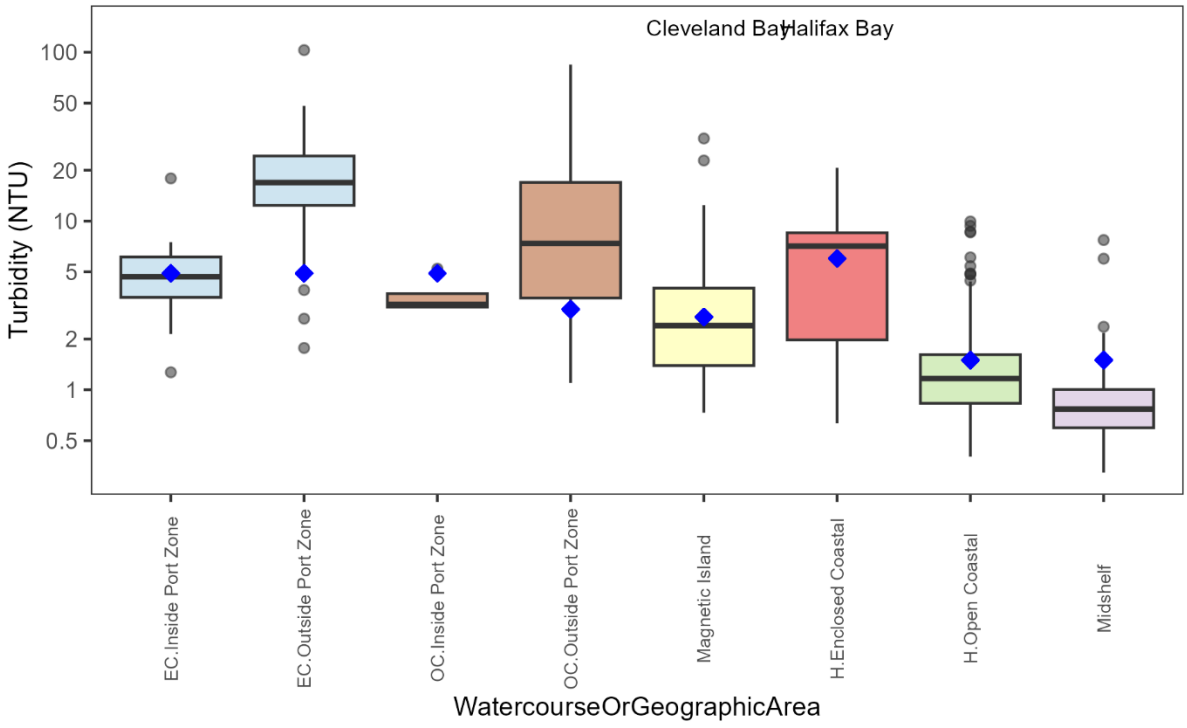

Figure 79. Turbidity (NTU) Boxplot: blue diamonds indicate the water quality objective.

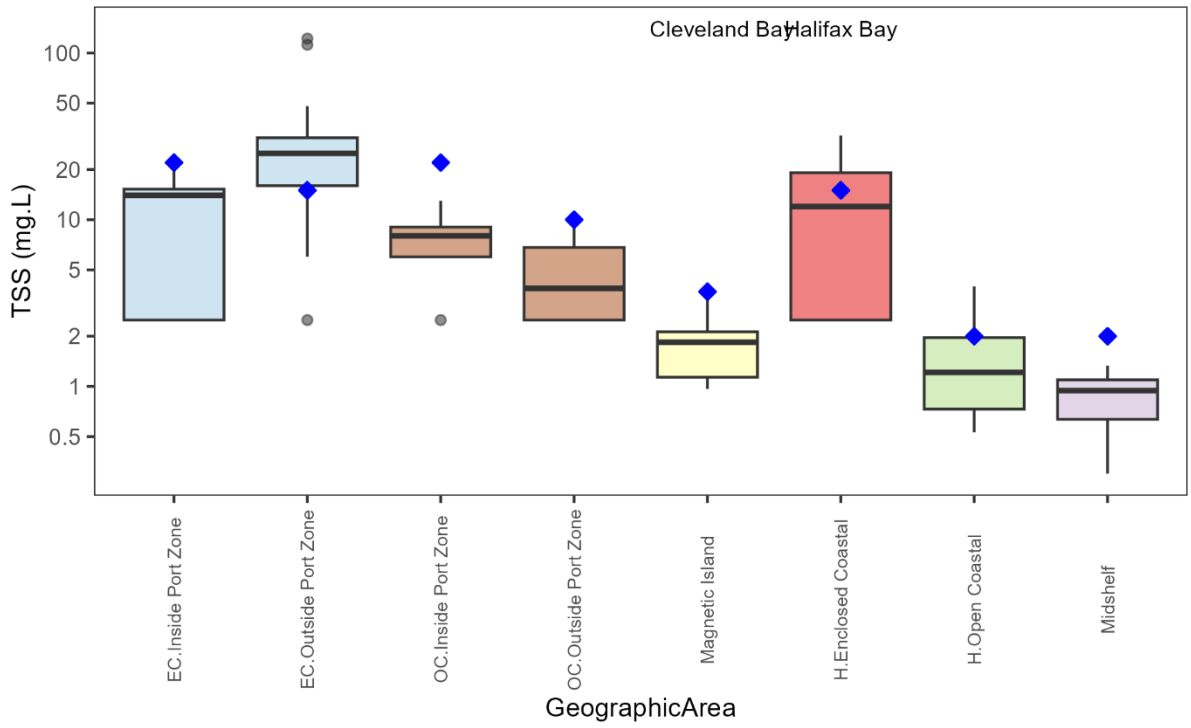

Figure 82. Total Suspended Solids (TSS) (mg/L) Boxplot: blue diamonds indicate the water quality objective.

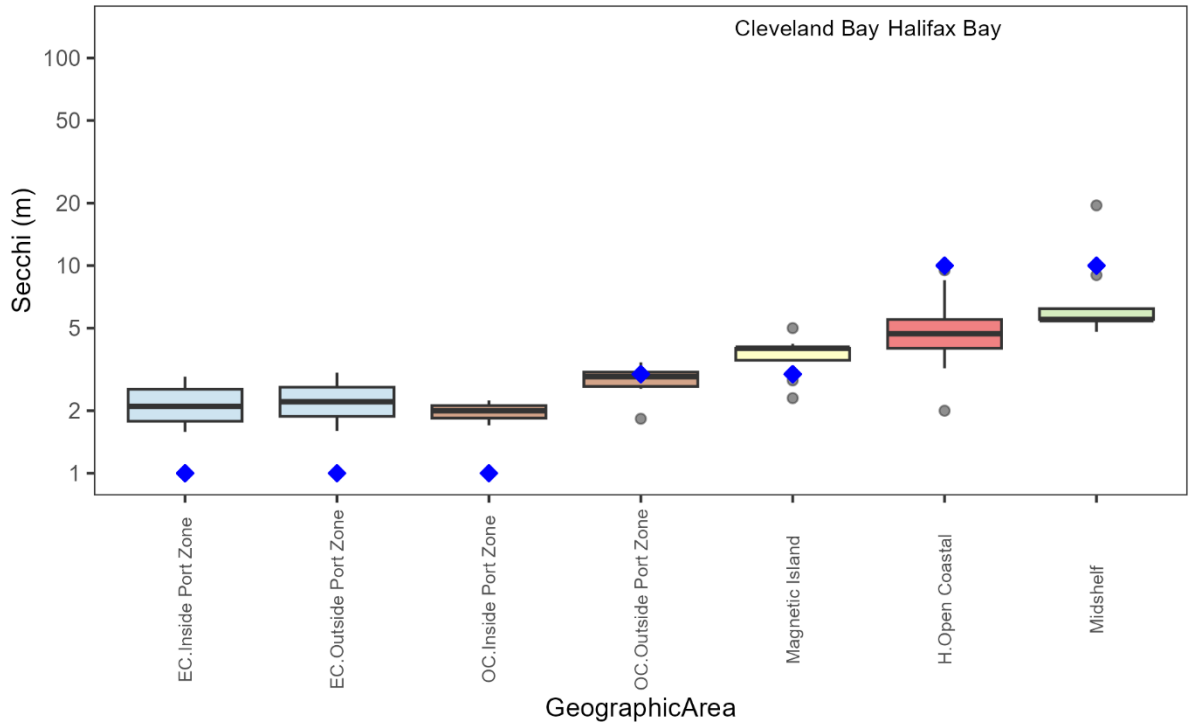

Figure 81. Secchi Depth (m) Boxplot: blue diamonds indicate the water quality objective.

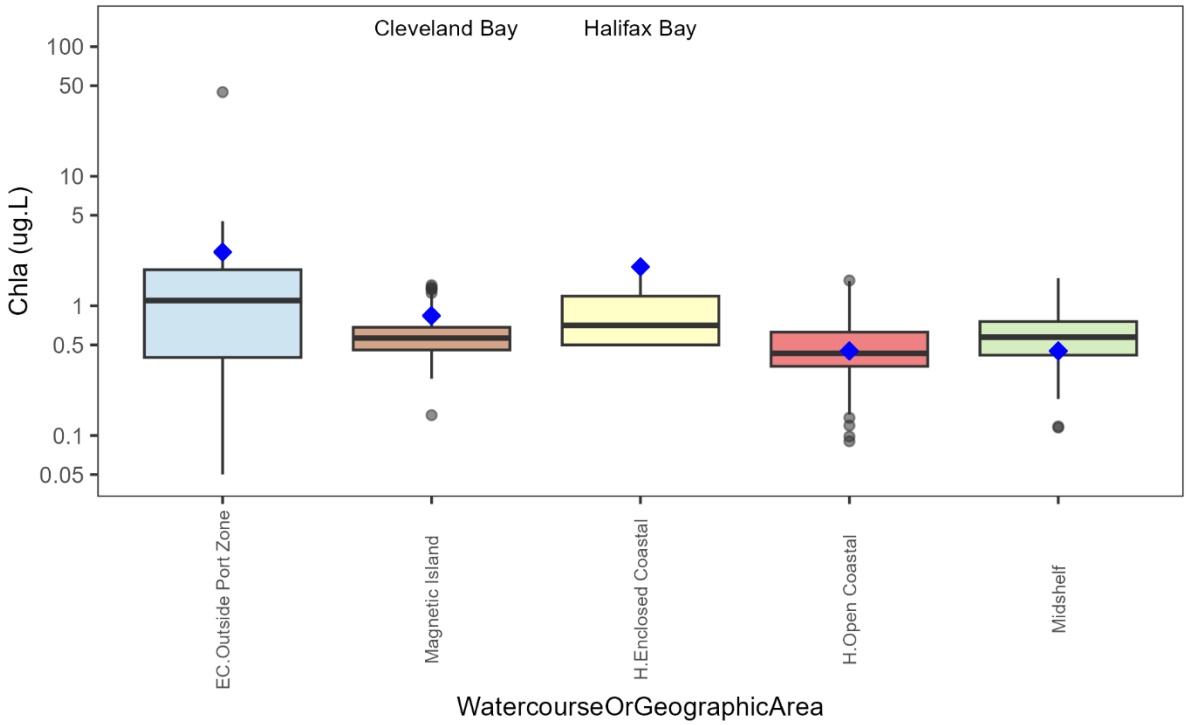

Figure 83. Chlorophyll a (ug.L) Boxplot: blue diamonds indicate the water quality objective.

Appendix YY. Inshore Marine Water Quality Line Plots

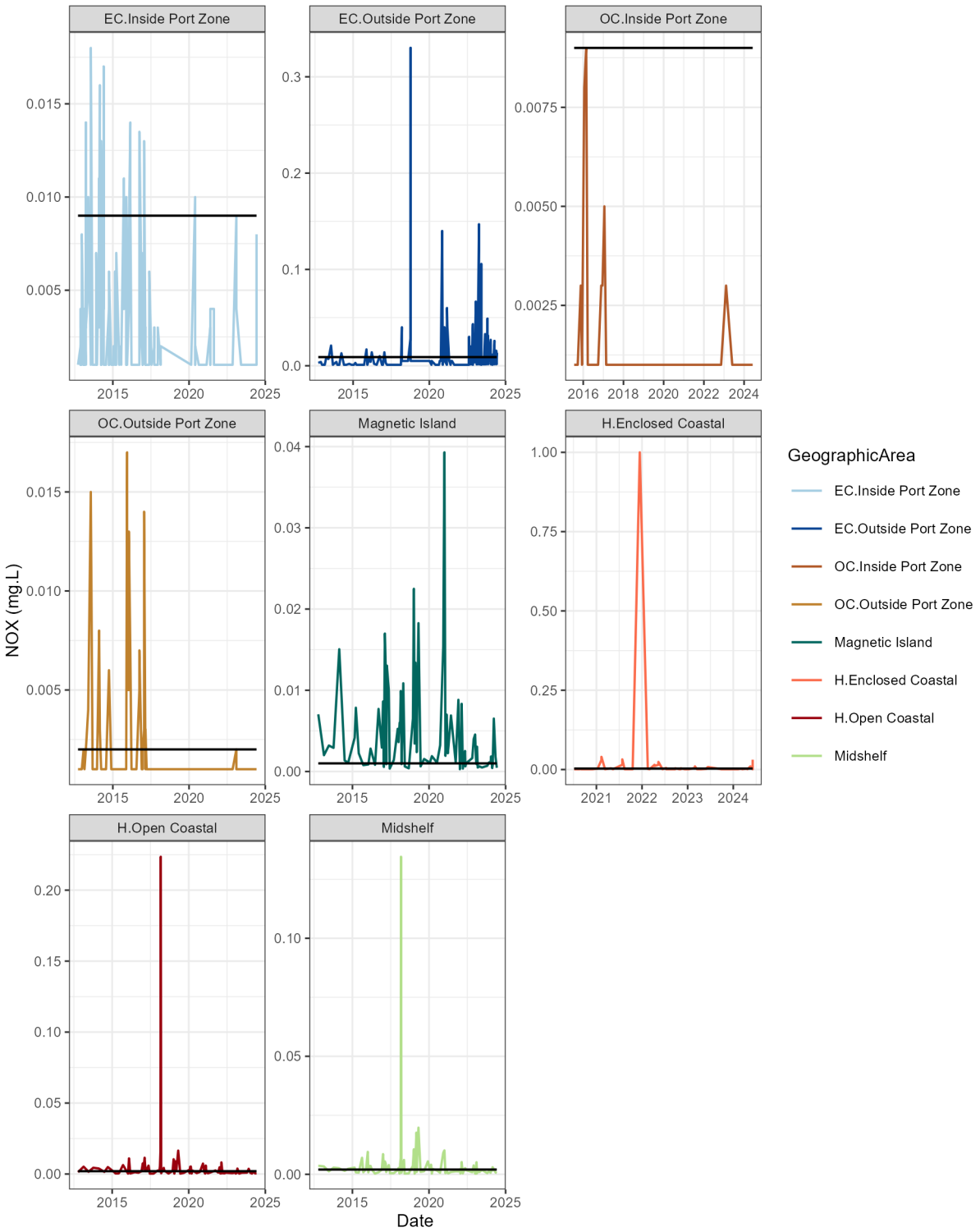

Figure 84. Dry Tropics inshore marine water quality line plots: NOx. The black line indicates water quality guidelines.

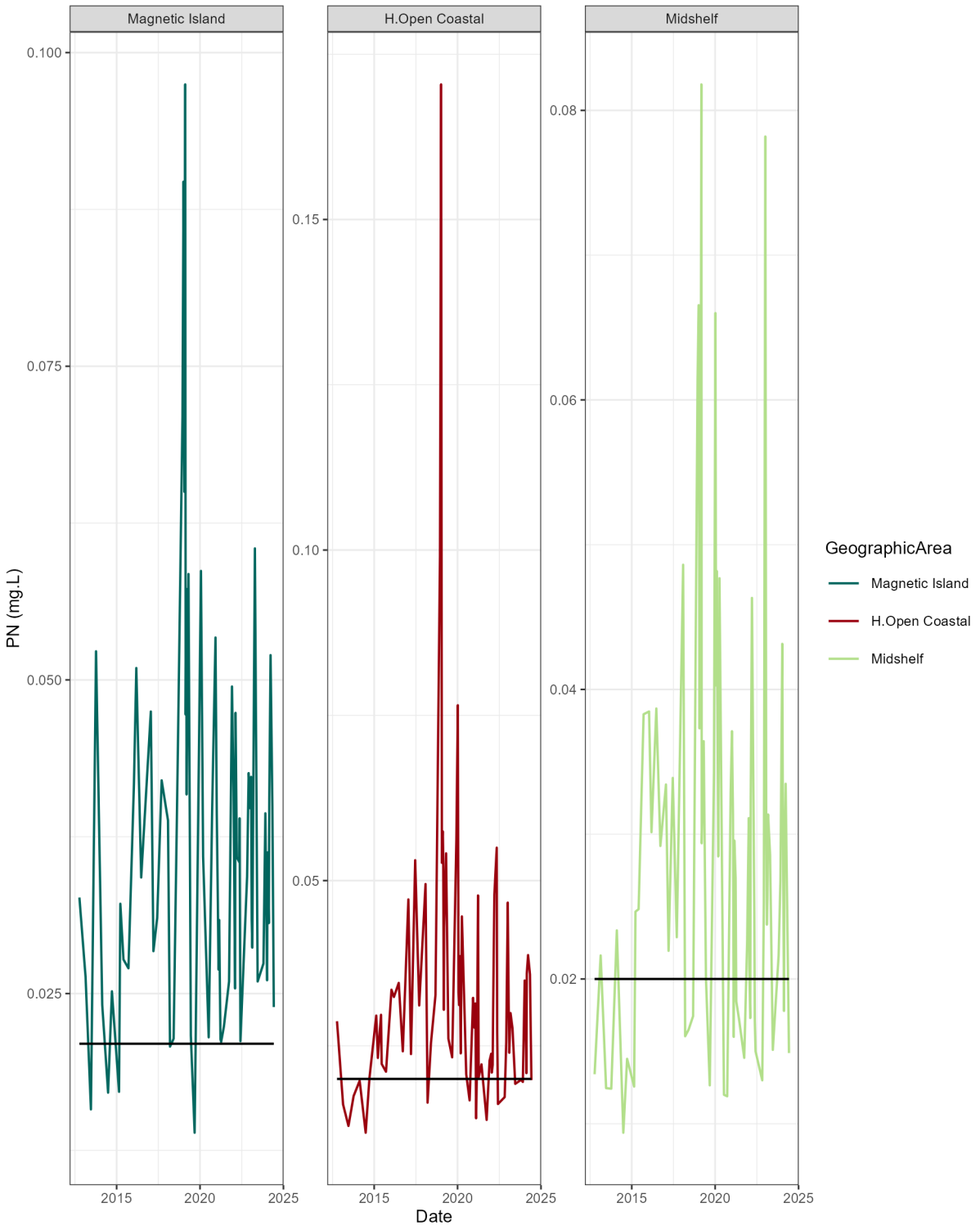

Figure 85. Dry Tropics inshore marine water quality line plots: PN. The black line indicates water quality guidelines.

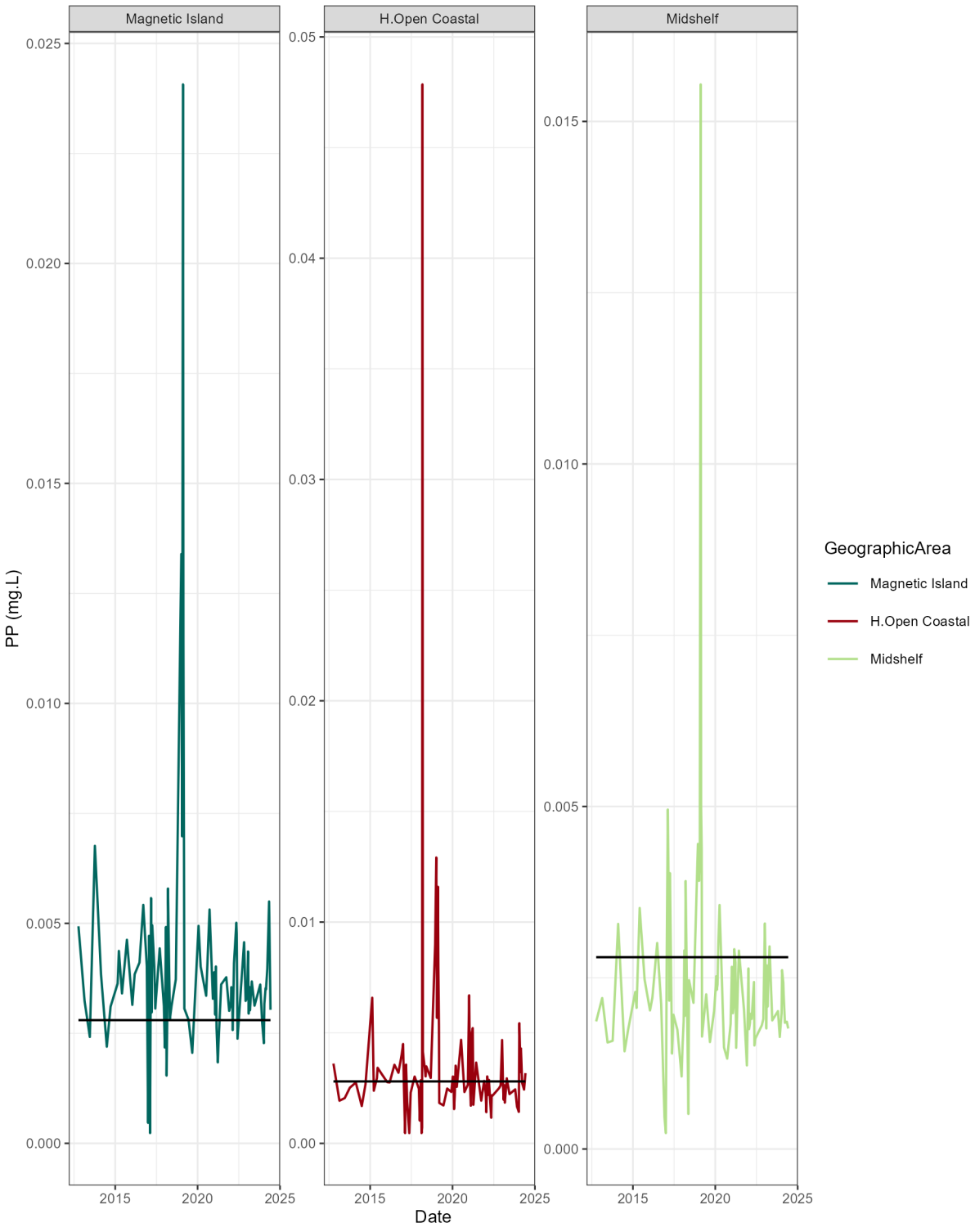

Figure 86. Dry Tropics inshore marine water quality line plots: PP. The black line indicates water quality guidelines.

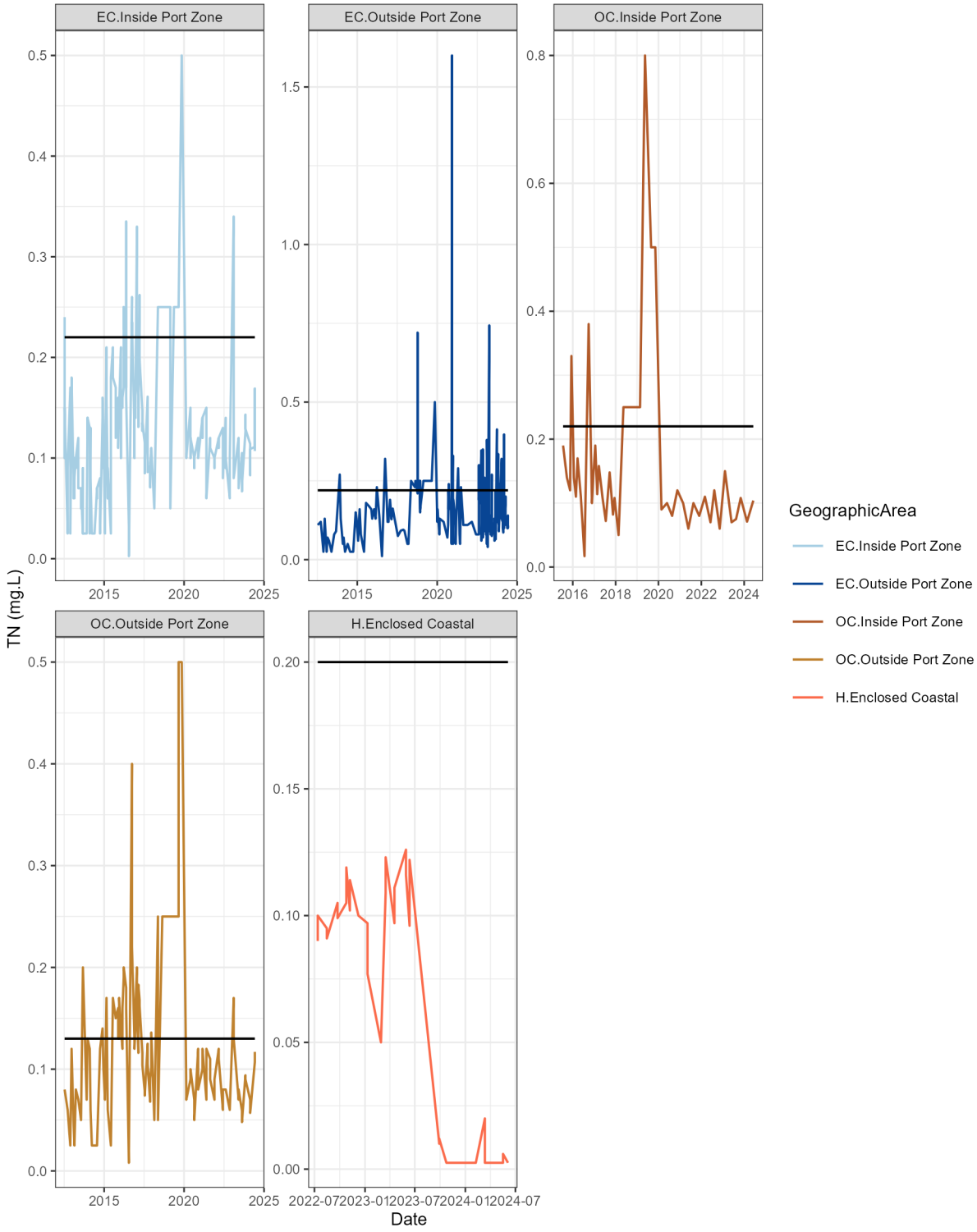

Figure 87. Dry Tropics inshore marine water quality line plots: TN. The black line indicates water quality guidelines.

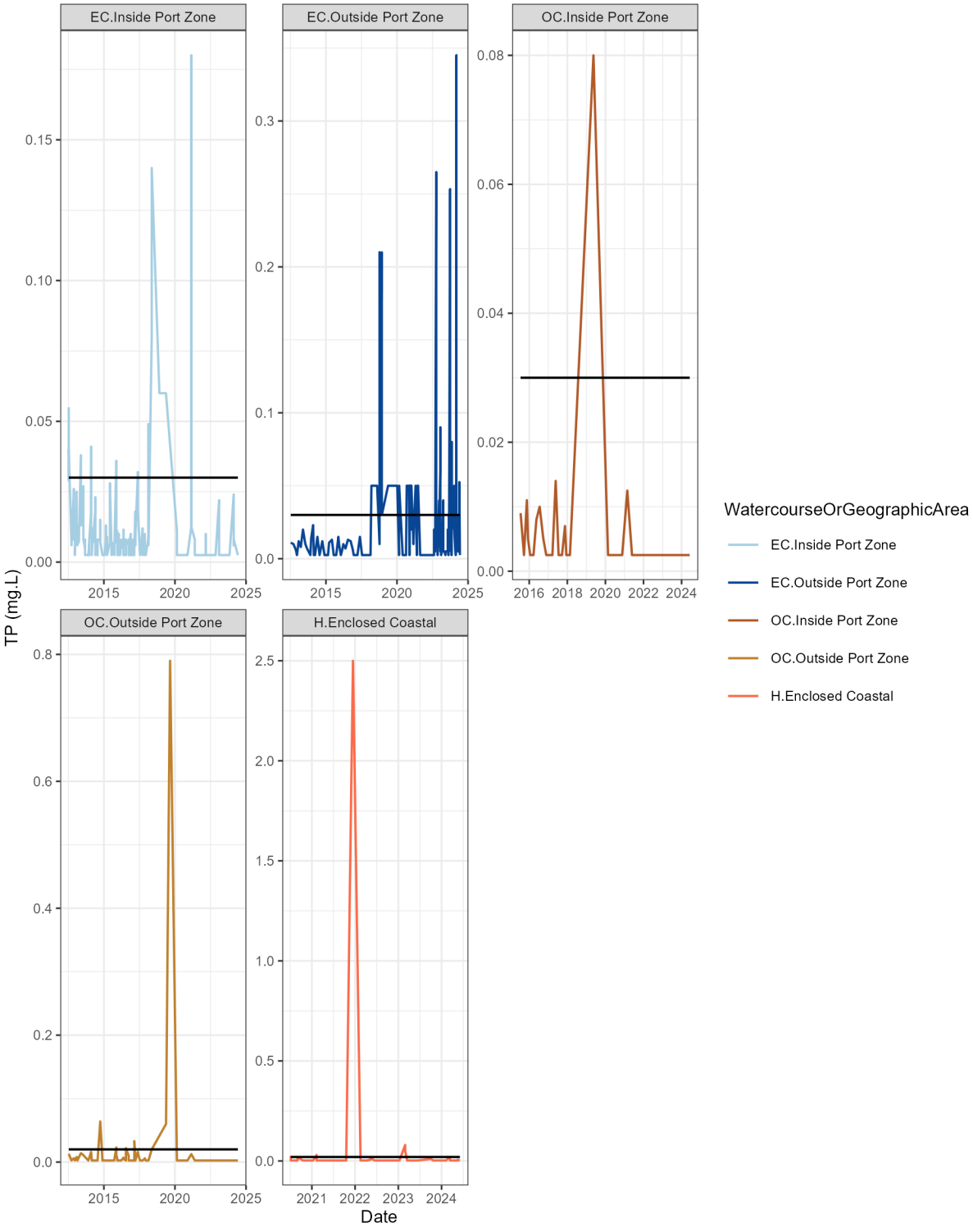

Figure 88. Dry Tropics inshore marine water quality line plots: TP. The black line indicates water quality guidelines.

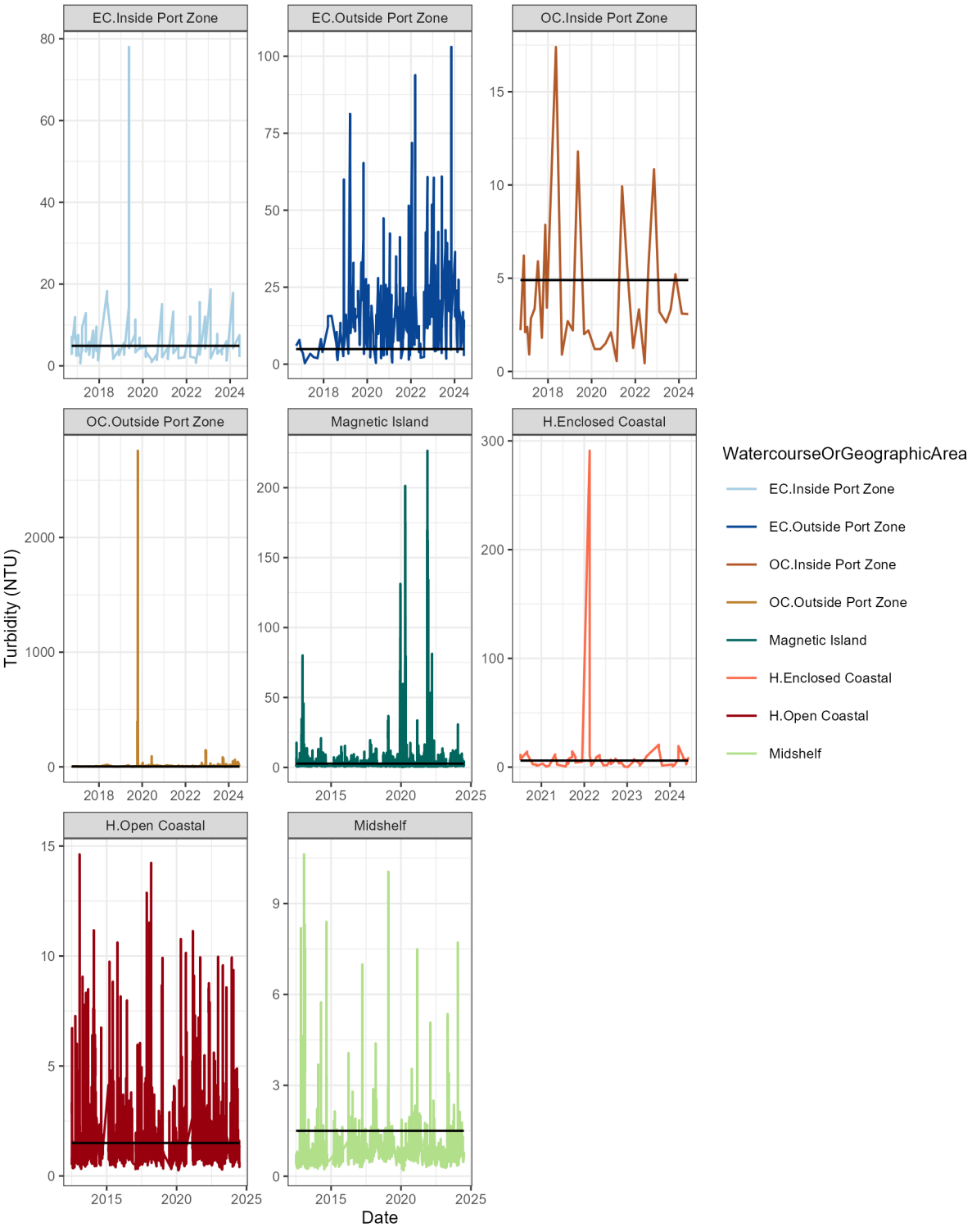

Figure 89. Dry Tropics inshore marine water quality line plots: NTU. The black line indicates water quality guidelines.

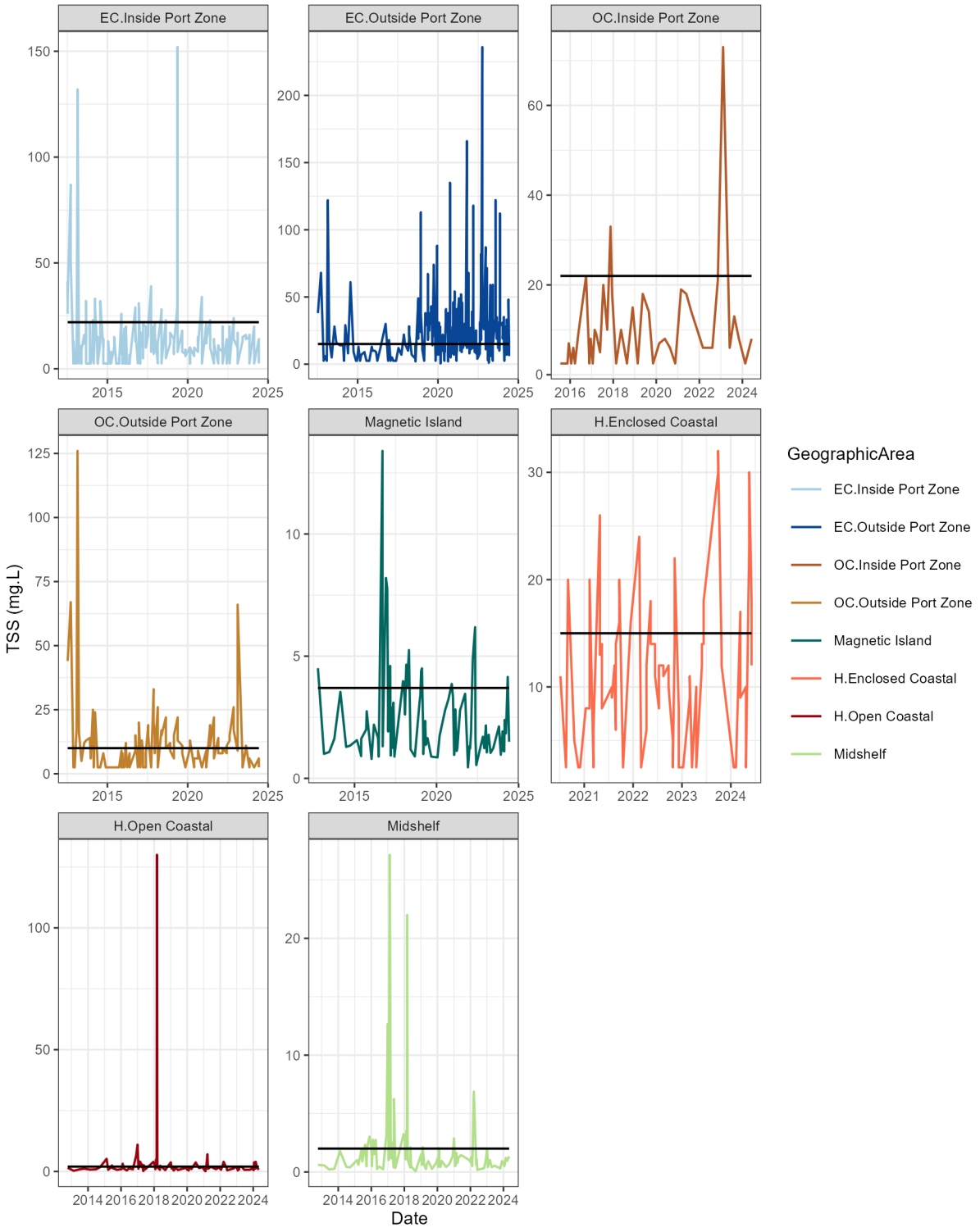

Figure 90. Dry Tropics inshore marine water quality line plots: TSS. The black line indicates water quality guidelines.

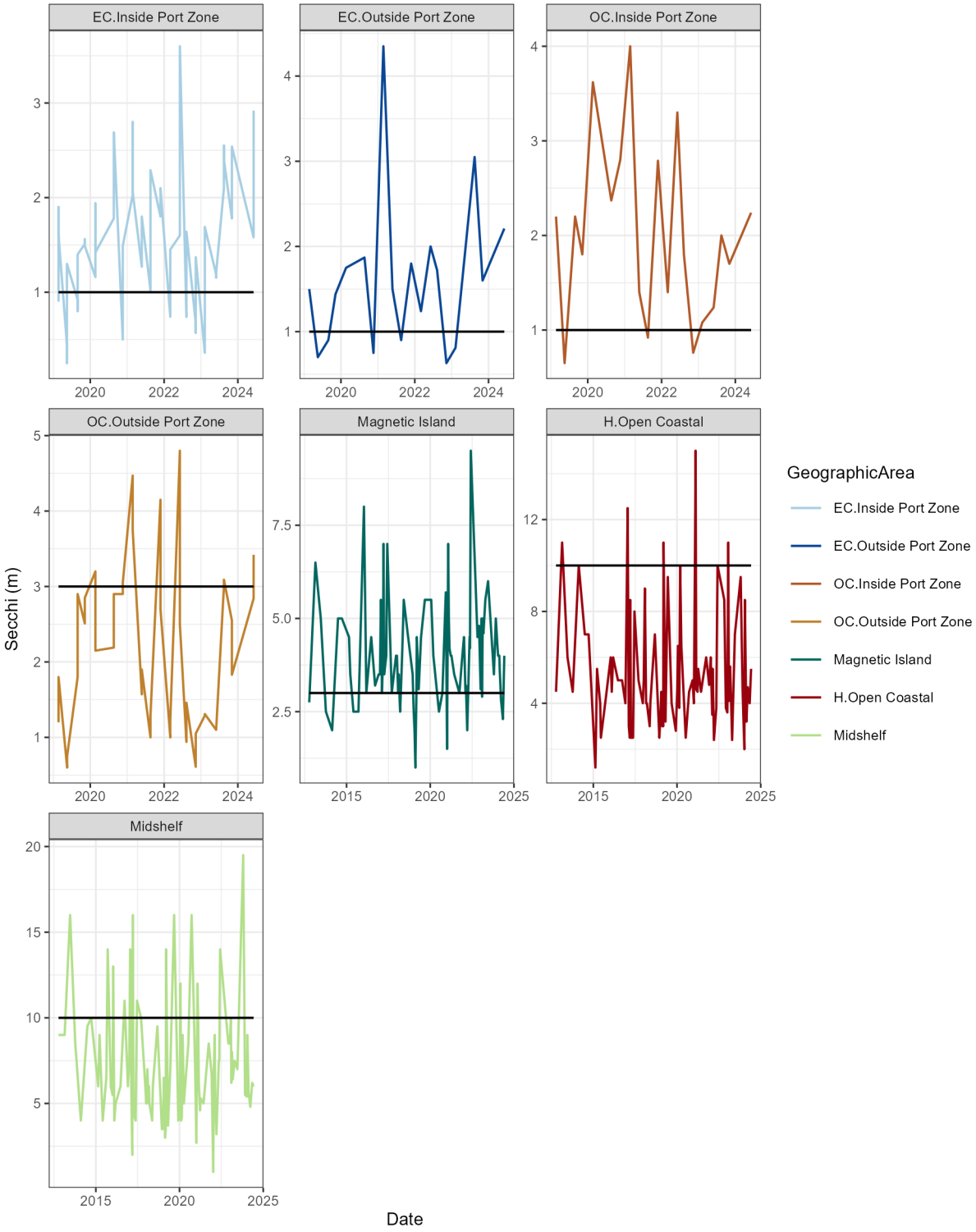

Figure 91. Dry Tropics inshore marine water quality line plots: Secchi. The black line indicates water quality guidelines.

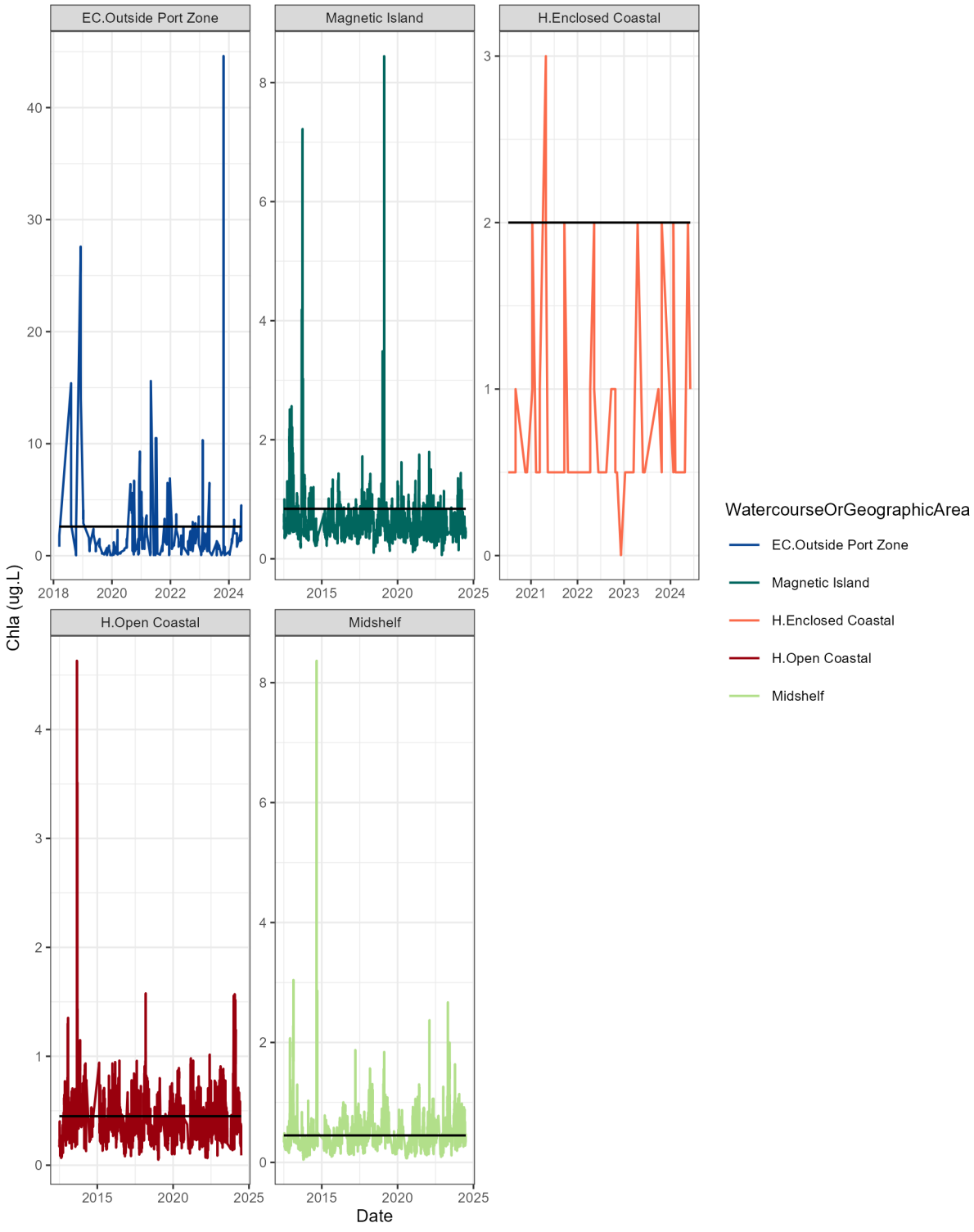

Figure 92. Dry Tropics inshore marine water quality line plots: Chl a. The black line indicates water quality guidelines.

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

Table 99. 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	76
		Open Coastal	Open Coastal	100	28	56	ND	61	
		Midshelf	Midshelf	85	35	79	ND	66	
				95	32	67	100	76	
Wet Tropics	Palm Island	-	-	88	32	68	ND	66	66

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 | - = Not Applicable (data available but not usable) | X = Data was not updated this year.

Table 100. 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	46	66	ND	56	61
		Open Coastal	Open Coastal	75	69	2	49	
		Midshelf	Midshelf	98	100	36	78	
				73	78	19	61	
Wet Tropics	Palm Island	-	-	75	84	ND	80	80

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 | - = Not Applicable (data available but not usable) | X = Data was not updated this year.

Appendix AAA. Seagrass Extent Change Over Time

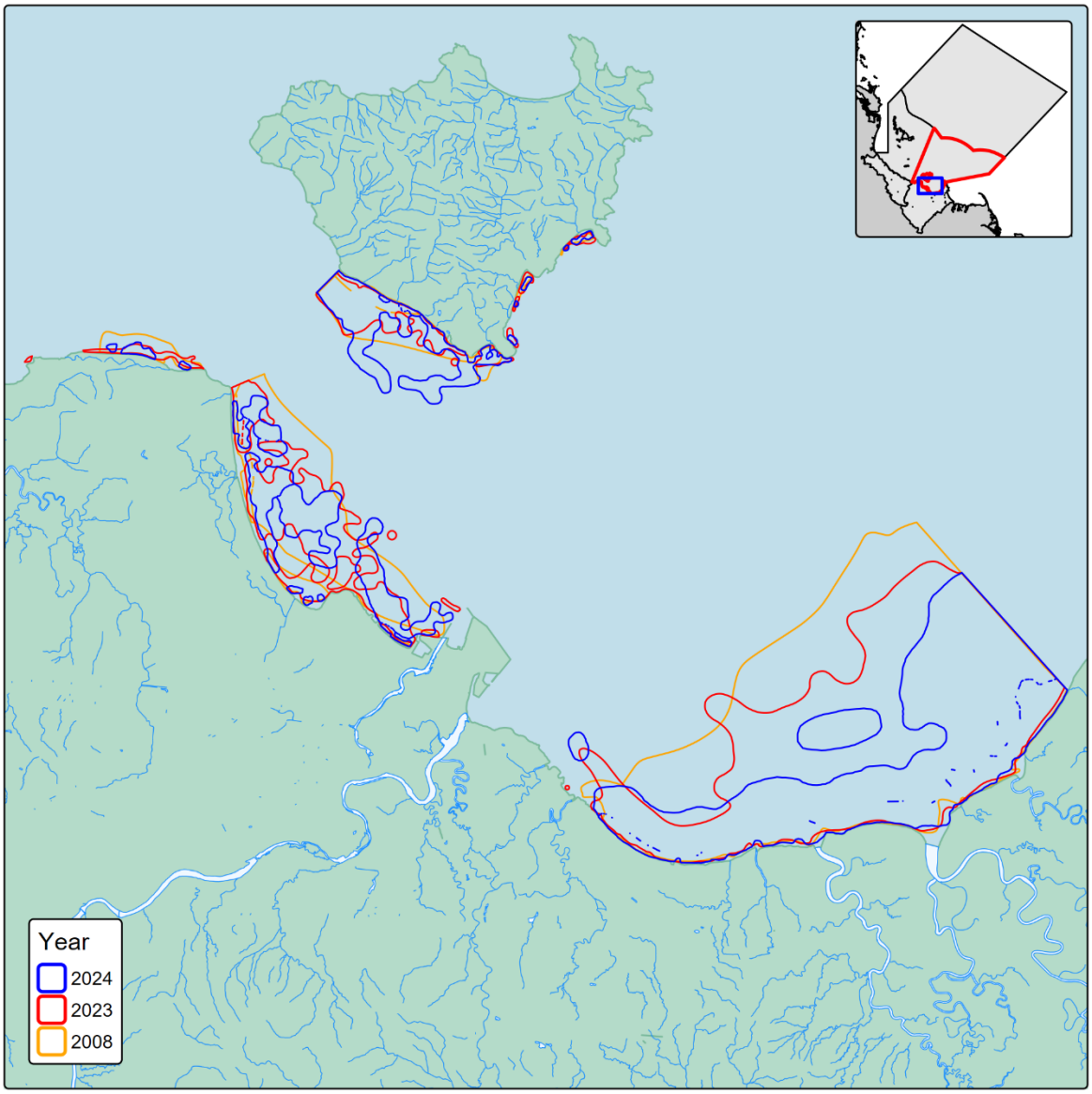

Figure 93. A comparison of seagrass meadow extent over time (2008 - surveys began, 2023 - previous reporting period, 2024 - current reporting period).

Appendix BBB. Report Change Log

The table below lists section number, page and paragraph number, and summary of updates for the 2023–2024 Technical Report to assist reviewers.

Section	Page Number	Details
Header	NA	NA
Footer	NA	Dates.
Throughout Doc	NA	Change log key table added (temporary – removed for final publication).
Front Cover	i	Dates.
General	ii	NA
Authorship Statement	ii	Dates. Katie added in place of Angus RRC TOs removed
Current DTPHW Members	ii	All DESI acronyms changed to DETSI.
Acknowledgements	iii.	NA
Executive Summary	iv	NA
The Healthy Waters Partnership for the Dry Tropics	iv-v	Dates. Link to web articles added.
Climate and Land use in the Dry Tropics Region	vi	Dates. Values (e.g., mm of rainfall, degrees).
State and Condition of the Environment	vi-vii	Table updated with latest year of data.
Freshwater Environment	vii-xi	Tables updated with 2023-2024 results. Key Messages added for all indices.
Estuarine Environment	ix-x	Tables updated with 2023-2024 results. Key Messages added for all indices.
Inshore Marine Environment	x-xi	Tables updated with 2023-2024 results. Key Messages added for all indices.
Offshore Marine Environment	xi	Tables updated with 2023-2024 results. Key Messages added for all indices.
Litter	xii-xiv	Tables updated with 2023-2024 results. Key Messages added for the index.
Table of Contents	xv-xvi	NA
Glossary of Terms	xvii-xxi	NA
Table of Tables	xxii-xxiv	Table titles shortened to single line.
Table of Figures	xxv-xxvii	Figure titles shortened to single line.
1. Introduction	1	NA
1.1 Overview	1	Dates.
1.2 Report Card Zones	1-3	Dates.

Section	Page Number	Details
1.3 Purpose of This Document	3	Dates.
1.4 Report Card History	3	Dates.
2. Methods	3	Dates.
2.1 Terminology and Aggregation	3-5	Dates.
2.2 Scoring	5	NA
2.3 Presentation	5-6	NA
2.4 Confidence Measure	6	NA.
Environmental Stressors Page divider	7	Dates.
3. Environmental Stressors in the Townsville Dry Tropics Region	8	Dates. Values/descriptions of stressors.
3.1 Land Use	9-10	NA
3.2 Climate	11	Dates. Updated text with relevant annual climatic events.
3.2.1 Rainfall	11-14	Dates. Values (e.g., mm of rainfall).
3.2.2 Air Temperature	15-17	Dates. Values (e.g., degrees). Monthly line plots removed.
3.2.3 Sea Surface Temperature	18-19	Dates. Values (e.g., degrees).
3.2.4 Degree Heating Weeks (Coral Bleaching)	20	Dates. Values (e.g., DHWs).
Freshwater Page divider	21	Dates.
4 Freshwater Environment	22	Dates.
4.1 Water Quality	22	Dates.
4.1.1 Monitoring Sites	22-24	NA
4.1.2 Overall Summary: Freshwater Quality	24-25	Text updated. Table updated with new results. Key messages updated.
4.1.3 Nutrients	25-26	Dates. Results text updated. Table updated with new results.
4.1.4 Physical-Chemical Properties	27-28	Dates. Results text updated. Table updated with new results.
4.1.5 Confidence Scores	29	NA

Section	Page Number	Details
4.2 Pesticides	30	NA
4.2.1 Monitoring Sites	30	NA
4.2.2 Overall Summary: Pesticides	30-31	Text updated to reflect new results.
4.2.3 Results: Pesticides	31	Scores updated. Text updated to reflect new results.
4.2.4 Confidence Scores	31	NA
4.3 Habitat and Hydrology	32	NA
4.3.1 Overall Summary: Freshwater Habitat and Hydrology	32	Dates. No new data.
4.3.2 Freshwater Riparian Extent	32	NA
4.3.2.1 Monitoring Sites	33	NA
4.3.2.2 Results: Freshwater Riparian Extent	33-34	NA
4.3.3 Freshwater Wetland Extent	34	NA
4.3.3.1 Monitoring Sites.	34	NA
4.3.3.2 Results: Freshwater Wetland Extent	34-35	NA
4.3.4 Artificial Barriers	36	NA
4.3.4.1 Monitoring Sites.	36	NA
4.3.4.1 Results: Freshwater Artificial Barriers	36	NA
4.3.4.2 Results: Freshwater Impoundment Length	36	NA
4.3.4.3 Results: Freshwater Fish Barriers	36-37	NA
4.3.5 Confidence Scores	37	NA
4.4 Fish	38	NA
4.4.1 Monitoring Sites	38	NA
4.4.2 Overall Summary: Freshwater Fish	38-39	NA
4.4.3 Proportion of Indigenous Species Expected	39	NA
4.4.3.1 Results: POISE	39	NA
4.4.4 Proportion of Non-Indigenous Species Expected	40	NA
4.4.4.1 Results: PONISE	40	NA

Section	Page Number	Details
4.4.5 Confidence Scores	40-41	NA
Estuarine Page divider	42	Dates. Names.
5 Estuarine Environment	43	Dates.
5.1 Water Quality	43	Dates.
5.1.1 Monitoring Sites	43—45	NA
5.1.2 Overall Summary: Estuarine Water Quality	45-46	Text and table updated with newest results.
5.1.3 Nutrients	46-47	Table updated with newest results. Results text updated with newest results.
5.1.4 Physical Chemical Properties	48-49	Table updated with newest results. Results text updated with newest results.
5.1.5 Confidence Scores	50	NA
5.2 Habitat	51	Dates.
5.2.1 Overall Summary: Estuarine Habitat	51	Dates. Values (scores, grades). Key Messages.
5.2.2 Mangrove and Saltmarsh Extent	52	Dates.
5.2.2.1 Monitoring Sites	52	NA
5.2.2.2 Results: Estuarine Mangroves and Saltmarsh	52-53	Dates. Values (e.g., ha of vegetation).
5.2.3 Estuarine Riparian Extent	54	NA
5.2.3.1 Monitoring Sites	54	NA
5.2.3.2 Results: Estuarine Riparian Extent	54-55	Text shortened. Values (scores, grades).
5.2.5 Confidence Scores	55	NA
Inshore Page divider	56	Dates.
6 Inshore Environment	57	NA
6.1 Water Quality	57	Dates.
6.1.1 Monitoring Sites	57-58	Dates.
6.1.2 Overall Summary: Estuarine Water Quality	59	Text and score updates. Table updated with latest year of data.
6.1.3 Updated Methodology	59	NA
6.1.4 Nutrients	59-61	Dates. Scores and text updated. Tables updated with latest year of data.
6.1.5 Physical Chemical Properties	62-63	Dates.

Section	Page Number	Details
		Scores and text updated. Tables updated with latest year of data.
6.1.6 Chlorophyll a	64	Dates. Scores and text updated. Tables updated with latest year of data.
6.1.7 Overlap with the Wet Tropics Technical Report	64	NA (appendix updated).
6.1.8 Confidence Scores	65	NA
6.2 Habitat	66	NA
6.2.1 Overall Summary: Inshore Habitat	66	Text and scores updated. Tables updated with latest results.
6.2.2 Coral	67	NA
6.2.2.1 Monitoring Sites	67-69	NA
6.2.2.2 Results: Inshore Coral	69-70	Values. Discussion.
6.2.3 Seagrass	71	Dates.
6.2.3.1 Monitoring Sites	71-72	Dates. Maps updated with newest seagrass boundaries
6.2.3.2 Results	72-73	Values. Discussion.
6.2.4 Confidence Scores	73-74	Text shortened.
Offshore Page divider	75	Dates. Names.
7 Offshore Marine Environment	76	Add new maps detailing area.
7.1 Water Quality	76-77	Dates. Table updated.
7.1.1 Data Source	77	Dates.
7.2 Habitat	77	Dates.
7.2.1 Overall Summary: Offshore Habitat	77	Values (Score), table updated. Key messages updated.
7.2.2 Coral	78	Dates of sampling updated.
7.2.2.1 Monitoring Sites	78	NA
7.2.2.2 Results: Offshore Coral	78-79	Values. Discussion.
7.2.3 Confidence Scores	79	NA
Litter Page divider	84	Dates. Names.
8 Litter	85	Text updated

Section	Page Number	Details
8.1 Monitoring Sites	85-88	Text updated. Maps yet to be updated
8.2 Comparison with previous years	88-89	Table and text updated
8.3 Key Messages	89	Text updated
8.4 Results	89-90	Table and text updated
8.5 Confidence Scores	90-91	NA
9. References	92-93	NA
Appendices page divider	94	Dates. Names.
10. Appendices	95-179	NA
Appendix A. to G.		New climate graphs/maps
Appendix H.		Table updated with summary stats for latest year.
Appendix I.		2023-2024 DIN and TP scores added.
Appendix J.		Table updated with summary stats for latest year.
Appendix K.		2023-2024 Turbidity and High/Low DO scores added.
Appendix L.		New table, adding historical sub basin indicator category scores.
Appendix M. and N.		New freshwater box and line plots for latest results added.
Appendix O.		NA
Appendix P.		Update pesticide proportion graphs with 2023-2024 data.
Appendix Q. to R.		NA
Appendix S.		Add 2023-2024 results (no results).
Appendix T. to FF.		NA
Appendix GG.		Table updated with summary stats for latest year.
Appendix HH.		2023-2024 DIN and TP scores added.
Appendix II.		Table updated with summary stats for latest year.
Appendix JJ.		2023-2024 Turbidity and High/Low DO scores added.
Appendix KK.		New table, adding historical sub basin indicator category scores.
Appendix LL. and MM.		New estuarine box and line plots for latest results added.
Appendix NN. to UU.		NA
Appendix VV.		Table updated with summary stats for latest year.
Appendix WW.		2023-2024 NOx, PN, PP, and TP scores added.
Appendix XX.		Table updated with summary stats for latest year.

Section	Page Number	Details
Appendix YY.		2023-2024 Turbidity, TSS, Secchi and Chla scores added.
Appendix ZZ.		New table, adding historical sub basin indicator category scores.
Appendix AAA. and BBB.		New inshore box and line plots for latest results added.
Appendix CCC.		Values for DT and WT updated.
Appendix DDD.		New Seagrass Extent change Over Time map