Wet Tropics Waterways

WET TROPICS REPORT CARD 2024

WATERWAY ENVIRONMENT RESULTS

REPORTING ON DATA: JULY 2022-JUNE 2023

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1. EXECUTIVE SUMMARY

The results presented in this document describe the state and condition for freshwater basin, estuarine, inshore marine and offshore marine environments. The results include scaled scores and grades for indicators, indicator categories, indices, and overall reporting zones, within each environment. The 2022-23 reporting year provides updated results for all indicators reported annually, where data are available, and also for longer-term indicators that are scheduled for update and have new data available. The indicator category and index groupings of indicators updated for 2022-23 are presented in Table i.

Table i. The indicator categories and indices reported for each of the four environments. Indicator categories not updated for 2022-23are shown in grey.

Environment	Index	Indicator category
Basins	Water quality	All indicator categories
	Habitat & hydrology	Habitat modification (impoundment length) *
		Flow
		Invasive weeds (instream)
		Wetland extent*
		Riparian extent*
	Fish (Herbert basin only)	Indigenous species*
		Non-indigenous species*
Estuaries	Water quality	All indicator categories
	Habitat & hydrology	Fish barriers (Hinchinbrook Channel only)*
		Flow
		Riparian extent*
		Mangrove and saltmarsh (extent)*
		Mangrove and saltmarsh (shoreline mangrove habitat)*
		Seagrass (Trinity Inlet and Moresby zones only)
Inshore marine	Water quality	All indicator categories
	Coral	All indicator categories
	Seagrass	All indicator categories (North and South zones only)
Offshore marine	Water quality	All
	Coral	All indicator categories

*signifies long-term indicators, which are usually updated every three to four years.

Comparisons between years must take into account any differences in monitoring, methodology and addition of indicators. The inshore marine monitoring has remained more consistent than basin, estuary and offshore marine monitoring over the reporting years and this facilitates direct comparison of the state and condition of these waterways between reporting periods. The reporting of offshore marine coral condition was modified for 2021-22 onwards due to an update in the sampling design which has decreased the number of reefs surveyed and increased the survey frequency to every year. The reporting of offshore marine water quality has been suspended as of 2020-21 due to decommissioning of the Marine Water Quality dashboard. This means that the reporting of offshore coral condition, and water quality when it is recontinued with the planned introduction of a new monitoring system for 2023-24, must account for the methodological changes when comparing with results from previous years.

The overall scores and grades across all waterway environments and reporting zones for 2022-23 were 'moderate' or 'good'. These results are produced from the aggregation of multiple indicators which are affected by a wide range of conditions and impacts, including climate, and are examined further within this report. Confidence levels associated with the results are based on assessment of the methods and analyses and are also presented. This document is intended to be read in conjunction with the methods technical report WTW 2024 available for download here, which details indicator selection, data collection, data analysis and scoring procedures for all indicators, and methods for scoring confidence.

Climate

For the 2022-23 period annual rainfall was above the long term mean across most of the Daintree Basin, and higher than average annual rainfall also occurred in the north-west upper basins of the Mossman and Herbert. Annual rainfall below the long term mean range occurred for most of the Murray Basin and for substantial areas of the Johnstone, Tully and lower Herbert basins. Over monthly time frames rainfall totals were well above average across the region for July with basins in the north of the region in the highest 1% of rainfall percentiles. Annual discharge of the major rivers was higher than the long-term mean at all monitoring sites, and for the Daintree at Lower Daintree, annual discharge was considerably higher than the long-term mean.

During 2022-23 sea surface temperatures for the Wet Tropics inshore and offshore zones were within range for low likelihood of coral bleaching for almost the entire marine region. Areas that reached sea surface temperatures with likelihood of a bleaching risk warning occurred in the far north and far south-east of the offshore zone, and in the far south of the Palm Island inshore zone.

Waterways

The index and overall scores and grades for the 2022-23 reporting period and the overall scores and grades from previous years are presented for quick reference for each waterway environment in Tables ii – v below. The indices of each waterway environment are comprised of multiple indicators and the scores and grades are presented in full at the relevant sections and in Appendix G for previous years. Selected key messages for results of particular interest are provided and refer to indicators which are presented in detail within the results sections.

The following standardised scoring ranges and grades have been applied: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100 | nd indicates no data available.

Basins

The assessment of basins is based upon water quality, comprising nutrients (dissolved inorganic nitrogen and filterable reactive phosphorus), sediments (total suspended solids) and pesticide risk; habitat and hydrology, comprising habitat extent (riparian and wetlands), habitat modification (impoundment length), flow, and invasive weeds; and fish, comprising native species and introduced species (translocated and non-Australian).

Table ii. Basin index and overall results for 2022-23 and overall results for preceding years.

Basins	Water quality	Habitat and hydrology	Fish	22-23	21-22	20-21	19-20	18-19	17-18	16-17	15-16
Daintree	82	77	nd	79	83	83	85	82	81	81	81
Mossman	68	65	77	70	69	72	74	63	67	63	55
Barron	64	45	48	52	56	54	54	61	61	64	63
Mulgrave	72	65	84	74	73	74	73	68	71	64	64
Russell	75	66	92	78	78	79	75	75	75	70	68
Johnstone	75	57	72	68	67	70	71	67	67	68	68
Tully	64	58	90	71	72	75	72	61	64	64	61
Murray	51	58	80	63	64	63	61	57	59	55	54
Herbert	65	56	83	68	71	70	71	59	66	66	67

Basin key messages

- Overall condition of basins was 'good' other than the Barron which graded 'moderate'. For all basins, water quality or fish were the highest scoring indices.

Water quality

- The Murray continued to have the poorest condition with respect to pesticide toxicity, and decreased substantially in score since the previous year.
- The Daintree and North Johnstone sites had the lowest concentrations of pesticides, and therefore, the lowest toxicity risk.
- The grades for sediment (total suspended solids) were 'very good' for all basins except for the Barron which was 'good'.
- Nutrients declined from 'good' to 'moderate' in the Barron (both dissolved inorganic nitrogen and filterable reactive phosphorus decreased in score), remained 'good' for Daintree and Russell, and remained 'moderate' for the other basins.
- From 2014-15 to 2022-23 filterable reactive phosphorus has tended to decrease in score for Mossman, Barron, Russell, Johnstone, Murray and Herbert, with scores for the other three basins fluctuating but not showing a decrease in score over time.

Habitat and hydrology

- Flow assessment sites in all basins were graded either 'good' or 'very good' except for Rudd Creek at Gunnawarra in the Herbert Basin, which was 'moderate'.
- Unusually high rainfall early in the reporting year was likely to have decreased the score for Rudd Creek at Gunnawarra, which typically has very low flows or no flows at that time of year.

Fish (Herbert Basin only)

- The fish index remained 'very good' for the Herbert Basin.
- The proportion of indigenous species expected declined from 'very good' to 'good' whilst the proportion of non-indigenous fish (translocated and alien species) remained 'very good'.

Estuaries

The assessment of estuaries is based upon water quality, comprising nutrients (dissolved inorganic nitrogen and filterable reactive phosphorus), physical-chemical (turbidity and dissolved oxygen), chlorophyll *a*, and pesticide risk; and habitat and hydrology, comprising habitat extent (riparian and mangrove-saltmarsh), fish barriers, flow, and seagrass.

Table iii. Estuary index and overall results for 2022-23 and overall results for preceding years.

Estuary	Water quality	Habitat and hydrology	22-23	21-22	20-21	19-20	18-19	17-18	16-17	15-16	14-15
Daintree	78	59	68	69	73	76	70	72	70	70	nd
Dickson Inlet	72	65	69	68	77	77	79	77	69	74	nd
Barron	45	55	50	51	62	57	53	54	55	46	62
Trinity Inlet	69	59	64	64	64	63	56	57	64	66	59
Russell-Mulgrave	70	67	68	69	73	75	68	70	72	72	75
Johnstone	66	56	61	61	70	69	65	65	65	57	nd
Moresby	71	56	63	60	66	70	66	65	67	66	53
Hinchinbrook Channel	73	72	72	69	72	78	74	77	81	78	nd

Estuary key messages

- Overall condition for estuaries remained 'good' except for the Barron which remained 'moderate' and the Moresby which improved from 'moderate' to 'good'.

Water quality

- Estuaries with pesticide monitoring (Daintree, Russell-Mulgrave and Johnstone) were at low risk or very low risk from pesticide toxicity.
- Daintree, Moresby and Hinchinbrook Channel have decreased in chlorophyll *a* score, due to increased chlorophyll *a* concentrations, with accompanying decline in grade from 'very good' over all reporting years, particularly during the last four years.
- Chlorophyll *a* concentrations decreased in the Barron and the grade improved to 'good'. Scores for chlorophyll *a* in the Barron estuary have been higher than other estuaries twice in the last three years after consistently scoring poorly in previous years.
- For the Barron estuary concentrations of DIN and FRP increased from the previous year, which resulted in substantially lower scores and a decline to grades of 'poor' for DIN and 'very poor' for FRP.

Habitat and hydrology

- The fish barrier indicator score for the Hinchinbrook Channel estuary area improved from 'moderate' to 'good' since the last assessment due to fishway construction works at several sites in the Hinchinbrook Channel estuary area.
- The most substantial change in the fish barrier indicator score was due to remediation of the rock weir barrier on the main channel of the Herbert River at Gedges Crossing which connected the 250 km of upstream waterways that have no barriers to the downstream reaches of the Herbert River.

- For the flow indicator the Barron and Johnstone estuaries remained graded 'good' whilst the Russell-Mulgrave estuary declined from 'very good' to 'good'. The grade of 'good', indicated flows to the estuaries were not substantially altered from reference condition.
- All measures of low flow and cease to flow conditions at the Freshwater Creek site were high scoring for a third year in a row.
- Seagrass condition in Trinity Inlet improved from 'poor' to 'moderate' reaching the highest score since 2015-16.
- For Trinity Inlet biomass of seagrass increased at subtidal meadows whilst area cover at the intertidal meadow remained low.
- Seagrass condition in the Moresby estuary remained 'very poor' but increased in score, and overall condition in 4 of the 5 monitoring meadows improved from last year.

Inshore

The assessment of the inshore marine environment is based upon water quality, comprising water clarity (total suspended solids and turbidity), nutrients (oxidised nitrogen, particulate nitrogen and particulate phosphorus), chlorophyll *a*, and pesticide risk; coral, comprising change in coral cover, juvenile density, macroalgae, coral cover, and composition; and seagrass, comprising of biomass, area, and species composition, or percent cover and resilience.

Table iv. Inshore marine index and overall results for 2022-23 and overall results for preceding years.

Inshore zone	Water Quality	Coral	Sea-grass	Fish	22-23	21-22	20-21	19-20	18-19	17-18	16-17	15-16
North	82	54	64	nd	66	64	57	60	60	54	48	52
Central	71	54	nd	nd	63	60	61	67	59	57	57	62
South	75	56	36	nd	55	53	51	56	47	41	37	44
Palm Island	75	47	nd	nd	61	56	55	59	56	51	57	59

Inshore marine key messages

- Overall inshore grades since the previous year remained 'good' in the North zone and 'moderate' in the South zone, whilst the Central and Palm Island zones improved from 'moderate' to 'good'.

- *Water quality*
  - Water quality index improved in all zones for the second consecutive year with the most substantial improvements in the Central and South zones.
  - Pesticide monitoring for all four inshore zones using passive samplers recommenced in 2022-23 following a suspension of monitoring in recent years.
  - The reporting of pesticide monitoring improved overall water quality index scores because of the typically high scores due to the low pesticide risk at inshore sites.
  - Scores for water clarity increased in all zones except the North zone, which declined from 'very good' to 'good'. Palm Island zone had the most substantial increase and improved from 'good' to 'very good'.
  - The scores for oxidised nitrogen (NO_x) improved substantially in all zones, with the North zone remaining 'very good' and the other three zones improving in grade.

- Grades for NO_x have improved substantially in all zones over recent years, which reflects declines of their annual mean NO_x concentrations.
- The North, Central and South zones showed spatial trends in water quality with highest concentrations of nutrients and total suspended solids occurring at sites closest to the river mouths, and higher concentrations correlating to periods of high rainfall.

Coral

- For 2022-23 in the Wet Tropics region there were no severe disturbance events to inshore coral communities such as cyclones. Sea surface summer temperatures for the inshore zones were within range for low likelihood of coral bleaching for almost the entire area.
- Crown-of thorns starfish were only observed in the Central zone, consistent with the previous year.
- Coral index grades for all zones remained 'moderate', with the scores declining for the Central and South zones and increasing for the North and Palm Islands zones, since the previous year.
- In the North zone composition improved substantially from 'poor' to 'moderate', mainly due to the re-emergence of *Acropora* at all reefs in the zone. Macroalgae grade remained moderate whilst the score decreased.
- In the Central zone the coral cover grade remained 'good'. Cover change declined to 'moderate' after seven years of grading 'good', however recovery of hard coral cover has continued at predicted rates. Macroalgae remained 'moderate', but the score decreased substantially due to very high macroalgae cover at several reefs.
- In the South zone cover change grade declined from 'good' to 'moderate', and the causes have been linked to higher levels of disease. Macroalgae grade improved from 'poor' to 'moderate'. Whilst the juvenile coral grade remained 'good' the score declined. In part a decline in the densities of juvenile coral is due to growth of corals which removes them from the juvenile size class.
- In the Palm Island zone coral cover grade remained 'moderate' but the score increased due to increased hard coral cover on several reefs since the previous year. Composition improved from 'moderate' to 'good' due to increased score at a single reef. Juvenile coral grade improved from 'poor' to 'moderate' with an increase in juvenile density occurring at most sites.

Seagrass

- Seagrass condition grade in the North zone improved from 'moderate' to 'good' and reached its highest score since the report card commenced in 2016.
- In the South zone the seagrass condition grade remained 'poor' with the score decreasing since the previous year.

Offshore

The offshore zone is assessed from the water quality index and the coral index. The water quality index has not been available since 2020-21, consequently an overall offshore score and grade has not been available since 2019-20. Up until 2019-20 the water quality index comprised total suspended solids and chlorophyll *a.* The coral index is comprised of juvenile density, change in coral cover, and coral cover.

Table v. Offshore marine index and overall results for 2022-23 and overall results for preceding years.

Water quality Score	Coral Score	22-23	21-22	20-21	19-20	18-19	17-18	16-17	15-16
nd	61	Insuf-ficient data	Insuf-ficient data	Insuf-ficient data	**70**	**73**	**75**	**83**	**84**

Offshore marine key messages

- Due to the lack of water quality monitoring, there was insufficient data to provide an overall grade and score for the offshore zone.

Water quality

- For the second consecutive year, in 2022-23 there was no water quality monitoring program in place to allow reporting of offshore water quality.

Coral

- The score for juvenile density decreased, whilst the scores for coral cover and coral change increased. The coral index score did not change, and the grade remained 'good'.
- Hard coral cover increased to its highest level since 2016-17 for the offshore zone and the grade improved from 'poor' to 'moderate'.
- Impacts of coral bleaching from the 2020-21 summer accumulated heat stress event were minimal on surveyed reefs.
- The 2022-23 reef surveys recorded no incipient or active crown-of-thorns starfish outbreaks in the offshore zone.
- All reefs have shown a general improvement in coral cover following impacts from heat stress and crown-of-thorns starfish between 2016 and 2018.

Confidence

The assessment of waterway condition and state also includes a measure of the confidence surrounding the data and analysis used for the indicators and indicator categories that constitute the indices. Assessment of confidence is based upon five criteria covering the maturity of the method (stage of development), level of data validation, representativeness (spatial and temporal factors, and sample size), directness of measurements, and measured error. The confidence rank is based on the score of the summed criteria. Confidence of an index is the average of the contributing indicator categories. Table vi presents the confidence ranks of the indices for each of the waterway environments. Confidence at the indicator and indicator category level is presented in the relevant section of the report.

Table vi. Confidence ranks of the indices for each waterway environment.

Environment	Water quality	Habitat and hydrology	Fish	Coral	Seagrass
Basin	3	3	3	-	-
Estuary	2 to 4	3	nd	-	-*
Inshore	3	-	nd	4	3
Offshore	nd	-	nd	4	-

Confidence rank: 1 (very low); 2 (low); 3 (moderate); 4 (high); 5 (very high). nd indicates no data available, - indicates index is not applicable. * note that estuary seagrass is included in the habitat and hydrology index.

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Terms and Acronyms

AIMS	Australian Institute of Marine Science
Basin	An area of land where surface water runs into smaller channels, creeks or rivers and discharges into a common point. A basin may include unconnected sub-basins which discharge at separate points.
Biomass	The total quantity or weight of organisms over a given area or volume.
BoM	Bureau of Meteorology
Chl-*a*	Chlorophyll-*a*: a measure used to estimate phytoplankton biomass. It is widely considered a useful proxy to measure nutrient availability and the productivity of a system.
CTF	Cease-to-flow
CV	Coefficient of variation
DES	Department of Environment and Science, Queensland
DHW	Degree heating weeks
DIN	Dissolved inorganic nitrogen
DO	Dissolved oxygen
EC	Enclosed coastal marine water body
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 if it is stable and sustainable - that is, if it is active and maintains its organisation and autonomy over time and is resilient to stress.
Estuary environment	The aquatic environment at the interface between freshwater and marine ecosystems and includes mid-estuary (ME) and lower-estuary (LE) waters (WTHWP 2018).
Fish (as an index)	Fish community health is assessed and included in the ecosystem health assessments (coasters). Inclusion in the report card will contribute to an assessment of the health of local fish communities.
Fish Barriers (as an indicator)	Fish barriers relate to any man-made barriers which prevent or delay connectivity between key habitats which has the potential to impact migratory fish populations, decrease the diversity of freshwater fish communities and reduce the condition of aquatic ecosystems (Moore, 2016).

Flow (as an indicator)	Flow relates to the degree that the natural river flows have been modified in the region's waterways. This is an important indicator due to its relevance to ecosystem and waterway health.
FNQROC	Far North Queensland Regional Organisation of Councils
FRP	Filterable Reactive Phosphorus
GBR	Great Barrier Reef
GBR CLMP	Great Barrier Reef Catchment Loads Monitoring Program
GBR Report Card	Great Barrier Reef Report Card developed under the Reef 2050 Water Quality Improvement Plan (2018).
GBRMPA	Great Barrier Reef Marine Park Authority
GV	Guideline Value
Impoundment length	An indicator used in the 'instream habitat modification' indicator for freshwater basins in the region. This index reports on the proportion (%) of the linear length of the main river channel when inundated at the Full Supply Level of an artificial instream structures such as dams and weirs.
Index	Is generated by indicator categories (e.g. the water quality index is made up of nutrients, water clarity, chlorophyll-*a* and pesticides indicator categories)
Indicator	A measure of one component of an environmental dataset (e.g. particulate nitrogen)
Indicator category	Is generated by one or more indicators (e.g. water clarity made up of total suspended solids and turbidity)
Inshore marine environment	Includes enclosed coastal (EC), open coastal (OC) and mid-shelf (MS) waters, extending east to the boundary with the offshore waters (WTHWP 2018).
In-stream Habitat Modification (as an indicator)	This basin indicator category is made up of two indicators: fish barriers and impoundment length.
IQQM	Integrated water quantity and quality simulation model – used to model pre-development flow for the flow tool score calculations.
LE	Lower estuary water type
LTMP	Long-Term Monitoring Program
Macroalgae (cover)	An indicator used in part to assess coral health. Macroalgae is a collective term used for seaweed and other benthic (attached to the bottom) marine algae that are generally visible to the naked eye.
ME	Mid-estuary water type

Measure	A measured value that contributes to an indicator score for indicators that are comprised of multiple measurements (e.g. flow, estuary fish barriers).
MMP	Great Barrier Reef Marine Monitoring Program – A collaboration between GBRMPA, JCU and AIMS. This provides water quality, coral and seagrass data for the inshore zones of the report card.
MS	Mid-shelf marine water body
MWQ	Marine water quality (MWQ) dashboard and data – Bureau of Meteorology.
NAMAC	Natural Asset Management Advisory Committee
NO_x	Oxidised nitrogen (nitrate and nitrite)
OC	Open coastal marine water body
Offshore marine environment	Includes all offshore waters within the Wet Tropics NRM marine region.
Overall Score	The overall scores for each reporting zone used in the report card are generated by an index or an aggregation of indices.
P2R	Paddock to Reef Integrated Monitoring, Modelling and Reporting Program
Palustrine wetlands	Primarily vegetated non-channel environments of less than eight hectares. Examples of palustrine wetlands include billabongs, swamps, bogs, springs, etc.
Pesticides (as an indicator)	Incorporating up to 22 herbicides and insecticides with different modes of action. A list of the relevant chemical components is provided in the Methods Report.
Pesticide Risk Metric	Refers to the methodology for estimation of ecological risk associated with pesticide pollution.
Phys-chem	The physical-chemical indicator category that includes two indicators: dissolved oxygen (DO) and turbidity.
PN	Particulate nitrogen
POISE	Proportion of indigenous fish species expected
PONI	Proportion of non-indigenous fish
PONSE	Proportion of native (fish) species expected
PP	Particulate phosphorus
Pre-clearing	Pre-clearing vegetation is defined as the vegetation or regional ecosystem present before clearing. This generally equates to terms such as ‘pre-1750’ or ‘pre-European’ used elsewhere (Neldner et al., 2019).

Pre-development flow	The pattern of waterflows, during the simulation period, using the IQQM computer program as if there were no dams or other water infrastructure in the plan area, and no water was taken under authorisations in the plan area. (Queensland Government 2016).
PRM	Pesticide Risk Metric
PSII herbicides	Photosystem II inhibiting herbicides (Ametryn, Atrazine, Diuron, Hexazinone, Tebuthiuron, Bromacil, Fluometuron, Metribuzin, Prometryn, Propazine, Simazine, Terbuthylazine, Terbutryn)
PSII-HEq	Photosystem II herbicide equivalent concentrations, derived using relative potency factors for each individual PSII herbicide with respect to a reference PSII herbicide, diuron (Gallen *et al.* 2014).
QPSMP	Queensland Ports Seagrass Monitoring Program
Queensland Government	The Queensland Government includes several departments that provide data sources and support for the report card. Key departments for the report card are the Department of Environment and Sciences (includes management of the GBR CLMP), the Department of Regional Development, Manufacturing and Water (includes management of water monitoring), and the Department of Resources (includes management of Queensland Spatial).
REMP	Receiving Environment Monitoring Plan
Resilience (MMP seagrass indicator)	Measure of the capacity of seagrass to cope with disturbances.
Riparian Extent (as an indicator)	An indicator used in the assessments of both basin and estuarine zones. This indicator uses mapping resources to determine the extent of the vegetated interface between land and waterways in the region.
SF	Scaling factor - A value used to set scoring range limits for indicators.
Standardised condition score	The transformation of indictor scores into the Wet Tropics Report Card scoring range of 0 to 100.
TSS	Total suspended solids
Waterway	All freshwater, estuarine and marine bodies of water, including reefs, and storm drains, channels and other human-made structures in the WT region.
Water quality guideline	For purposes of waterway assessment, the term water quality guideline refers to values for condition assessment of water quality drawn from a range sources including water quality objectives scheduled under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (DES 2020), and water quality guideline values obtained from the Queensland Water Quality Guidelines (DEHP 2009), the GBRMPA Guidelines (GBRMPA 2010) and the ANZG (2018).

Water quality objective (WQO)	Water quality objective refers to values for condition assessment of water quality scheduled under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (DES 2020).
WTW	Wet Tropics Waterways (previously known as Wet Tropics Healthy Waterways Partnership WTHWP)

2. INTRODUCTION

2.1. General

Wet Tropics Waterways was launched in July 2016 with the release of the 'Pilot Report Card' in December 2016 which reported on the 2014-15 year. Report cards have been released annually since the release of the pilot report card with the current 'Report Card 2024' reporting on the 2022-23 year (1 July 2022 to 30 June 2023) and from here on is referred to as the Report Card. The Report Card includes water quality and ecosystem state and condition assessments for freshwater, estuarine, inshore marine and offshore marine environments. In some cases where seasonal monitoring programs extend outside of the financial year period, for example inshore coral, the data from the whole monitoring period is included. For monitoring programs that collect data less frequently than annually (e.g. wetland extent) then the most recent data set is included.

The summary scores from 2015-16, to 2021-22 are presented alongside the 2022-23 scores in each waterway environment section. The complete scores for each waterway environment are presented in full at the relevant section for 2022-23 and in Appendix G for previous years. For details on the design of the Report Card program including reporting zones for the waterway environments, refer to the Program Design (WTHWP 2018) and for details of the methods applied for the Report Card refer to the current methods technical report (WTW 2024).

2.2. Purpose of this Document

The purpose of this document is to provide detailed results of monitoring and assessment activities to support the Report Card. The results presented in this document are assessments of the state and condition for freshwater basin, estuarine, inshore marine and offshore marine environments. A log of the updates applied for 2022-23 results technical report is presented in Appendix I.

This document presents scaled scores and grades for indicators, indicator categories, indices, and for overall reporting zones within each environment. Key messages are presented for indicators that have been updated for the current reporting period. Included in this document are the confidence scores associated with the results, which are based on assessment of the methods and analyses, used to obtain the data. The data collection periods for indicators, indicator categories and indices are presented in the methods technical report (WTW 2024).

2.3. Terminology and Scoring

The Report Card assesses different indicators of ecosystem health to report on overall state and condition. Scores for indicators are aggregated depending on the aspect of the ecosystem they are assessing, such as water quality, coral or fish. The terminology used in this document for defining the level of aggregation of indicators is as follows.

- An indicator is a measured variable (e.g. particulate nitrogen) or generated from more than one measure, for example the flow indicator is generated from multiple hydrological measures.
- Indicator categories (e.g. nutrients) are generated by the averaging of indicators.

- Where an indicator category is represented by a single indicator, the indicator category score is equal to the indicator score.
- Indices (e.g. water quality) are generated by the averaging of indicator categories.
- Overall score is generated by the averaging of indices.

Overall scores and scores for indices are represented in the report card and website by a coaster (Figure 1). Presentation of the coaster can be without the indicator category outer ring as in the case of the Report Card publication. The overall scores are produced from a high level of aggregation which means these scores will be slow to change. It is important to take notice of the scores for indicators and indicator categories which can change more over time than overall scores.

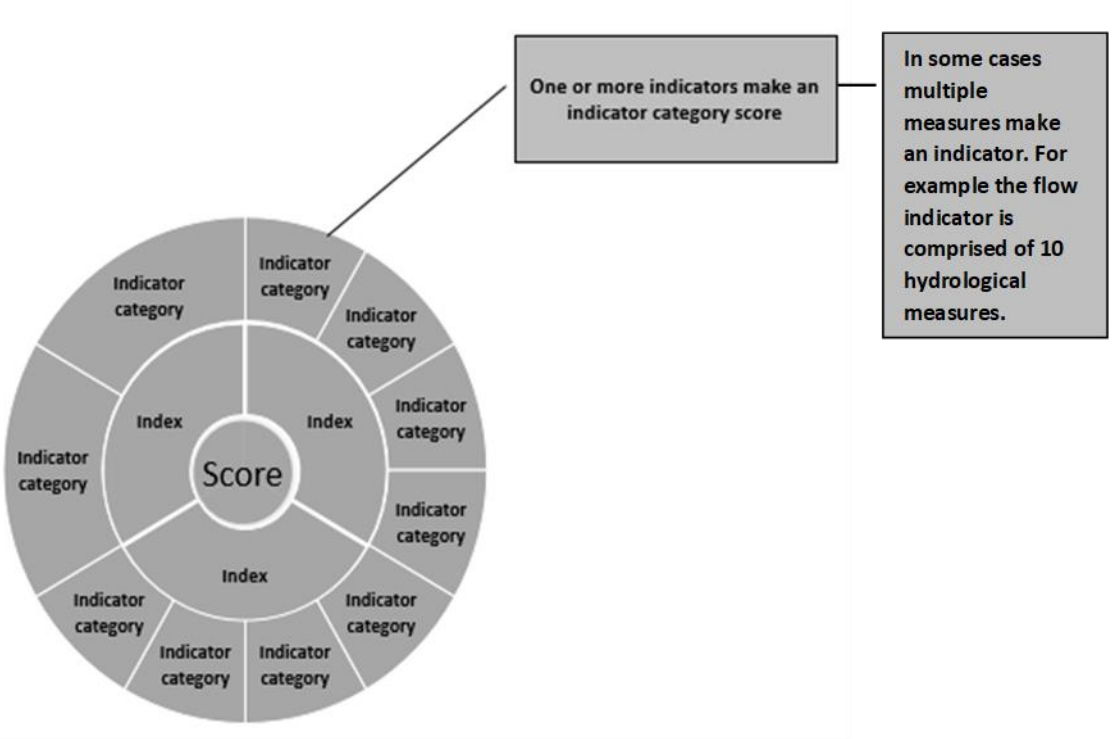

Figure 1 Terminology used for defining the level of aggregation of indicators.

Scoring of indicators is conducted using scales developed for setting scoring ranges according to the report card grading system of 'very poor', 'poor', 'moderate', 'good' and 'very good'. Indicator scales are specific to indicators and are converted (if required) to a standardised scale of between 0 -100 (Table 1). In some cases the specific indicator scoring ranges are aligned with the standardised scoring range (e.g. basin nutrients) whilst other specific indicators' scoring ranges differ from the standardised scoring range (e.g. basin pesticides) and require conversion to the standardised scoring ranges. The indicator results tables present both the specific indicator scores and the standardised indicator scores. The standardised scale allows for the aggregation of indicators, indicator categories and indices and is calculated to one decimal place to allow for differentiation between grades. For presentation in the summary tables the scores are then rounded down and presented as integers.

Table 1 Standardised scoring ranges and corresponding condition grades.

Scoring range	Condition grade and colour code
81-100	Very Good
61 to <81	Good
41 to <61	Moderate
21 to <41	Poor
0 to <21	Very Poor

Values for condition assessment of water quality are drawn from a range of sources including water quality objectives scheduled under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 Wet Tropics basins (DES 2020) and water quality guideline values obtained from the Queensland Water Quality Guidelines (DEHP 2009), the GBRMPA Guidelines (GBRMPA 2010) and the ANZG (2018). Further explanation on which values were used for condition assessment is outlined in Appendix B . For the purposes of this assessment and to simplify terminology, all values obtained from these sources will be referred to as water quality guideline values.

The assessment results in the Report Card were rated in terms of the confidence surrounding the analysis. Confidence scores range from 4.5 to 13.5 and are assigned a confidence ranking from 1 (low) to 5 (high) totalled for each index.

Further details of the terminology and levels of aggregation and confidence scoring are provided in the methods technical report (WTW 2024).

3. CLIMATIC INFLUENCES IN THE REGION

For the 2022-23 period annual rainfall totals for the Wet Tropics region were highest in the Russell Basin and lowest in the Herbert Basin (Figure 2, top). Annual rainfall was above the long term mean across most of the Daintree Basin, with most areas receiving 500-1000 mm above the long-term mean, and higher than average annual rainfall also occurred in the north-west upper basins of the Mossman and Herbert (Figure 2, bottom). Annual rainfall below the long term mean range (-500 to 0 mm) occurred for most of the Murray Basin and for substantial areas of the Johnstone, Tully and lower Herbert basins (Figure 2).

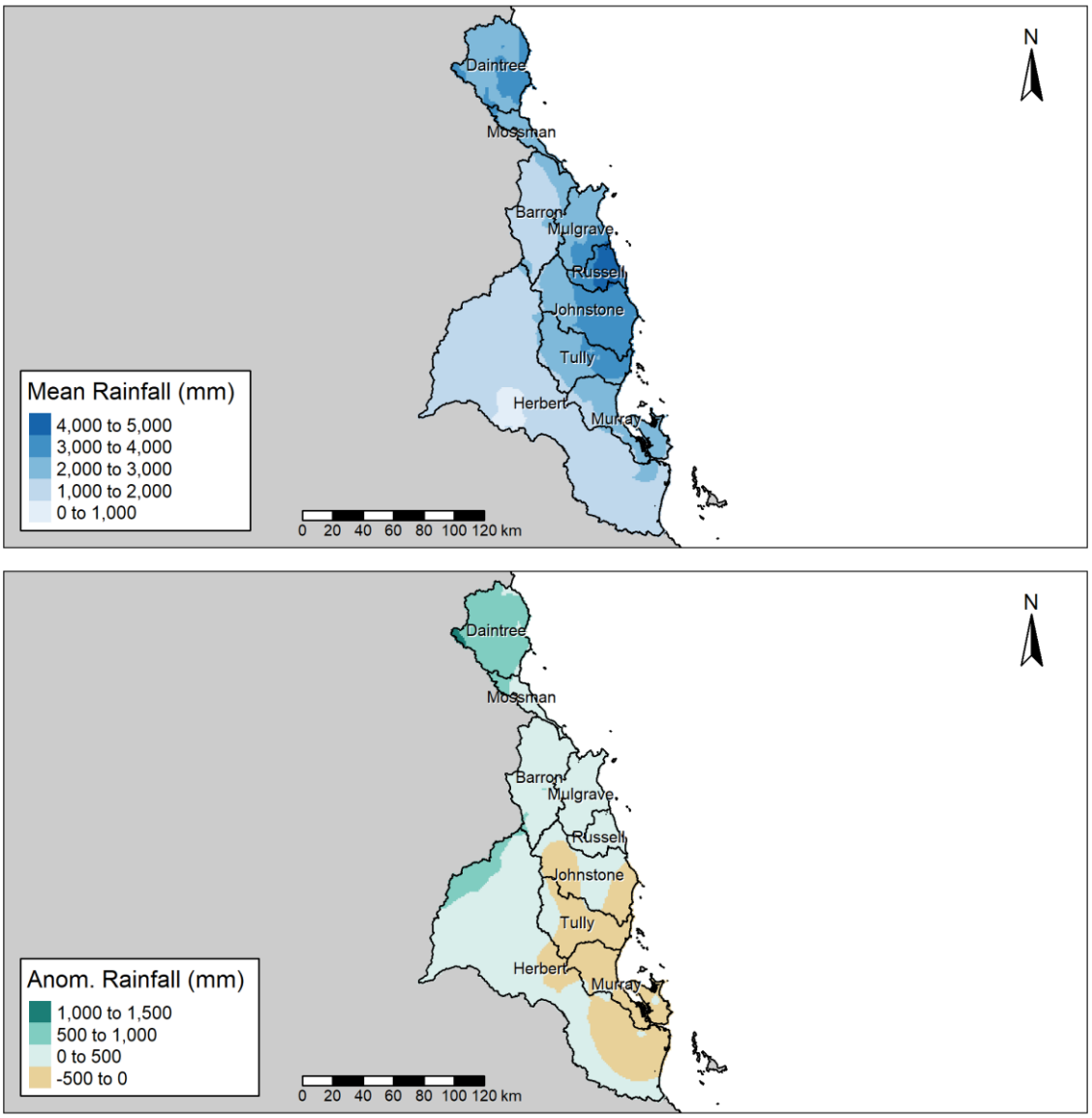

Figure 2 Annual rainfall total (top) and rainfall anomaly of total annual rainfall from long-term mean annual rainfall (bottom) for the Wet Tropics region during 2022-23.
Data for the map was sourced from the Bureau of Meteorology Australian Water Outlook (https://awo.bom.gov.au/) which uses a long-term mean based upon historical rainfall records from 1911 to 2017.

The annual rainfall percentile category was above average (≥70 - <90 percentile) for basins in the north of the region (Barron, Mossman and Daintree) and average (≥30 - <70 percentile) for all other basins (Figure 3). The Daintree recorded the largest difference at 126 % of its long-term mean (Table 2). In comparison to the previous year, the annual totals for 2022-23 for all basins were higher for all basins except the Mulgrave where rainfall was slightly lower (Appendix A, Figure 20).

Table 2 Annual rainfall statistics for basin areas of the Wet Tropics for 2022-23.

	Total (mm)	Long-term mean (mm)	Anomaly (mm +/- long-term mean)	Percentage of long-term mean
Daintree	2892	2297	595	126
Mossman	2425	1959	467	124
Barron	1782	1451	331	123
Mulgrave	2791	2602	189	107
Russell	3989	3719	269	107
Johnstone	3030	3051	-21	99
Tully	2634	2688	-55	98
Murray	2173	2244	-71	97
Herbert	1418	1248	170	114

Data was sourced from the Bureau of Meteorology Australian Water Outlook using historical data for 1911-2017.

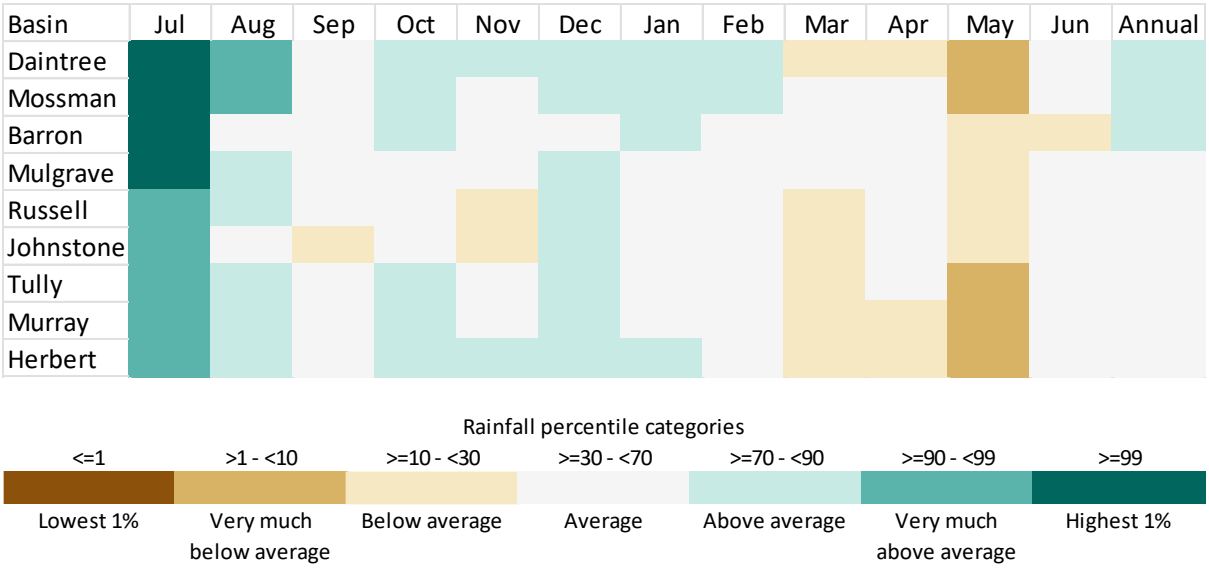

Figure 3 Monthly rainfall percentiles and annual mean percentiles for basin areas of the Wet Tropics (2022-23).
Data was sourced from the : Bureau of Meteorology Australian Water Outlook using historical data for 1911-2017.

The percentiles of monthly rainfall totals were well above average across the region for July 2022. In the north of the region (Daintree, Mossman and Barron) rainfall percentiles were in the highest 1% and a new record of 230.6 mm was set at Kuranda (Barron Basin) surpassing the previous July record of 213.0 mm in 1969 from 126 years of observation (BoM 2022). Rainfall in August was also above average or very much above average across the region except for the Barron and Johnstone which

recorded average rainfall. Rainfall was also above average across the region during December, except for the Barron basin which had average rainfall. Rainfall in May contrasted with the wetter months during 2022 and had drier than average conditions with rainfall very much below average for the basins to the north and south reaches of the region and below average rainfall for the basins in the more central area.

Annual discharge of the major rivers was higher than the long-term mean at all monitoring sites, and for the Daintree at Lower Daintree annual discharge was considerably higher than the long-term mean (Figure 4). Annual discharge corresponded to the annual rainfall percentile categories across all basins.

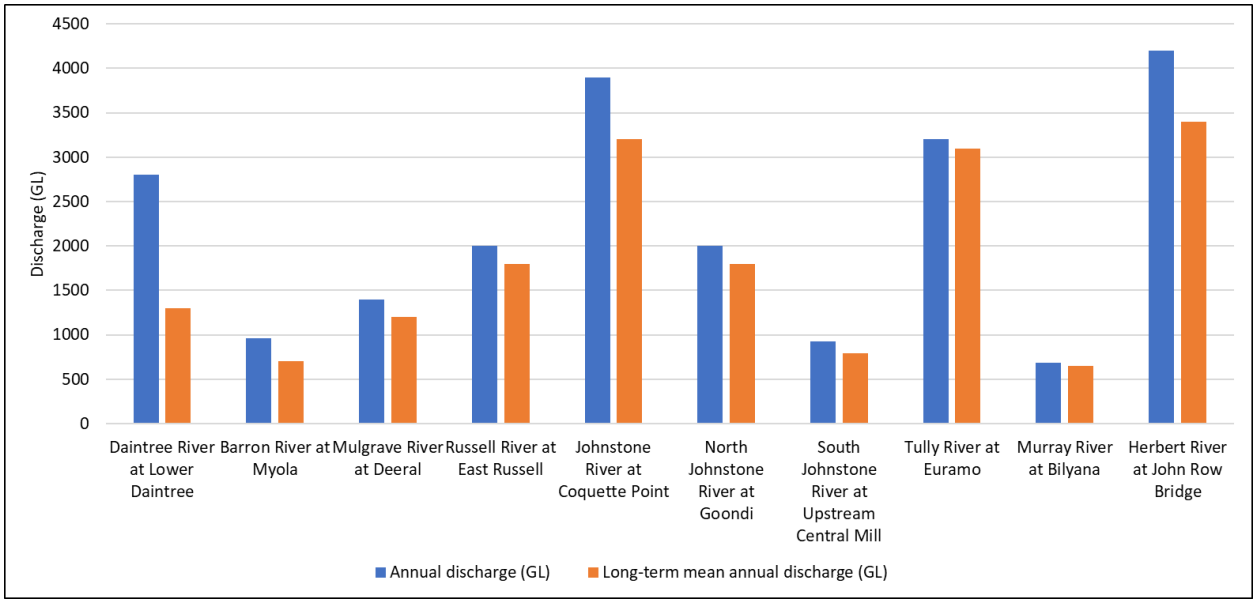

Figure 4 Long-term mean annual discharge and discharge for 2022 – 2023 recorded from gauging stations at the most downstream locations of the major river channel for freshwater basins.
Long-term mean annual discharge is based on historical gauging station records until present from the Department of Regional Development, Manufacturing and Water (water-monitoring.information.qld.gov.au) and Department of Environment, Science and Innovation. Historical flow records dated from 1957 for the Barron at Myola, 1972 for the Tully River at Euramo and 1915 for the Herbert River at Ingham. For recently constructed gauging stations modelled data was used from 1986 until they became operational which was 2018 for the Murray, 2017 for the Daintree, 2015 for Johnstone River at Coquette Point and 2013 for the Mulgrave and Russell.

During 2022-23 sea surface temperatures for the Wet Tropics inshore and offshore zones were within range for low likelihood of coral bleaching for almost the entire marine region (Figure 5). Areas that reached sea surface temperatures of a bleaching risk warning occurred in the far north and far south-east of the offshore zone, and the far south of the Palm Island inshore zone. Sea surface temperature anomalies were considerably lower than the previous year.

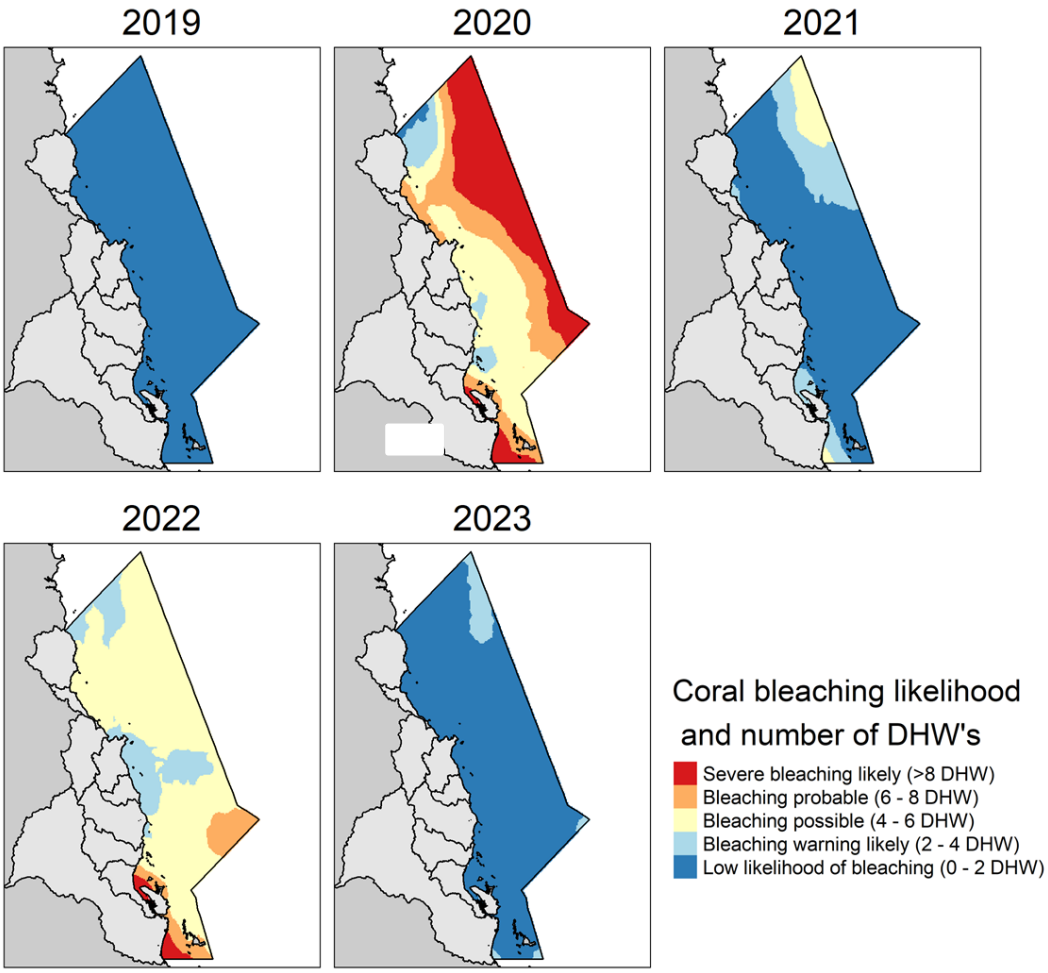

Figure 5 Annual degree heating week estimates for likelihood of coral bleaching from 2018-19 to 2022-23 for the Wet Tropics inshore and offshore marine environments. Data are the annual maximum degree heating week estimates for each ~25 km² pixel. Data were sourced from NOAA coral reef watch.

Note: Degree heating week (DHW) is an accumulated measurement of sea surface temperature 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.

Key messages

- Annual rainfall across the region relative to the long-term average was highest for almost the entire Daintree Basin, and lowest for most of the Murray and Tully basins and areas of the Johnstone, and lower Herbert basins.
- Annual rainfall totals were above the average rainfall percentile category for Barron, Mossman and Daintree basins, and within the average rainfall percentile category for all other basins.
- The percentiles of monthly rainfall totals were very much above average across the region for July and were in the highest 1% for basins in the north of the region (Daintree, Mossman and Barron).

- Rainfall in August and December was above average for most basins, whilst rainfall for May was below average for all basins across the region.
- Annual discharge of the major rivers was higher than the long-term mean at all monitoring sites, and for the Daintree at Lower Daintree annual discharge was considerably higher than the long-term mean.
- During 2022-23 sea surface temperatures for the Wet Tropics inshore and offshore zones were within range for low likelihood of coral bleaching for almost the entire marine region.

4. FRESHWATER BASINS

The freshwater basin reporting zones and the water quality site locations are shown in Figure 6. An additional site (GBR CLMP) is shown in the upper catchment of the Tully Basin; this is used as a reference site for water quality but is not included in the Report Card condition assessment.

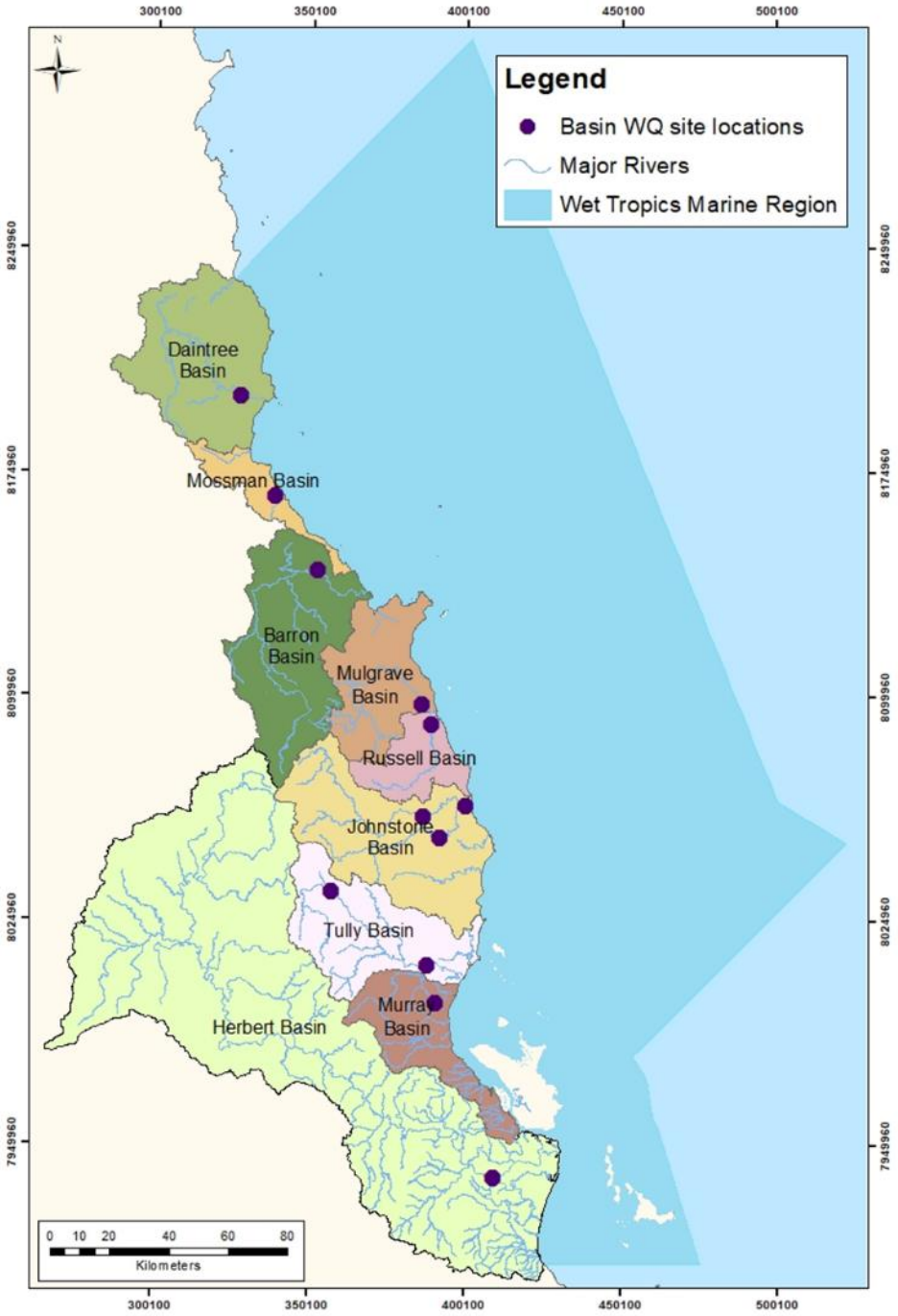

Figure 6 Freshwater basin water quality (WQ) monitoring site locations and basin reporting zones. The site in the upper Tully Basin is used as a GBR CLMP reference site and is not used for the Report Card condition assessment. The most downstream site in the Johnstone Basin is located in the estuary zone at Coquette Point. It is used for assessment of pesticides only for the Johnstone Basin.

The position of the water quality monitoring sites in relation to primary land use in the Wet Tropics region is shown in Figure 7 and provides a graphical presentation of land use upstream of the sites, which potentially affects the water quality of the samples collected. Note that the impact of land use downstream of the sampled sites, or in separate sub-basins, is not reflected in the water quality samples. The land use map also provides context for the habitat and hydrology indicators including riparian vegetation extent and wetland extent. Figure 7 shows the location of the Tully Gorge GBR CLMP reference site and its isolation from disturbed landscapes.

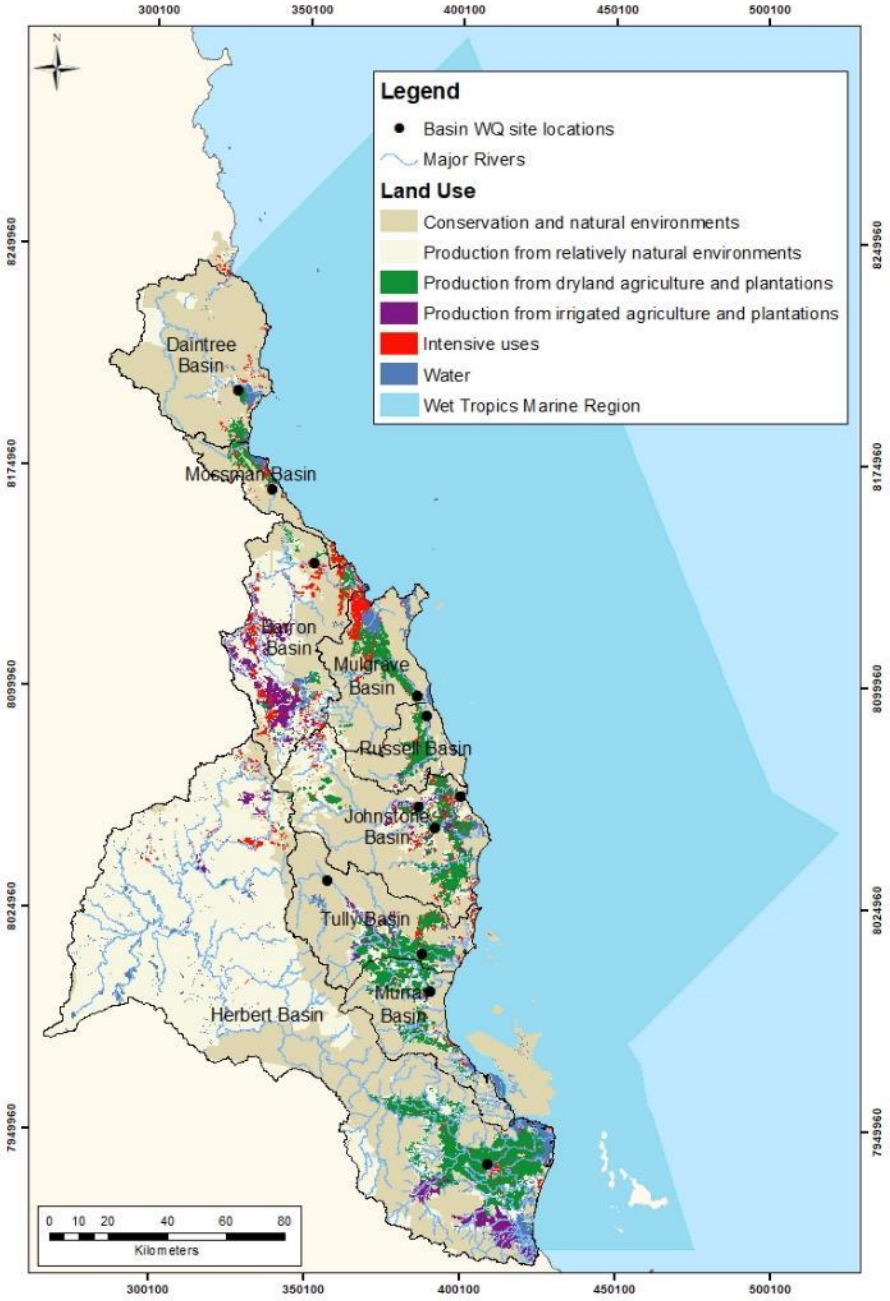

Figure 7 Location of freshwater basin water quality (WQ) monitoring site locations and primary land use in the Wet Tropics region. Source: Queensland Land Use Mapping Program Wet Tropics NRM region 2015 land use data set. http://qldspatial.information.qld.gov.au/

4.1. Water Quality

The methods for scoring water quality are described in the methods technical report (WTW 2024). The water quality index is comprised of sediment (total suspended solids), nutrients, (dissolved inorganic nitrogen and filterable reactive phosphorus) and pesticides (pesticide risk).

The water quality index grades for 2022-23 were the same as the previous year for all basins (Table 3). The Daintree had the highest score (82) and graded 'very good', the Murray had the lowest score (51) and graded 'moderate', whilst all other basins were graded 'good'. The most substantial change in water quality index score from the previous year occurred for the Barron (75 to 64) with poorer scores for nutrients (Table 5 and Table 100). The water quality scores tend to reflect the proportion of land use in catchments upstream of monitoring sites that is natural or relatively natural versus land uses developed for production (Figure 7), with the Daintree having the highest proportion of natural land use and the highest score and the Murray having the lowest proportion of natural land use and the lowest score.

Table 3 Basin water quality index scores and grades for all reporting years

	Water quality							
Basin	**22-23**	**21-22**	**20-21**	**19-20**	**18-19**	**17-18**	**16-17**	**15-16**
Daintree	82	87	88	91	84	82	nd	nd
Mossman~	68	64	66	78	69	71	nd	nd
Barron	64	75	70	69	74	78	81	82
Mulgrave	72	69	73	69	66	66	63	62
Russell	75	74	75	67	75	68	70	73
Johnstone	75	70	75	78	75	69	72	79
Tully	64	65	71	71	68	63	66	65
Murray	51	57	49	49	59	nd	nd	nd
Herbert	65	70	66	73	61	71	76	80

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. nd indicates no data or insufficient data available. ~Mossman River was assessed for base-flow only.

Pesticides

The pesticide risk metric (PRM) values (expressed as percentage of species protected) represents the average pesticide risk over the wet season for 182 days when exposed to a mixture of up to 22 different pesticides, including nine PSII herbicides (Photosystem II inhibitors), 10 non PSII herbicides and three insecticides. The wet season is determined as commencing when a rise in river water level occurs, but which is co-incident with an increase in aqueous pesticide concentrations (Warne *et al*. 2020 and Warne *et al*. 2023). For each basin the PRM scores and standardised scores are presented in Table 4 and the proportion of the three pesticide categories that contribute to the pesticide risk metric is presented in Figure 8. The standardised scores for pesticides are also presented in Table 5 alongside the other water quality indicator scores, and in Appendix F, Table 100 to Table 106 for the previous years (2015-16 to 2021-22). Sampling for pesticides was expanded in 2017-18 and 2018-19 in order to populate the Pesticide Risk Baseline, and dropped back to a more routine sampling regime in 2019-20 and 2020-21 which did not include the Barron or Mossman basins. Pesticide monitoring was conducted in the Mossman River during 2022-23 hence the scores and grades are available for reporting. Pesticide monitoring was also conducted at several sub-catchment sites across the Wet Tropics region for 2022-23. The relative contribution of chemicals to pesticide risk

are presented for these additional sites alongside the routine sampling sites for 2022-23 and previous years in Appendix B , Figure 24 to Figure 27.

Note that for 2016-17 and 2015-16 the PRM was calculated from 13 PSII herbicides. The back-calculated PRM for 2016-17 for the 22 pesticides was provided for reference in the results technical report for 2017-18 (WTW 2019).

Table 4 The percentage of species protected for basins using the pesticide risk metric, based upon 22 pesticides, and the standardised pesticide scores for the 2022-23 reporting period.

	Pesticide risk metric	
Basin	**Percent species protected**	**Standardised score**
Daintree	>99	86
Mossman	95.8	65
Barron	nd	nd
Mulgrave	98.4	78
Russell	97.7	74
North Johnstone	>99	-
Johnstone (Coquette Point)	98.3	77
Tully	91.1	45
Murray	81.6	24
Herbert	94.0	57

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 Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. Note: the catchment upstream of the North Johnstone site is a sub-basin of the Johnstone Basin and only the Coquette Point site is used for scoring the Johnstone Basin. nd indicates no data or insufficient data available, - indicates not applicable as the North Johnstone site is not used to calculate the basin water quality score.

Additional information is provided in Appendix E about the pesticide risk metric, how pesticides can interact with waterway ecosystems and how to interpret the scoring ranges including percent of species protected.

The pesticide risk score for the Mossman, Mulgrave and Russel basins were slightly higher than the previous year and their grades remained 'good'. The Johnstone (Coquette Point) increased substantially from 69 to 77 and also remained 'good'. The Tully and Herbert basins declined from 'good' the previous year to 'moderate', whilst the Murray remained 'poor' but the score declined substantially from 40 to 24 (Table 5). The Murray has consistently recorded the poorest pesticide risk score, and has dropped to a score similar to previous years after an increase to 40 and just below the 'moderate' grade in 2021-22. For further explanation about the higher pesticide risk recorded for the Murray and how pesticide risk varies between sites in the Wet Tropics region refer to Appendix B in last year's results technical report (WTW 2023).

The proportional contribution of pesticide categories for all sites was highest for 'PSII herbicides' except for Mossman for which 'Insecticides' was highest (Figure 8). Since 2021-22 the proportions of pesticides have remained consistent except for a proportional increase of 'Insecticides' for Mossman and of 'PSII herbicides' for the Mulgrave with the proportion of 'Other insecticides' decreasing for

both basins. Note that the proportional contribution of pesticide categories was not presented for the Daintree and North Johnstone due to the very low concentrations recorded.

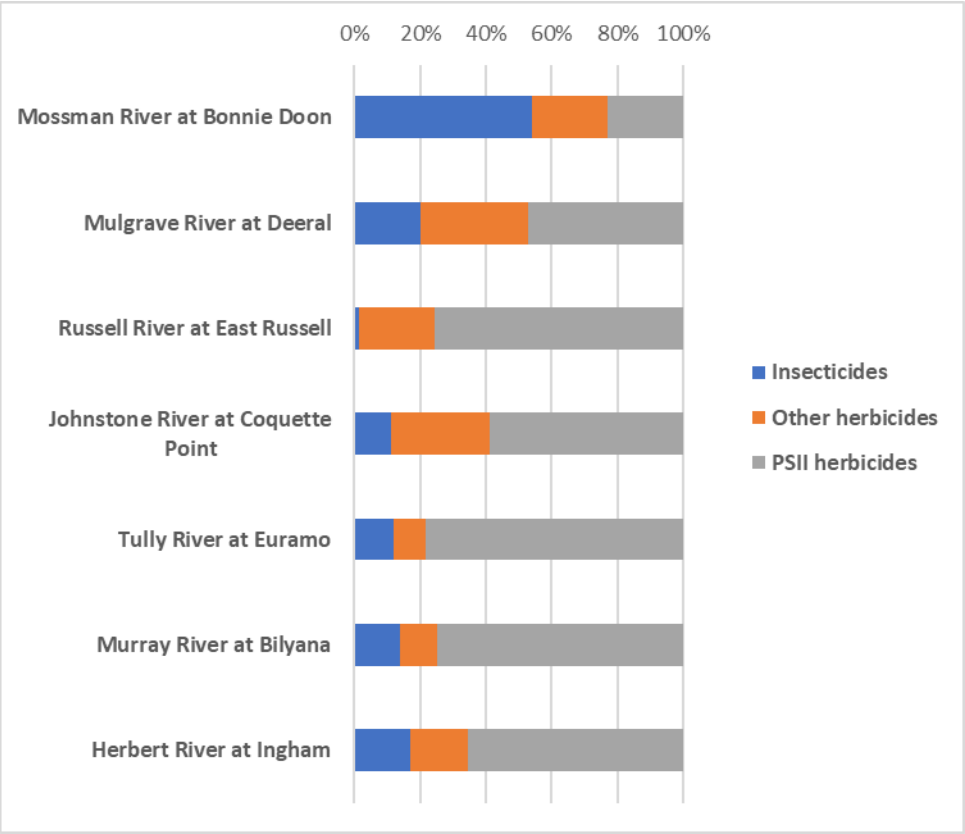

Figure 8 Percentage of pesticide categories contributing to the pesticide risk metric measure of percent species affected at basin sites.

Note: Daintree and North Johnstone sites were excluded due to the very low concentrations recorded.

The relative contribution of chemicals to pesticide risk for all monitored sites, which includes some additional sites used for calibration, is presented in Appendix B p.101. From 2021-22 to 2022-23 imidacloprid increased in relative contribution at Mossman, Tully, and Herbert, diuron increased in relative contribution at Tully, Murray and Herbert, and atrazine increased in the Herbert. Despite some recent declines in the pesticide risk, this measure increased notably for Tully, Murray and Herbert but decreased for the Johnstone (Coquette Point).

Application rates and the selection of pesticides for use on sugarcane crops varies between years due to a range of factors. The following Information from sugarcane industry support services provides insight into management practices during the 2022-23 reporting year. The selection of atrazine and diuron may have been influenced by their lower cost compared to alternative herbicide products, and by crop damage reported for newer alternative herbicides. Atrazine may have been selected as a preferred herbicide due to the high soil moisture content during 2022. Such practices could have contributed to the increased contribution of both chemicals to pesticide risk for 2022-23.

More information on past pesticide results including the relative contribution of chemicals to pesticide risk and additional sampling sites introduced in 2021-22 is provided in Appendix B of the 2021-22 results technical report (WTW 2023).

Pesticide concentrations for water samples collected by Water Quality and Investigations for the Catchment Loads Monitoring, which includes the monitoring sites in the Wet Tropics region, are available from the Pesticide Reporting Portal.

Key messages: pesticides

- The Murray continued to have the poorest condition with respect to pesticide toxicity, and decreased substantially in score since the previous year.
- The Tully and Herbert declined in grade from 'good' to 'moderate'.
- The Daintree and North Johnstone sites had the lowest concentrations of pesticides, and therefore, the lowest toxicity risk.
- Compared to the previous year the Tully, Murray and Herbert notably decreased in score meaning their toxicity risk increased.
- The Johnstone (Coquette Point) notably increased in score meaning its toxicity risk declined.
- Since the previous year the proportional contribution of insecticides increased to the highest of the three categories for Mossman.
- Contribution of imidacloprid to pesticide risk increased for the Mossman, Tully and Herbert
- Contribution of diuron to pesticide risk increased for Tully, Murray and Herbert.

Sediment and nutrients

The scores and grades for water quality indicators, indicator categories and water quality index for 2022-23 are presented in Table 5. The complete water quality scores for 2021-22 back to 2015-16 are presented in Appendix G Table 100 to Table 106. Water quality scores for 2014-15 are available from the results visualisations at the WTW website. The water quality monthly values for TSS, DIN and FRP concentrations along with scores and grades are presented separately for high flow and base-flow conditions in Appendix B (Table 60 to Table 69). Box and whisker plots of all data points for TSS, DIN and FRP concentrations of each basin for high flow and base-flow are presented in Appendix B (Figure 21 to Figure 23). Note that water quality sampling for the Mossman Basin was limited to lower flow conditions only, whilst for the Daintree Basin site water quality reporting for base-flow periods began in 2019-20, and added to the reporting for high flow periods, which began in 2017-18. Further information is available in the methods technical report (WTW 2024).

Table 5 Basin water quality index, indicator category and indicator scores and grades for the 2022-23 reporting period and water quality index results for preceding years.

Basin	Sediment	Nutrients			Pesticides	Water quality
	TSS	DIN	FRP	**Nutrients**		
Daintree	83	82	73	**78**	**86**	**82**
Mossman~	84	40	68	**54**	**65**	**68**
Barron	80	56	43	**49**	**nd**	**64**
Mulgrave	90	41	60	**50**	**78**	**72**
Russell	90	55	69	**62**	**74**	**75**
Johnstone	90	73	47	**60**	**77**	**75**
Tully	90	44	74	**59**	**45**	**64**
Murray	82	33	59	**46**	**24**	**51**
Herbert	82	38	74	**56**	**57**	**65**

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. nd indicates no data or insufficient data available. *Pesticide score was calculated from monitoring at the Coquette Point GBR CLMP site on the Johnstone River downstream of the confluence with the South Johnstone River. ~Mossman River was assessed for base-flow only. For each basin DIN and FRP indicator values are averaged to provide the nutrient indicator category score (presented in bold) and the three indicator categories (sediment, nutrients and pesticides) are averaged to provide the WQ score (all presented in bold).

The 2022-23 year began with higher-than-average rainfall across the region in July and for most basins in August. The wet season had average or above average rainfall until March, then rainfall was below average until the end of the year with driest conditions occurring across the region in May compared to the monthly averages (Figure 3). The higher-than-average rainfall in July was most extreme for the four basins in the north of the region which had rainfall in the top 1 % of records.

During 2022-23 the Barron monitoring site at Myola had 290 days of the year above the base-flow threshold (8.2 m^3/s). Over the year there were 89 sampling events over 10 months for nutrients and sediment and all occurred at times when discharge was above the base-flow threshold. Consequently, there were no base-flow scores for TSS, DIN and FRP.

For 2022-23 the grades for sediment (total suspended solids) were ‘very good’ for all basins except for the Barron which was ‘good’ and scored 80. Grades improved from ‘good’ the previous year for the Mulgrave and Tully basins. From 2014-15 to 2022-23, sediment has scored consistently high with grades of ‘good’ or ‘very good’ for all basins expect for the Barron in 2019 which graded ‘moderate’.

For 2022-23 nutrients remained ‘good’ for the Daintree and Russell but declined from ‘good’ to ‘moderate’ in the Barron (both DIN and FRP decreasing in score). All other basins remained ‘moderate’ with slight declines in score for the Mossman, Mulgrave, Herbert and increases in score for Johnstone Tully and Murray. The plots for DIN and FRP (Figure 9) for all basins show that DIN scores have been higher for Daintree, Johnstone, and Barron with grades typically ‘good’ or ‘very good’ whilst grades for all other basins have been ‘moderate’ or ‘poor’. Unlike DIN, which has not shown a decreasing or increasing trend in score over time, FRP has tended to decrease in score over time for Mossman, Barron, Russell, Johnstone, Murray, and Herbert, whilst scores for the other basins have fluctuated but not shown as clear a decrease in score over time. Interactive visualisations for all indicator scores and zones can be viewed on the WTW website dashboard.

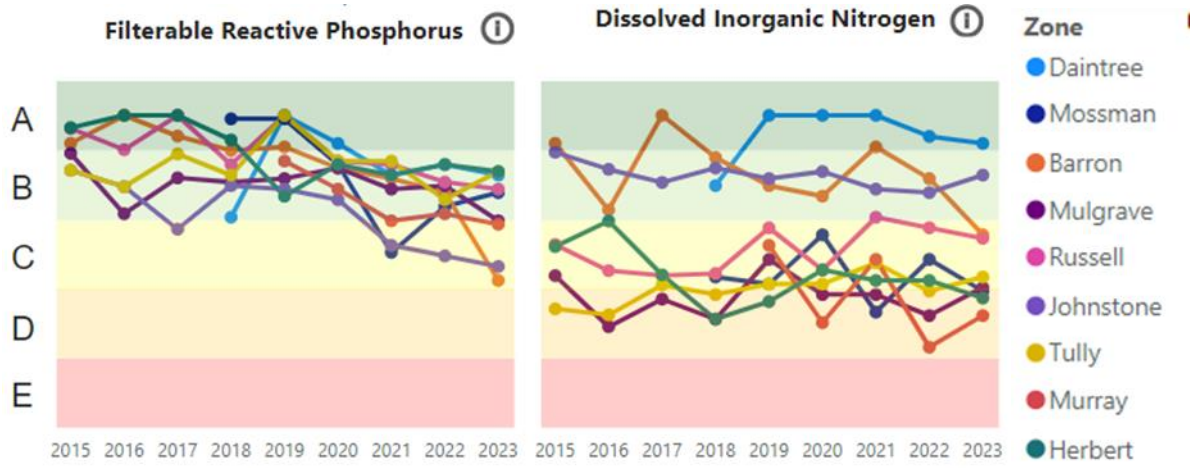

Figure 9. Filterable reactive phosphorus (FRP) and dissolved inorganic nitrogen (DIN) grades and scores for all basins from 2014-15 to 2022-23. (E – very poor (0-20), D – poor (21-40), C – moderate (41-60), B – good (61-80), A – very good (81-100))

For the basins where both high flow and baseflow conditions are monitored (all basins except the Mossman), FRP has had poorer scores during high flow conditions over the last four years for all basins. The annual score for TSS, DIN and FRP is calculated from the high flow and baseflow scores weighted by the proportion of days in the year within each flow type. The number of high flow days has tended to increase over time for most basins (Figure 10) and this, in combination with typically lower scores for FRP during high flow periods, may have contributed to the trend of decreasing FRP scores over time. The tendency for the FRP score to decrease with an increase in the number of high flow days is presented for the Barron Basin as an example (Figure 11).

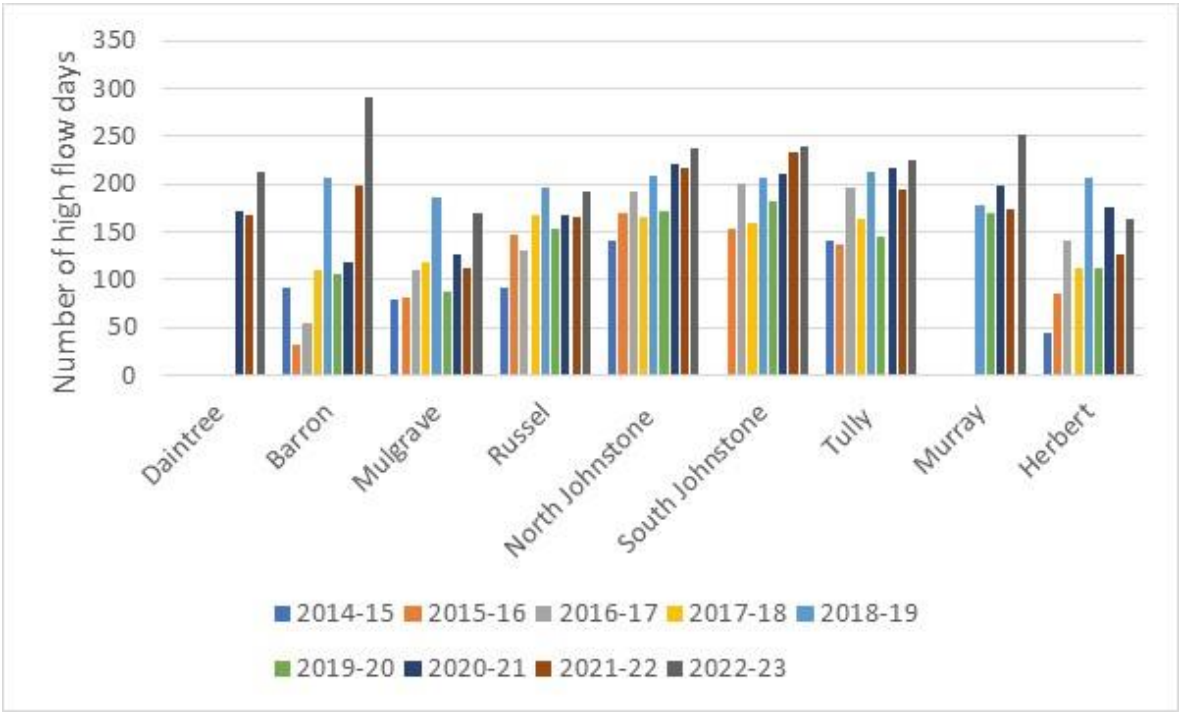

Figure 10 Number of high flow days per year for each basin from 2014-15 to 2022-23.

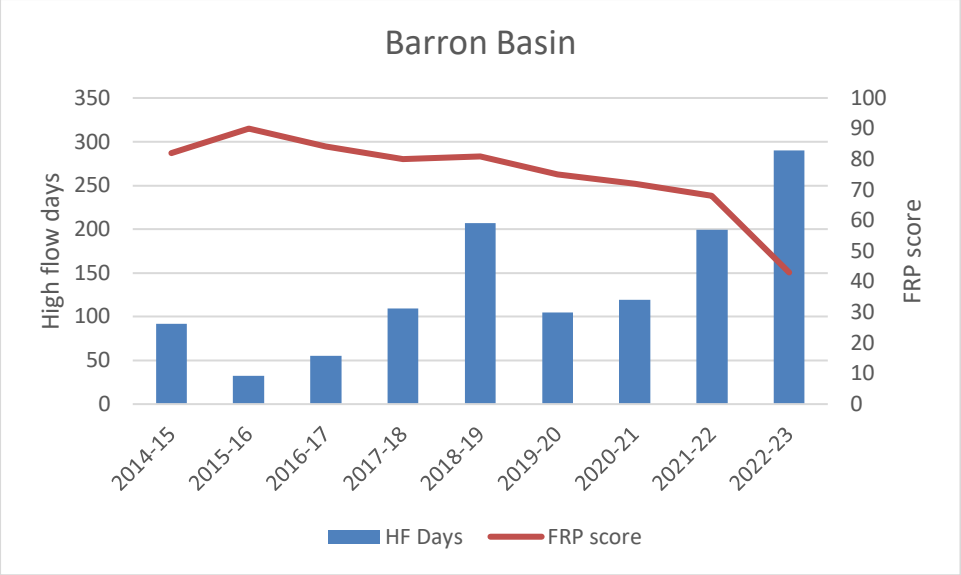

Figure 11 Plot of filterable reactive phosphorus (FRP) and number of high flow (HF) days per year for the Barron Basin over all reporting years.

Key messages: sediment

- The grades for sediment (total suspended solids) were 'very good' for all basins except for the Barron which was 'good' and scored 80. Grades improved from 'good' the previous year for the Mulgrave and Tully basins.
- During baseflow conditions the highest TSS concentration occurred in the Herbert in late November, recorded when discharge was increasing just following a period when the river was at its lowest discharge of the year.
- During high flow conditions the highest TSS concentration occurred in the Daintree during February coinciding with a rapid increase in discharge from ~400 to ~2000 m^3/s.
- Across all basins most monthly medians met the guideline values, which resulted in 'good' or 'very good' grades during both high flow and baseflow conditions.

Key messages: nutrients

- Nutrients declined from 'good' to 'moderate' in the Barron (both DIN and FRP decreasing in score), remained 'good' for Daintree and Russell and 'moderate' for the other basins.
- From 2014-15 to 2022-23 DIN scores have been higher for Daintree, Johnstone and Barron with grades typically 'good' or 'very good', whilst grades for all other basins have been 'moderate' or 'poor'. DIN scores have not shown a general increase or decrease over time.
- From 2014-15 to 2022-23 FRP score has tended to decrease over time for Mossman, Barron, Russell, Johnstone, Murray and Herbert, with scores for the other three basins fluctuating but not showing a decrease in score over time.
- For the basins where both high flow and baseflow conditions are monitored (all basins except the Mossman, and the Barron which had monitoring only on high flows), FRP had poorer scores during high flow conditions. This seasonal pattern also occurred for the three previous years (2019-20, 2020-21 and 2021-22).

The water quality index is a proxy for condition and is generated by comparing instantaneous water quality measurements (for example nutrient concentrations) against guideline values. The results do not directly relate to measurement of sediment, nutrient and pesticide loads. Programs that assess pollutant loads, for example Paddock to Reef, also apply modelling to standardise the effects of rainfall and climate variation (Hateley et al. 2014). This means that, during drier years, condition assessments such as the water quality index may represent areas that are identified as high risk for water quality more favourably than loads assessments. Condition assessments should therefore not be used as a proxy for loads.

Confidence

Confidence scores and ranks for sediment, nutrients, pesticides and water quality index for freshwater basin water quality results are shown in Table 6. Confidence scores (1 – 3) for each criterion were weighted according to the 2017 updated methods for assessing confidence (WTHWP 2017). There was higher confidence in the sediment and nutrients results than in the pesticide results. For all three indicator categories 'representativeness' received the lowest score available (1 out of a possible 3). This was due to the low spatial representation of monitoring in the basins where monitoring mostly occurs at a single site and pesticides are monitored for only part of the year (wet season only).

Table 6 Confidence associated with sediment, nutrients and pesticides results in freshwater basins.

Indicator category	Maturity of methodology (x0.36)	Validation (x0.71)	Represent-ativeness (x2)	Directness (x0.71)	Measured error (x0.71)	Final score	Rank
Sediment	3	3	1	3	2	8.8	3
Nutrients	3	3	1	3	2	8.8	3
Pesticides	3	2	1	2	2	7.3	2
Water quality index							
Basins with pesticide monitoring*	3	2.7	1	2.7	2	8.3	3
Basins without pesticide monitoring*	3	3	1	3	2	8.8	3

Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are the sum of the weighted confidence criteria. **Rank based on final score:** 1 (very low): 4.5 – 6.3; 2 (low): >6.3 – 8.1; 3 (moderate): >8.1 – 9.9; 4 (high): >9.9 – 11.7; 5 (very high): >11.7 – 13.5. *All basins have pesticide monitoring except for the Barron. Pesticide monitoring in the Barron Basin ceased after the 2018-19 reporting year.

4.2. Habitat and Hydrology

The habitat and hydrology index scores and grades for all reporting years are presented in Table 7, and the index consists of instream habitat modification, flow, riparian extent, wetland extent and invasive weeds.

The habitat and hydrology index is comprised of four longer-term indicator categories that are scheduled to be updated every four years: wetland extent (updated for 2022-23), riparian extent,

invasive weeds (updated for 2019-20), instream habitat modification (impoundment length (updated for 2022-23) and fish barrier indicators (in development)). Note that the riparian extent indicator has not been updated since reporting for the Wet Tropics commenced (2014-15 data) due to a lack of appropriate pre-clear mapping data. The Program Design provides the full schedule for when new data are to be presented for longer-term indicators that are reported for periods longer than a year (WTHWP 2018). The annual scores for the habitat and hydrology index from 2015-16 to 2016-17 represented changes resulting from the addition of indicators and not changes in existing indicator scores themselves. During the reporting period from 2015-16 to 2016-17, invasive weeds reporting commenced in 2015-16 and flow reporting commenced in 2016-17, whilst riparian extent, wetland extent and impoundment length were not updated. Changes in scores between 2019-20 to 2021-22 were due to the annual update of the flow indicator, with all other indicators remaining unchanged. Changes in score for 2022-23 were due to the update of the impoundment length indicator, flow indicator and wetland extent.

Table 7 Basin habitat and hydrology index scores and grades for all reporting years

Basin	Habitat and hydrology							
	22-23	21-22	20-21	19 -20	18 -19	17 -18	16 -17	15 -16
Daintree	77	78	78	78	80	80	81	81
Mossman	65	68	72	68	56	63	63	55
Barron	45	45	44	46	47	45	47	43
Mulgrave	65	66	67	66	63	71	65	66
Russell	66	69	69	66	63	69	70	63
Johnstone	57	60	64	63	59	65	65	57
Tully	58	62	63	56	54	65	61	57
Murray	58	55	58	55	56	58	55	54
Herbert	56	59	60	56	57	61	56	54

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

Habitat modification (instream)

The habitat modification indicator category was based upon the impoundment length indicator only (updated for 2022-23), since the fish barrier condition indicator is still in development. Impoundment length scores and grades are provided in Table 8. Since the previous assessment there were no changes to existing impoundments or construction of new impoundments. The 2022-23 assessment did identify four existing impoundments in the region that were not included in the previous assessments. The additional impoundments were the Tully Falls Weir impounding 3.6 km of waterway on the Tully River (Tully Basin), Gedges crossing impounding 2.9 km of waterway on the Herbert River (Herbert Basin), Victoria Mill weir impounding 4.2 km of waterway on Palm Creek (Herbert Basin) and Lagoon Creek weir (Herbert) impounding 1.5 km of waterway on Lagoon Creek. The additional impounded waterway lengths resulted in a decrease in score of 57 to 52 for the Tully Basin and 92 to 87 for the Herbert Basin whilst the grades remained moderate for the Tully Basin (5.3 % of waterway length impounded) and very good for the Herbert Basin (0.7 % of waterway length impounded) (Table 8). There were no impoundments on streams of order three or higher in the Daintree, Mossman, Mulgrave, Russell, and Murray basins, and 0.1% impounded streams on the Johnstone giving a condition score of ‘very good’. The Barron received a ‘poor’ with 7.7% of the total

length of the streams (order three and above) impounded by artificial structures. The Barron and Tully have the lowest scores due to large water infrastructure such as Tinaroo Dam (Barron) and Koombooloomba Dam (Tully). The impoundment length indicator is updated every four years and was initially reported for the 2014-15 reporting period.

Table 8 Results for impoundment length indicator for basins.

Basin	Not impounded (km)	Impounded (km)	Total (km)	% total	Standardised score	Grade
Daintree	2,795	0	2,795	0.0	100	VG
Mossman	335	0	335	0.0	100	VG
Barron	791	66	857	7.7	36	P
Mulgrave	344	0	344	0.0	100	VG
Russell	174	0	174	0.0	100	VG
Johnstone	782	1	783	0.1	98	VG
Tully	457	26	483	5.3	52	M
Murray	351	0	351	0.0	100	VG
Herbert	3,282	22	3,304	0.7	87	VG

Impoundment (% total): Very Poor = ≥10% | Poor = 7 to <10% | Moderate = 4 to <7% | Good = <4 to 1% | Very Good <1%. **Standardised scoring range:** Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100

The score and grade for the habitat modification indicator category are presented in Table 9.

Table 9 Results for habitat modification indicator category for basins.

Basin	Fish barrier condition score	Impoundment length condition score	Habitat modification grade
Daintree	nd	100	VG
Mossman	nd	100	VG
Barron	nd	36	P
Mulgrave	nd	100	VG
Russell	nd	100	VG
Johnstone	nd	98	VG
Tully	nd	52	M
Murray	nd	100	VG
Herbert	nd	87	VG

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. nd indicates no data available.

Habitat extent

Of the two habitat extent indicators, wetland extent was updated for 2022-23 from mapping data of 2019. Riparian extent was not updated for 2022-23 due to insufficient data.

The scoring and grading of habitat extent is based upon the percentage of habitat extent loss and applies formulas to convert the percent loss value to a standardised score (Table 10). Further information on the methods used for generating the habitat extent indicators are provided in the methods technical report (WTW 2024).

Table 10 Scoring ranges, grades and standardisation formula for the habitat extent indicators.

Percent of habitat loss	Grade	Scaling of scores for aggregation
≤5.0%	Very Good	VG = 81+ ABS((19 - ((score-0) *(19/4.9))))
>5.0-15.0%	Good	G= 61+ ABS((19.9 - ((score -5.1) *(19.9/9.9))))
>15-30.0%	Moderate	M=41+ ABS((19.9 -((score -15.1) *(19.9/14.9))))
>30-50%	Poor	P= 21+ ABS((19.9- ((score -30.1) * (19.9/19.9))))
>50%	Very Poor	VP=ABS((20.9 - ((score-50.1) *(20.9/49.9))))

The riparian extent percent loss since pre-clearing, and the scores and grades are shown for each basin in Table 11.

Table 11 Results for riparian vegetation extent indicator: percent loss from pre-clearing to 2013.

Basin	Riparian extent loss (%) to 2013	Standardised score	Grade
Daintree	0.0	99	VG
Mossman	11.5	68	G
Barron	11.1	68	G
Mulgrave	6.1	78	G
Russell	5.7	79	G
Johnstone	8.1	74	G
Tully	9.0	72	G
Murray	7.8	75	G
Herbert	3.9	85	VG

Riparian extent (% loss): Very Poor = >50% | Poor =>30 to 50% | Moderate = >15 to 30% | Good = >5 to 15% | Very Good ≤5%. **Standardised scoring range:** : ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. **Note**: These results are for extent of riparian (woody vegetation), not condition.

The Daintree and Herbert scored 'very good', with all other basins scoring 'good'. The midlands and uplands generally have better riparian extent due to protected areas and less development, whilst the lowlands are poorer due to development and land use. The riparian extent indicator is updated when riparian extent mapping updates are produced by the Remote Sensing Centre, Department of Environment and Science. The period of update for the Wet Tropics report card is generally every four years. However, the mapping data from 2017 onward has been undergoing considerable change to satellite imagery used and data processing to improve resolution and accuracy of vegetation mapping. Updated mapping was released in 2023 and this will also require revision to the riparian extent indicator to align with the new data sets.

The wetland extent percent loss as at 2019 since pre-clearing, and the scores and grades, along with the hectares lost since 2017, are shown for each basin in Table 12.

Table 12 Results for wetland extent indicator: percent wetland loss from pre-clearing to 2019 and hectares lost from 2017-2019.

Basin	Wetland Extent Loss (%) to 2019	Standardised Score	Hectares lost 2017 - 19
Daintree	20.4	53	2
Mossman	63.3	15	0
Barron	78.7	8	0
Mulgrave	40.0	31	0
Russell	46.8	24	0
Johnstone	55.9	18	0
Tully	63.0	15	6
Murray	51.7	20	5
Herbert	56.5	18	4

Wetland extent (% loss): Very Poor = >50% | Poor =>30 to 50% | Moderate = >15 to 30% | Good = >5 to 15% | Very Good ≤5%. **Standardised scoring range:** Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. **Note:** These results are for wetland extent (palustrine water bodies), not condition of wetlands.

The Daintree was graded 'moderate', the Mulgrave and Russell graded 'poor' and all other basins graded 'very poor'. These results include a high level of historical loss of wetland extent since pre-clearing to 2019, due to development. Wetland area losses since 2017 occurred in the Daintree, Tully, Murray and Herbert basins and consisted of several hectares. Wetland loss is low in areas with no development or low levels of development, for example wetlands are largely intact in the upper freshwater catchment of the Daintree Basin. The wetland extent indicator is typically updated every four years.

The wetland area version releases are based on updated mapping procedures and can result in changes of estimated wetland areas, which are evident when comparing wetland area estimates for the same year from each version. For Version 5 and previous versions the pre-clearing wetland extent remaining was estimated from regional ecosystem pre-clear and remnant mapping for all regional ecosystems identified as wetlands, which included areas of modified wetlands. The updates for Version 6 generate a preclearing wetland extent layer based on regional ecosystem mapping and wetland waterbody mapping and provides a more accurate estimation of the likely extent of pre-clearing wetlands. Version 6 with mapping up to 2019 (released in 2023 (DES 2023)) compared to version 5 with mapping up to 2017 (released in 2019 (DES 2019)) estimated that palustrine wetland areas were greater for 2017 in all basins except the Mossman and Barron which decreased, and greater for pre-clear in all basins except Mossman which decreased (Table 13). The estimated wetland loss since pre-clear in Version 6 compared to Version 5 was slightly higher for all basins except the Murray which declined marginally (Table 13). It is important to note that these differences in wetland area that occur between versions due to mapping updates relate to changes in methodology and not actual change (loss or gain) in wetland area, and need to be taken into account when comparing report card results produced from different versions.

Table 13 The estimated palustrine wetland area for 2017 and pre-clear, and the estimated percentage of palustrine wetland area cleared in 2017 produced from the 2019 wetland areas (Version 6) and 2017 wetland areas (version 5), with the difference in estimated palustrine wetland area values between the two mapping versions (version 6 2019 - version 5 2017)

	2019 Wetland Mapping (version 6)			2017 Wetland Mapping (version 5)			Difference between wetland mapping years (2019 - 2017)		
Basin	2017 area (ha)	Pre-clear (ha)	2017 area cleared (%)	2017 (ha)	Pre-clear (ha)	2017 area cleared (%)	2017 area (ha)	Pre-clear area (ha)	Loss since pre-clear (%)
Daintree	2274	2855	20.4	1967	2336	15.8	+307	+519	+5
Mossman	165	449	63.3	190	485	60.7	-25	-36	+3
Barron	279	1311	78.7	281	1048	73.2	-2	+263	+6
Russell/Mulgrave	8256	14865	44.5	8098	12946	37.4	+158	+1919	+7
Johnstone	4407	9987	55.9	4010	7313	45.2	+397	+2674	+11
Tully	4368	11779	62.9	4177	9893	57.8	+191	+1886	+5
Murray	5213	10782	51.7	4981	10718	53.5	+232	+64	-2
Herbert	12120	27826	56.4	11828	24605	51.9	+292	+3221	+5

Invasive weeds (aquatic)

The invasive weeds indicator was not updated for 2022-23. Invasive weeds are assessed and results updated every four years. The most recent assessment was for 2019-20. Information on the status of the recent outbreak of the Amazon frogbit (*Limnobium laevigatum*) in the Wet Tropics region was provided in the previous results technical report (WTW 2023).

The assessment of invasive aquatic weeds divides the actual basin impact score by the potential basin impact score of the basins to produce the percent impact score for each basin which are converted to standardised scores (0-100) (Table 14). Invasive weeds had the greatest percent impact score in the Murray and Herbert basins (both 'very poor') with substantial percent impact scores in the Barron and Johnstone ('poor'). Daintree, Mulgrave and Russell were moderately impacted. The lowest impacts were recorded in the Tully ('good') and Mossman ('very good').

Table 14 Results for invasive weed potential impact scores and grades for basins 2019-20.

Basin	Basin impact score	Potential impact score	Percent impact score	Standardised score	Grade
Daintree	1,174	8,692	13.5	54.4	M
Mossman	126	1,098	11.5	81.0	VG
Barron	1,962	12,512	15.7	34.7	P
Mulgrave	732	4,917	14.9	43.8	M
Russell	589	3,863	15.2	41.0	M
Johnstone	2,741	16,594	16.5	24.7	P
Tully	1,357	11,238	12.1	71.2	G
Murray	1,068	6,234	17.1	19.9	VP
Herbert	7,659	38,983	19.7	19.3	VP

Invasive weed percent impact score: Very Poor > 16.8 | Poor >15.2-16.8 | Moderate >12.8-15.2 | Good >11.5-12.8 | Very Good 0-11.5. **Standardised scoring range:** Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100.

Flow

All basins were assessed with the flow indicator for 2022-23 except for the Daintree Basin which was not assessable due to the lack of modelled pre-development data.

For the Wet Tropics region annual rainfall for the Mossman and Barron basins was above the average percentile range and all six basins to the south were within the average percentile range (Table 2, Figure 3). Monthly rainfall leading up to the wet season included months with above average rainfall for all eight basins with the northern basins (Mulgrave, Barron and Mossman) in the highest 1 percent of rainfall records for July, whilst the Russell and Johnstone recorded below average rainfall late in the dry season (Figure 3). Rainfall during wet season months (December to March) did not differ substantially from average. During May all eight basins had dry conditions with rainfall below or very much below monthly averages.

The flow indicator includes an assessment of the rainfall type for the reporting year and then compares the flows from the reporting year to modelled pre-development flows from past years with the same rainfall type. This means that the flow metrics for the reporting year provide scores based upon previous years with similar rainfall totals. The results are to be interpreted within the context of the prevailing rainfall conditions for the reporting year. The rainfall type, calculated by the flow indicator (Table 15), remained 'wet' for the Mossman and Mulgrave, 'average' for the Russell, and 'dry' for Tully basins, whilst conditions changed from 'average' to 'wet' for the Barron, and 'dry' to 'average' for the Murray and the Herbert since the previous year. Note that some differences can occur between rainfall classification produced by the flow indicator tool and BoM climate reporting (Figure 3) due to differences between the analyses used to assess rainfall.

Table 15 Rainfall type and number of flow assessment sites for 2022-23, and standardised flow indicator basin scores and grades for the 2022-23 and previous years.

Basin	Rainfall type	Number of assessment sites	Score and grade 2022-23	Score and grade 2021-22	2020-21	2019-20	2018-19	2017-18	2016-17
Daintree	-				nd	nd	nd	nd	nd
Mossman	Wet	1	61	75	95	75	61	95	95
Barron	Wet	7	78	77	69	80	65	51	62
Mulgrave	Wet	2	75	78	80	75	55	93	61
Russell	Average	2	86	91	91	76	61	95	95
Johnstone	Dry	5	72	77	96	92	66	97	96
Tully	Dry	1*	80	95	100	61	43	99	80
Murray	Average	2	75	61	78	61	68	78	61
Herbert	Average	12	73	80	86	66	69	92	62

Standardised scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd: no data available to assess the flow indicator for the Daintree Basin. *The only 2022-23 data available for the Tully Basin was the end of system site at Euramo on the Tully River, the additional flow assessment site at Cochable Creek had insufficient data during 2022-23 to assess.

With the exception of one site, the flow assessments sites in all basins were graded either 'good' or 'very good' (Appendix C Table 84) which corresponds to the majority of flow measures being within 68% of the expected range (Stewart-Koster *et al.* 2018). For most flow assessment sites the flow categories of cease to flow, low flows, low to medium flows and high flows, as represented by the 10 flow measures (Appendix C Table 84), were not substantially altered from modelled pre-

development in their capacity to provide key ecological values of water holes, low flow spawning fish, riffle habitats and fisheries production. The flow categories are representative of the conditions required for maintaining key hydraulic habitat and refuge within waterways.

The only assessment site that was graded below 'good' was Rudd Creek at Gunnawarra in the Herbert Basin (Queensland Government gauging station number: 116016A), which was graded 'moderate' and scored 49. The flow indicator compared the 2022-23 observed flows to modelled pre-development flows from previous years of the same 'average' rainfall type. The lower score was due to the measures for frequency of cease to flow and 10th percentile flows scoring 1 and 2 out of 5, respectively. Unseasonably high rainfall in July 2022 generated larger discharge than normal through until mid-September, a period where typically Rudd Creek at Gunnawarra would have ceased to flow. As evidenced in Figure 12, which presents the hydrographs and rainfall for 2022-23 (observed flow) and the representative 'average' rainfall type year for 2005-6 (observed and modelled predevelopment flow), the comparison shows the marked difference in flow and no-flow conditions during the dry season between the two years.

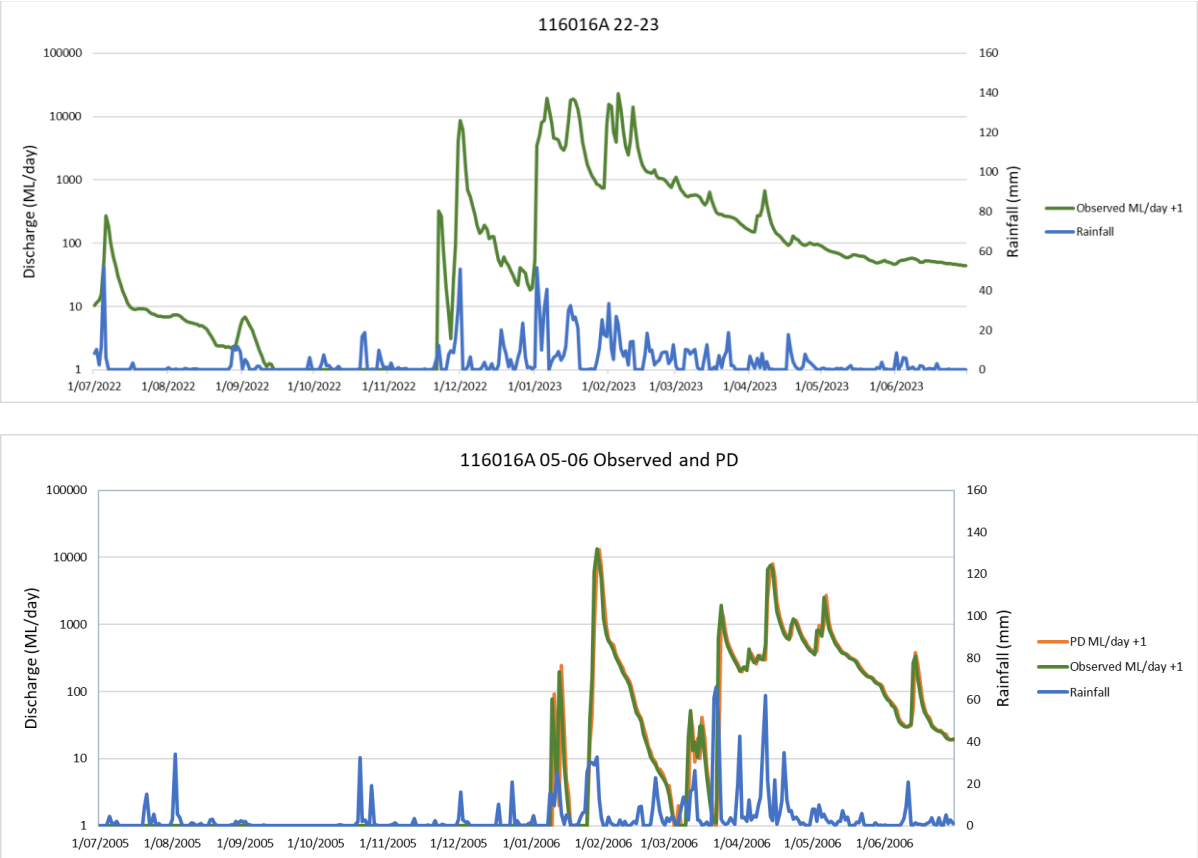

Figure 12 Discharge and rainfall at Rudd Creek at Gunnawarra Basin (Queensland Government gauging station number: 116016A) for observed flows during 2022-23 (top), and observed and modelled pre-development flows for 2005-6 (bottom). Note that discharge was transformed (+1) to allow for log scaling.

Seasonally flowing waterways are widespread in Australia and over 70% of Australian rivers are non-perennial (Sheldon *et al.* 2010). Non-perennial rivers support distinct ecosystems that differ from perennial rivers in their aquatic communities and biogeochemistry (Shanafield *et al*. 2024). Alteration of flow patterns in non-perennial rivers, including a shift to perennial flow, can occur from water resource development, such as flow supplementation but may also be driven by event-based rainfall or prolonged change in seasonal rainfall patterns. The implications of flow alterations to the ecosystems of non-perennial rivers are wide ranging (Shanafield *et al*. 2024).

Key messages: flow

- Annual rainfall for the Mossman and Barron basins was above the average percentile range whilst all six basins to the south were within the average percentile range.
- For the year, three basins had a wet rainfall type (Mossman, Barron, Mulgrave), two had a dry rainfall type (Johnstone and Tully) and the others had an average rainfall type.
- Flow assessment sites in all basins were graded either 'good' or 'very good' except for Rudd Creek at Gunnawarra in the Herbert Basin' which was 'moderate'.
- Unusually high rainfall early in the reporting year was likely to have decreased the score for Rudd Creek at Gunnawarra, which typically has very low flows or no flows at that time of year.

Habitat and hydrology index

The 2022-23 scores and grades for basin habitat and hydrology indicator categories and index are presented in Table 16. The habitat and hydrology indicator categories and index scores for basins from 2021-22 back to 2015-16 are presented in Appendix G Table 107 to Table 113.

Table 16 Results for habitat and hydrology indicator categories and index for2022-23

Basin	Flow	Invasive weeds	Habitat modifi-cation	Riparian extent (change)	Wetland extent (change)	2022-23
Daintree	nd	54	100	99	53	**77**
Mossman	61	81	100	68	15	**65**
Barron	78	34	36	68	8	**45**
Mulgrave	75	43	100	78	31	**65**
Russell	86	41	100	79	24	**66**
Johnstone	72	24	98	74	18	**57**
Tully	80	71	52	72	15	**58**
Murray	75	19	100	75	20	**58**
Herbert	73	19	87	85	18	**56**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available. The habitat and hydrology index (scores in bold) is an average of the five indicator categories.

Confidence

Confidence for habitat and hydrology results are shown in Table 17. Confidence scores (1 – 3) for each criterion have been weighted according to the 2017 updated methods for assessing confidence (WTHWP 2017).

Table 17 Confidence associated with habitat and hydrology indicator results in basins.

	Maturity of method-ology (x0.36)	Valid-ation (x0.71)	Represent-ativeness (x2)	Direct-ness (x0.71)	Measured error (x0.71)	Final	Rank
Impoundment length	2	2	3	2	1	10.2	4
Riparian extent	2	2	2	2	2	8.9	3
Wetland extent	3	2	2	2	2	9.3	3
Invasive weeds	2	2	3	2	2	10.9	4
Flow: Mossman, Mulgrave, Russell, Tully Murray	1	2	1	1	1	5.2	1
Flow: Barron, Johnstone, Herbert	1	2	2	1	1	7.2	2
Habitat and Hydrology							
Daintree	2.3	2	2.5	2	1.8	10.5	4
Mossman, Mulgrave, Russell, Tully Murray	2	2	2.2	1.8	1.6	9.6	3
Barron, Johnstone, Herbert	2	2	2.4	1.8	1.6	9.8	3

Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are the sum of the weighted confidence criteria. **Rank based on final score:** 1 (very low): 4.5 – 6.3; 2 (low): >6.3 – 8.1; 3 (moderate): >8.1 – 9.9; 4 (high): >9.9 – 11.7; 5 (very high): >11.7 – 13.5.

4.3. Fish

The basin fish index was updated for 2022-23 from fish surveys conducted during 2021-22 for the Herbert Basin only. The basin fish assessment commenced in the 2017-18 reporting period with assessments for the Mulgrave and Russell basins. The assessment was expanded in 2019-20 and surveys were conducted in all basins except for the Daintree. The assessment was updated for 2022-23 for the Herbert Basin from surveys conducted from 2021-22 across the basin. For details of the methods and results of 2017-18 refer to WTW 2020a (methods) and WTW 2020b (results). The number of sites surveyed, the total number of fish species caught, and the number of alien species (species introduced into Australia) and translocated species (Australian species moved to areas outside their natural distribution) caught for the 2019-20 reporting for each basin and the 2022-23 reporting for the Herbert Basin are presented in Table 18. The results for the proportion of indigenous fish species (POISE) caught and the proportion of non-indigenous fish (PONI) caught (comprised of the proportion of alien fish and translocated fish measures) are presented as indicator scores and standardised scores in Table 19. Further results of the fish assessment in Appendix E present the list of fish species caught in the Wet Tropics region (Table 86), the fish species caught at the sites within each basin (Table 87 to Table 95), the translocated and alien species caught within each basin (Table 96) and, for the 2019-20 assessment, box plots showing the distribution of sites for each basin in relation to the POISE and PONI indicators (Figure 29).

Table 18 The number of sites surveyed, the total number of species caught, and the number of alien and translocated species caught, for each basin during the 2019-20 fish assessment, and 2021-22 (Herbert Basin only) fish assessment.

Assessment period	Basin	Number of sites	Number of species caught	Number of alien species caught	Number of translocated species caught
2019-20					
	Mossman	13	22	2	0
	Barron	11	29	2	13
	Mulgrave	13	38	3	0
	Russell	14	38	3	0
	Johnstone	11	30	4	3
	Tully	11	36	3	0
	Murray	13	32	3	1
	Herbert	28	41	5	3
2021-22					
	Herbert	16	53	3	6

It is important to note that 'Translocated' refers to Australian native species that were found in waterways within which they do not naturally occur, and 'Alien' refers to fish species from outside of Australia. Some species are indigenous to the lowland sections of some basins but have been translocated to upper sections above waterfalls. This is particularly the case for the Barron Basin as described in the key messages below.

Translocation of fish species in the Wet Tropics region has occurred for over 100 years and more recently this activity has been regulated with the introduction of permits for fish stocking in 1996 (Burrows 2004). The stocking of fish under permits in the Wet Tropics region has been conducted in lower river reaches of the Barron, Mulgrave, Russell, Johnstone, Tully, Murray and Herbert and also in the more heavily stocked impoundments of Tinaroo Falls Dam (Barron River, Atherton Tablelands) and Koombooloomba Dam (headwaters of the Tully River) (Burrows 2004). Fish species stocked under permits in these two impoundments in recent years are barramundi (*Lates calcarifer*) and sooty grunter (*Hephaestus fuliginosus*), with limited stocking of northern saratoga (*Scleropages jardini*) in Tinaroo Falls Dam (Queensland Government 2020). These species do not naturally occur at these locations. Of these species, barramundi is unable to develop self-sustaining populations in impoundments due to its life cycle requirement for migration to marine environments to reproduce, whilst sooty grunter has established self-sustaining populations in Koombooloomba Dam (Burrows 2004). There has been no evidence that northern saratoga became successfully established in Lake Tinaroo (Queensland Government 2020). These populations can potentially contribute to the number of translocated fish reported for the fish assessment if they move from impoundments into connected waterways that are surveyed.

Table 19 Results for the freshwater basin fish indicators and index for 2022-23 and 2019-20, and fish index results for 2017-18.

		Fish indicator scores				Standardised scores			
Assessment period	**Basin**	**POISE**	Prop Trans	Prop Alien	**PONI**	**POISE**	**PONI**	**Fish**	**Fish 17-18**
2019-20	Mossman	0.63	0.00	0.00	0.00	55	100	**77**	
	Barron	0.67	0.06	0.02	0.13	60	35	**48**	
	Mulgrave	0.79	0.00	0.01	0.01	79	89	**84**	76
	Russell	0.91	0.00	0.01	0.01	91	94	**92**	86
	Johnstone	0.78	0.00	0.02	0.04	78	66	**72**	
	Tully	0.80	0.00	0.00	0.00	81	100	**90**	
	Murray	0.72	0.00	0.00	0.01	68	92	**80**	
	Herbert	0.81	0.00	0.00	0.02	81	88	**85**	
2022-23	Herbert	0.73	0.00	0.00	0.01	70	95	**83**	

Fish indicator scoring range POISE: ■ Very Poor = 0 to <0.4 | ■ Poor = 0.4 to <0.53 | ■ Moderate = 0.53 to <0.67 | ■ Good = 0.67 to <0.8 | ■ Very Good = 0.8 – 1; **PropTrans, PropAlien, PONI:** ■ Very Poor = >0.2 to 1 | ■ Poor = >0.1 to 0.2 | ■ Moderate = >0.05 to 0.1 | ■ Good = >0.03 to 0.05 | ■ Very Good = 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 – 100. Fish indicator scores are the proportion of indigenous species expected (POISE), and proportion of non-indigenous fish (PONI). The PONI indicator is the median of the proportion of translocated fish (PropTrans) and proportion of alien fish (PropAlien) measures summed for each site. nd indicates no data available.

The 2022-23 results were based on surveys at fewer sites in the upper Hebert Basin and four additional sites in the coastal areas of the Herbert Basin compared to the previous assessment. Since the previous assessment, the fish index remained 'very good', POISE declined from 'very good' to 'good', and PONI remained 'very good' and increased in score. The sites in the upper basin have a much lower number of expected indigenous species than the coastal sites, and typically scored higher for POISE, whilst the scores for PONI were typically higher for the coastal sites which tended to have higher species diversity and abundance of native fish. Fish communities are separated between the coastal waterways and upper catchments of the Herbert Basin by the physical barriers of the mountainous terrain.

Whilst the 2019-20 and 2022-23 results for the Herbert Basin had 'very good' grades for the proportion of non-indigenous fish numbers across the survey sites, the highly invasive species Mozambique tilapia (*Oreochromis mossambicus*) was detected during both survey runs. For the 2019-20 surveys (reported for 2019-20), the species was present at low numbers at three sites in the upper Herbert Basin (Rudd Creek, Wild River and Herbert River), and in the 2021-22 surveys (reported for 2022-23), the species was present at higher numbers across two sites in the upper Herbert Basin (Rudd Creek and Herbert River) and was also present in the main channel of the Herbert River in the lower basin. More recent fish monitoring in the Herbert Basin (2022-23) as part of the Fish Homes and Highways fish barrier project (Terrain NRM 2024) has detected the presence of *O. mossambicus* at Tyto wetlands on Log Bridge Creek, a tributary of Palm Creek which drains into the main channel of the Herbert River in the lower basin. Multiple fish surveys for this project have caught increasing numbers of *O. mossambicus* over 18 months period at the Tyto Wetland site. These finding demonstrate the importance of freshwater fish surveys to detect changes in the distribution and abundance of invasive fish species and identify locations and spread of invasive fish species such as *O. mossambicus* to enable targeted management and control.

Fish stocking

From the Queensland Department of Agriculture and Fisheries fish stocking records in Wet Tropics basins for 2010 to 2018, the only species stocked during this period has been barramundi. The most recent stocking and the most fish stocked has been in impoundments with Tinaroo Falls Dam receiving the greatest numbers (Table 20). Numbers stocked into rivers was highest for the Herbert River but occurred in 2010 whilst lower numbers were stocked into the other river locations in the Mulgrave and Russell basins during 2012 (Table 20). The most likely influence of fish stocking on survey results would be linked to the impoundments in the Barron and Tully basins due to the high numbers stocked and the more recent stocking events. There were no barramundi recorded during assessments at sites within the Barron Basin and the species was only recorded at two Tully sites, both in lowland tributaries of the Tully River (Appendix E), demonstrating that stocked barramundi could not have had a substantial effect on report card results.

Table 20 Barramundi stocking locations, year and numbers stocked for the Wet Tropics region from 2010 to 2018.

Basin	Location	Year	Total stocked
Barron	Barron River	2012	500
	Tinaroo Falls Dam	2010-18	141007
	Copperlode Dam	2016-17	26925
Mulgrave	Trinity Inlet	2012	500
	Mulgrave River	2012	500
Russell	Russell River	2012	500
Tully	Koombooloomba Dam	2010-2018	15370
Herbert	Herbert River	2010	8741

Data source: Queensland Government (https://www.data.qld.gov.au/dataset/queensland-freshwater-fish-stocking-records)

Key messages: fish

2019-20 assessment period

- The Mossman and Barron basins had the lowest observed species diversity compared to expected, with both basins graded moderate for the POISE indicator.
- The Russell Basin had the highest observed species diversity compared to expected.
- All basins, except for the Barron and Johnstone, were graded ‘very good’ for the proportion of non-indigenous fish indicator meaning they had low numbers of translocated and alien species.
- The Barron was graded ‘poor’ for the proportion of indigenous fish indicator, with translocated fish species rather than alien fish species representing most of the non-indigenous fish species present.
- Most of the Barron catchment is above the Barron Falls which is a natural barrier to fish movement. The upper-Barron catchment is located upstream of Tinaroo Falls which may have been a significant natural barrier to fish and is now the site of Tinaroo Falls Dam. Consequently, the species diversity of fish in the catchment upstream of the Barron falls is naturally depauperate. The stocking of fish species into the Barron has been common practice and the fish fauna upstream of Barron Falls is one of the most modified in Australia (Burrows 2004).

- The fish index for basins was 'very good' except for the Mossman, Johnstone and Murray graded 'good' and the Barron graded 'moderate'.
- Fish assemblages showed substantial spatial variation within each basin. Whilst the basin scores are based on the median values from all sites, at the site level the scores for both indicators varied considerably (Appendix D Figure 29).

2022-23 assessment period

- The fish index remained 'very good' for the Herbert Basin.
- The proportion of indigenous species expected declined from 'very good' to 'good' whilst the proportion of non-indigenous fish (translocated and alien species) remained 'very good'.

Fish communities and risk to species from pesticides

Whilst the 2019-20 risk assessment of pesticides identified high risk to species of biota for the Murray River (graded 'poor' with 80 - <90% of species protected), the health of the waterways in terms of the fish index for the Murray basin (based upon fish species counts and species diversity but not species population health) was graded 'good'. The pesticide risk metric is based on the results of toxicity tests (generally under laboratory or mesocosm conditions) that provide measures of the effects of pesticides upon a wide range of (predominantly non-fish) species. The species most at risk from pesticides depends on the type of pesticides that they are exposed to. This occurs because pesticides are designed to kill or knock down 'pest' species. Ideally, pesticides target the pest organism with minimal effects on non-target organisms. For example, herbicides are designed to target plants (weeds); therefore (in general) they are a higher risk to other phototrophic species, i.e. algae and aquatic plants (including seagrass and coral), but a lower risk to animal species. In contrast, insecticides are designed to target insects, and therefore are (in general) a higher risk to aquatic insects and other arthropods (e.g. crabs, lobsters, prawns and copepods), but a lower risk to plant and other animal species. That said, many of the organisms upon which the effects of pesticides have been tested are likely to be components of fish habitat (e.g. aquatic algae and plants) and diet (e.g. aquatic macroinvertebrates). These indirect impacts to the non-target organisms in catchments exposed to pesticide risk are still unknown at this stage and require further investigation.

Additional information is provided in Appendix E about the pesticide risk metric, how pesticides can interact with waterway ecosystems and how to interpret the scoring ranges including per cent of species protected.

Confidence

Confidence fish indicator results are shown in Table 21. Confidence scores (1 – 3) for each criterion have been weighted according to the revised methods for assessing confidence (WTHWP 2017).

Table 21 Confidence associated with fish indicator results in basins.

	Maturity of methodology (x0.36)	Validation (x0.71)	Represent-ativeness (x2)	Direct-ness (x0.71)	Measured error (x0.71)	Final	Rank
Native richness	1	2	2	3	1	8.6	3
Pest fish relative abundance	1	2	2	3	1	8.6	3
Fish index	1	2	2	3	1	8.6	3

Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are the sum of the weighted confidence criteria. **Rank based on final score:** 1 (very low): 4.5 – 6.3; 2 (low): >6.3 – 8.1; 3 (moderate): >8.1 – 9.9; 4 (high): >9.9 – 11.7; 5 (very high): >11.7 – 13.5.

4.4. Overall basin scores and grades

The index and overall scores and grades for 2022-23 are presented in Table 22, and the overall scores and grades for each reporting year are presented in Table 23. The overall score is averaged from the water quality, habitat and hydrology and fish indices. When comparing overall scores and grades between years it is important to note that differences relate to the addition of indicators as well as changes in scores over time. The habitat and hydrology index scores represent the addition of indicators for invasive weeds in 2015-16 (reported every four years) and flow in 2016-17 (updated annually), with updates to the wetland extent (2017-18), impoundment length (2018-19 but no change in score) and invasive weeds (2019-20). The riparian extent, (first reported for 2014-15) has not been updated as yet. The water quality index scores have been updated annually. Fish assessment reporting began in 2017-18 for the Mulgrave and Russell basins and was expanded in 2019-20 to all basins except for the Daintree Basin.

Table 22 Index and overall scores and grades for 2022-23.

Basins	Water quality	Habitat and hydrology	Fish	22-23
Daintree	82	77	nd	**79**
Mossman	68	65	77	**70**
Barron	64	45	48	**52**
Mulgrave	72	65	84	**74**
Russell	75	66	92	**78**
Johnstone	75	57	72	**68**
Tully	64	58	90	**71**
Murray	51	58	80	**63**
Herbert	65	56	83*	**68**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. *Updated for 2022-23

Table 23 Overall basins scores and grades for all years.

Basins	22-23	21-22	20-21	19-20	18-19	17-18	16-17	15-16
Daintree	79	83	83	85	82	81	81*	81*
Mossman	70¥	69¥	72¥	74¥	63	67	63*	55*
Barron	52¥	56¥	54¥	54¥	61	61	64	63
Mulgrave	74¥	73¥	74¥	73¥	68¥	71¥	64	64
Russell	78¥	78¥	79¥	75¥	75¥	75¥	70	68
Johnstone	68¥	67¥	70¥	71¥	67	67	68	68
Tully	71¥	72¥	75¥	72¥	61	64	64	61
Murray	63¥	64¥	63¥	61¥	57	59*	55*	54*
Herbert	68¥	71¥	70¥	71¥	59	66	66	67

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. *Scores do not include the water quality index and represent habitat and hydrology index only. ¥Score includes the fish index.

5. ESTUARIES

The locations of the estuary reporting zones are shown in Figure 13. Monitoring and assessment of estuarine indicators was conducted in the vicinity of the reporting zone locations as described in the methods technical report (WTW 2024).

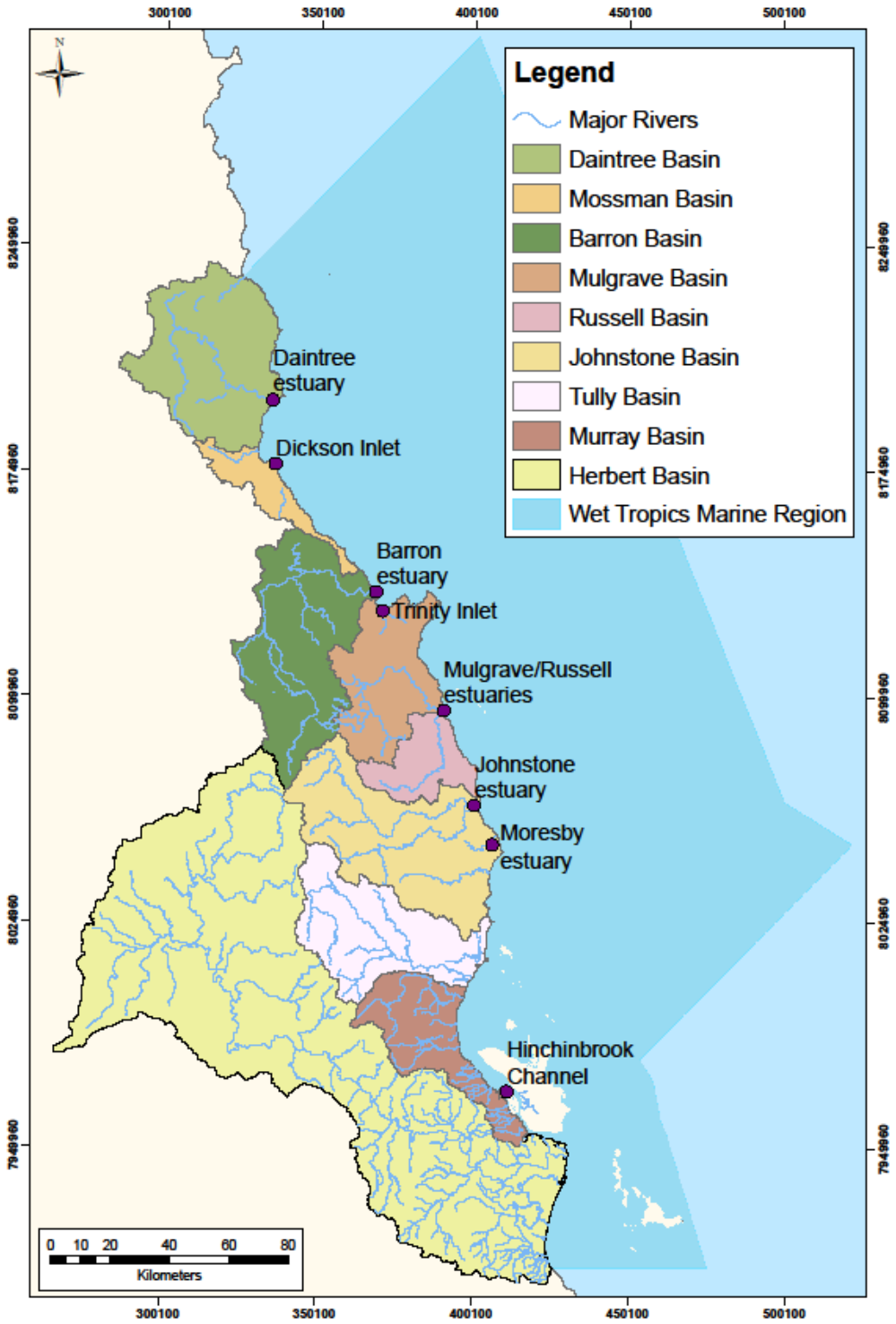

Figure 13 Location of estuary reporting zones.

5.1. Water Quality

Details of the monitoring frequency, indicators, and sample and site locations are provided in the methods technical report (WTW 2024). The water quality index is comprised of pesticides (pesticide risk), phys-chem (turbidity and dissolved oxygen), nutrients (dissolved inorganic nitrogen and filterable reactive phosphorus) and chlorophyll *a*.

The water quality index scores for 2022-23 were lower than the previous year for all estuaries except for Dickson Inlet and Moresby which increased slightly. All grades were 'good' except for the Barron which was 'moderate' and all were unchanged from the previous year.

Table 24 Estuary water quality index scores and grades for all years.

Estuary	Water quality							
	22-23	21-22	20-21	19-20	18-19	17-18	16-17	15-16
Daintree	78	79	88	92	81	85	80	79
Dickson Inlet	72	71	82	81	83	80	64	nd
Barron	45	46	70	60	61	66	64	50
Trinity Inlet	69	73	73	70	58	65	78	83
Russell-Mulgrave	70	72	79	80	72	66	75	78
Johnstone	66	67	77	76	76	67	72	63
Moresby	71	67	76	83	80	79	81	78
Hinchinbrook Channel	73	73	79	85	77	82	90	85

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available.

Pesticides

For the three estuaries where pesticides are reported, the monitoring sites are the GBR CLMP end of system sites as used for freshwater basins. Sampling for pesticides was expanded in 2017-18 and 2018-19 in order to populate the Pesticide Risk Baseline, and dropped back to a more routine sampling regime in 2019-20 which did not include the Barron estuary. The pesticide risk metric (PRM) value for the Russell-Mulgrave was calculated as the average value of the two basins. The PRM values (expressed as a percentage of species protected) represent the average pesticide risk over the wet season for 182 days when exposed to a mixture of up to 22 different pesticides, including nine PSII herbicides (Photosystem II inhibitors), 10 non PSII herbicides and three insecticides. The wet season is determined as commencing when a rise in river water level occurs, but which is co-incident with an increase in aqueous pesticide concentrations (Warne *et al*. 2020 and Warne *et al*. 2023). For each estuary the PRM score is presented in Table 25 and the proportion of the three pesticide types that contribute to the pesticide risk metric is presented in Figure 14. The relative contributions of chemicals to pesticide risk for 2022-23 and previous years at the basin pesticide sites used for estuary reporting are presented in Appendix B Figure 24 (note that results for Russell and Mulgrave are provided separately). The standardised scores for pesticides are presented in Table 25 and Table 26 for 2022-23 and in Appendix G Table 115 to Table 121 for the previous reporting years. Note that for 2016-17 and 2015-16 the PRM was calculated from 13 PSII herbicides. The back-calculated PRM for 2016-17 for the 22 pesticides was provided for reference in the results technical report for 2017-18 (WTW 2019).

Table 25 The percentage of species protected for estuaries using the pesticide risk metric, based upon 22 pesticides, and the standardised pesticide scores for the 2022-23 reporting period.

Estuary	Pesticide risk metric Percent species protected	Standardised score
Daintree	> 99	86
Russell-Mulgrave	98.1	76
Johnstone (Coquette Point)	98.3	77

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 Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. Note that the most recent result for the Barron estuary was for 2018-19 with > 99% percentage of species protected.

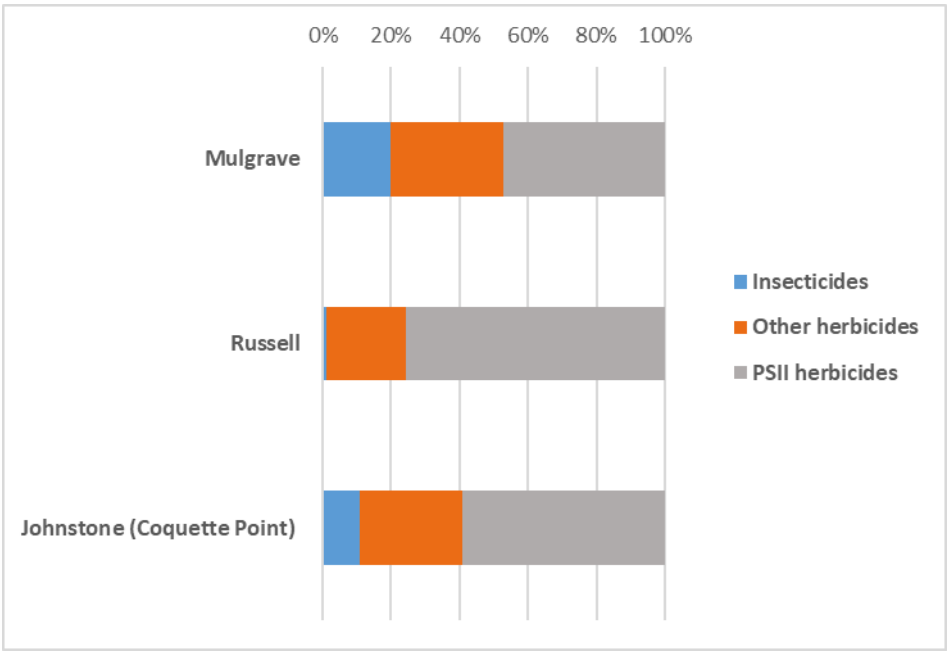

Figure 14 Percentage of pesticide categories contributing to the pesticide risk metric measure of percent species affected for estuaries.

Note: Daintree was excluded due to the very low concentrations recorded.

For pesticides in 2022-23 the Daintree estuary was graded 'very good' and the Russell-Mulgrave and Johnstone estuaries were graded 'good' which equates to pesticide toxicity of very low risk and low risk, respectively. In comparison to 2021-22, the pesticide scores decreased from 93 to 86 in the Daintree, whilst the Russell-Mulgrave increased from 73 to 76 and the Johnstone increased from 69 to 77 (Table 26 and Appendix G Table 115). The proportion of pesticide categories differed from the previous year for the Mulgrave with insecticides increasing and both herbicide types declining, whilst both Russell and Johnstone were very similar to the previous year with the highest contribution from PSII herbicides. The major contributing chemicals were metolachlor (other herbicide) and diuron (PSII herbicide) for the Mulgrave, and diuron for the Russell and Johnstone (Appendix B Figure 25).

Key messages: pesticides.

- Estuaries with pesticide monitoring (Daintree, Russell-Mulgrave and Johnstone) were at low risk or very low risk from pesticide toxicity.
- Grades for pesticides in 2022-23 remained the same for all three monitored estuaries.
- The risk metric score declined for the Daintree estuary and increased for Russell-Mulgrave and Johnstone estuaries from the previous year.
- The proportion of insecticides increased at the Mulgrave monitoring site compared to the previous year.

Whilst there is no targeted monitoring of pesticides in the Hinchinbrook Channel, both the Murray River and Herbert River are monitored for pesticides and drain into the north and the south of the channel, respectively. The additional monitoring site for 2021-22 and 2022-23 on Catherina Creek also drains into the Herbert River close to the river mouth. The pesticide monitoring data, particularly the relative contribution of chemicals of these rivers (Appendix B Figure 25 and Figure 27) can provide insight into pesticide types and risk of waters entering the channel noting that dilution of river discharge occurs when mixing with the enclosed coastal waters of the channel.

Additional information is provided in Appendix E about the pesticide risk metric, how pesticides can interact with waterway ecosystems and how to interpret the scoring ranges including per cent of species protected.

Chlorophyll *a*, nutrients and physical-chemical

The scores and grades for the water quality index for all reporting years are presented in Table 24. The scores and grades for the water quality indicators, indicator categories and water quality index for 2022-23 are presented in Table 26. The scores and grades for indicators, indicator categories and water quality indices from previous reporting years (2021-22 back 2015-16) are presented in Appendix G Table 115 to Table 121. Water quality scores for 2014-15 are available from the results visualisations at the WTW website. For estuary reporting zones where more than one water type is monitored, the annual scores and grades for chlorophyll *a*, turbidity, dissolved oxygen, dissolved inorganic nitrogen (DIN) and filterable reactive phosphorus (FRP) are aggregated from mid-estuary and lower estuary/enclosed coastal water types. The monthly means, condition scores and grades for each reporting zone are presented in Appendix B Table 70 to Table 77.

Table 26 Estuary water quality indicator, indicator category and index scores and grades for 2022-23.

Estuary	Chl *a*	Nutrients			Phys/Chem				Pest-icides	Water quality
	Chl *a*	DIN	FRP	Nut-rients	Turb-idity	DO Low	DO High	Phys/ Chem	Pest-icides	
Daintree	**62**	69	90	**79**	90	78	90	**84**	**86**	**78**
Dickson Inlet	**85**	58	61	**59**	90	54	90	**72**	**nd**	**72**
Barron	**62**	23	4	**14**	58	61	90	**60**	**nd**	**45**
Trinity Inlet	**76**	69	72	**70**	90	30	90	**60**	**nd**	**69**
Russell-Mulgrave	**82**	35	64	**49**	90	58	90	**74**	**76**	**70**
Johnstone	**90**	25	48	**37**	73	62	90	**62**	**77**	**66**
Moresby	**52**	72	90	**81**	90	70	90	**80**	**nd**	**71**
Hinchinbrook Channel	**46**	90	90	**90**	90	76	90	**83**	**nd**	**73**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. Risk metric scores for pesticide are from GBR CLMP sites as per freshwater basins. nd indicates no data available. For each estuary DIN and FRP indicator values are averaged to provide the Nutrient indicator category score (presented in bold) and that the turbidity and DO indicator scores (using the lowest of the two DO values) are averaged to provide the Phys/Chem indicator score (presented in bold). The indicator categories (Chl *a*, nutrients, Phys/Chem and Pesticides) are averaged to provide the WQ score (all presented in bold). **Note:** Pesticides are from GBR CLMP high flow data as per freshwater basins.

Since 2021-22, chlorophyll *a* improved from 'moderate' to 'good' for the Daintree, 'good' to 'very good' for Dickson Inlet, 'poor' to 'good' for the Barron, and remained 'good' at Trinity Inlet, 'very good' at the Russell-Mulgrave and Johnstone, and 'moderate' at Moresby and Hinchinbrook Channel. Up until 2020-21, the Barron consistently scored the poorest for chlorophyll *a* but has now had two grades of 'good' and scored higher than other estuaries twice in the last three years (Figure 15). Over the last eight years Daintree, Moresby and Hinchinbrook Channel have decreased in chlorophyll *a* score with accompanying decline in grade from 'very good', particularly during the last four years (Figure 15).

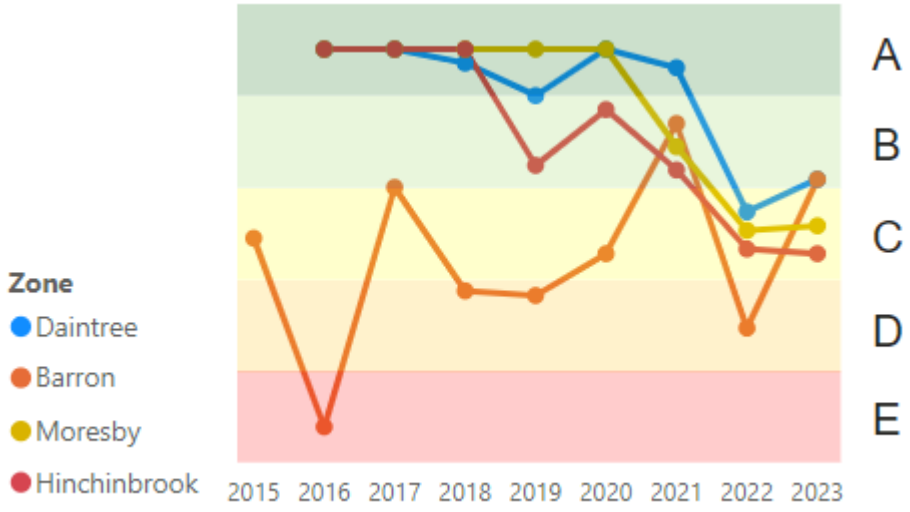

Figure 15 Chlorophyll *a* grades and scores for select estuaries from 2014-15 to 2022-23. (E – very poor (0-20), D – poor (21-40), C – moderate (41-60), B – good (61-80), A – very good (81-100)).

DIN declined from ‘good’ to ‘moderate’ for Dickson Inlet, the Daintree, and from ‘very good’ to ‘good’ for Trinity Inlet. All other estuary grades for DIN remained unchanged. Whilst the Barron estuary remained ‘poor’ for DIN the score decreased substantially from 37 to 23. FRP declined from ‘moderate’ to ‘very poor’ for the Barron, ’very good’ to ‘good’ for Trinity Inlet, and improved from ‘moderate to ‘good’ for the Russell-Mulgrave. Whilst Dickson Inlet remained ‘good’ for FRP the score decreased substantially from 80 to 61.

The most notable results for nutrients during 2022-23 were the increased concentrations of DIN and FRP for the Barron estuary, which resulted in substantially lower scores and grades since the previous year. The Barron had a very high proportion of high flow days during the year (290 days) recorded at the basin end of system monitoring site at Myola which is upstream of the Barron Falls (p. 19 - 23). Whilst these flows may have decreased residence time and contributed to the decrease of chlorophyll *a* concentrations and its associated improvement of score in the Barron estuary, they may also have facilitated transport of DIN and FRP to the estuary. Both DIN and FRP concentrations were higher for 2022-23 than the previous year at Myola resulting in notably lower basin scores (p. 19 - 23), and concentrations of DIN and FRP during 2022-23 were substantially higher than mid-estuary guideline values at the freshwater site downstream of the Barron Falls monitored by Cairns Regional Council.

With the exception of the Barron and the Johnstone, turbidity was graded ‘very good’ for all estuaries with grades unchanged from the previous year. Turbidity declined from ‘good’ (75) to ‘moderate’ (58) for the Barron, and from ‘very good’ (90) to ‘good’ (73) for the Johnstone, since the previous year.

Dissolved oxygen grades declined for the Daintree (‘very good’ to ‘good’), Trinity Inlet (‘moderate’ to ‘poor’), and Russell-Mulgrave (‘good’ to ‘moderate’), and improved from ‘moderate’ to ‘good’ for the Barron and the Moresby, since the previous year. The grades for all other estuaries did not change.

Over the last six years Trinity Inlet has consistently scored substantially lower than all other estuaries for dissolved oxygen (Figure 16). Trinity Inlet is a relatively large estuary in the Wet Tropics comprised of a network of mangrove channels and receives freshwater flows from a small sub-catchment of the Mulgrave Basin. The Trinity Inlet sub-catchment also includes a substantial urban footprint with waterways such as Chinaman Creek and Wrights Creek draining areas with some of the highest levels of residential and industrial development within the Wet Tropics region. The limited supply of freshwater draining into the estuary and inputs from surrounding urban environment may result in lower dissolved oxygen saturation compared to smaller estuaries fed by catchments with greater freshwater flows and lower levels of urban development. An assessment of available long-term monitoring dissolved oxygen saturation data for Trinity Inlet collected by the Queensland Department of Environment and Science was presented in WTW 2022 (Appendix B p.132). The historical data was collected at sites across a greater spatial coverage of the estuary than the sites used for the Wet Tropics report card, which are located in the western arm and were established to inform the Receiving Environment Monitoring Plan (REMP) for Cairns Regional Council. The long-term monitoring sites show a gradient of dissolved oxygen saturation which is highest at downstream sites and lowest at upstream sites on the western arm. The gradient is likely due to a positive effect of tidal waters on dissolved oxygen saturation which reduces with distance

from estuary mouth, the influence of land use development on water quality along the western arm, and the limited freshwater inflows.

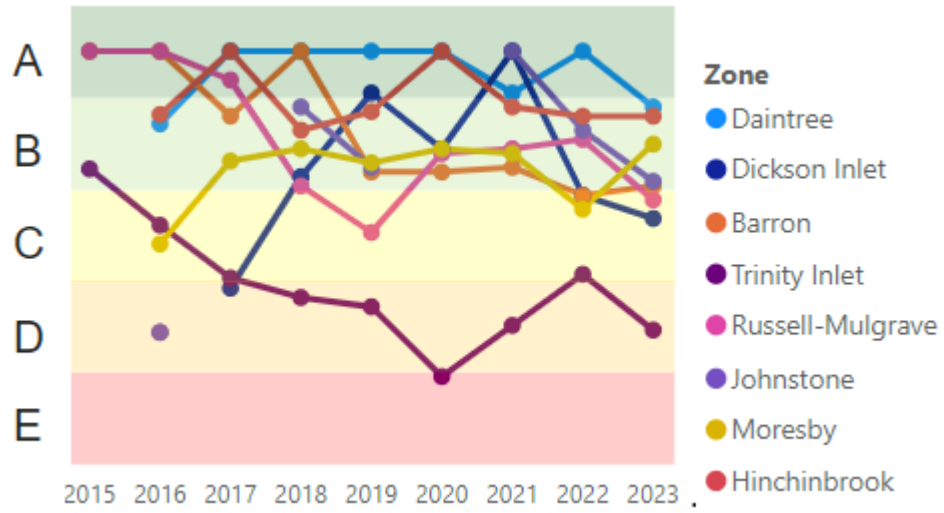

Figure 16 Dissolved oxygen (percent saturation (low)) grades and scores for all estuaries from 2014-15 to 2022-23. (E – very poor (0-20), D – poor (21-40), C – moderate (41-60), B – good (61-80), A – very good (81-100)).

Key messages: chlorophyll *a*, nutrients, physical-chemical.

- Daintree, Moresby and Hinchinbrook Channel have decreased in chlorophyll *a* score with accompanying decline in grade from 'very good' over all reporting years, with the most marked decline during the last four years.
- Chlorophyll *a* in the Barron improved to 'good' and has scored higher than other estuaries twice in the last three years after consistently scoring poorly and considerably lower than all other estuaries for all years previous.
- For the Barron estuary concentrations of DIN and FRP increased from the previous year, which resulted in substantially lower scores and grades.
- Turbidity was graded 'very good' for all estuaries except for the Barron which declined from 'good' to 'moderate' and the Johnstone which declined from 'very good' to 'good'.
- Dissolved oxygen grades declined for the Daintree ('very good' to 'good'), Trinity Inlet ('moderate' to 'poor'), and Russell-Mulgrave ('good' to 'moderate'), and improved for the Barron and the Moresby (both from 'moderate' to 'good').
- Over the last six years Trinity Inlet has consistently scored substantially lower than all other estuaries for dissolved oxygen.

Confidence

Confidence scores are presented in Table 27. Confidence scores (1 – 3) have been weighted according to the 2017 updated methods for assessing confidence (WTHWP 2017). Confidence in pesticides is expected to improve as the methodology and analysis of the pesticide risk metric calculations progress in subsequent years.

Table 27 Confidence for water quality indicator categories and index in estuary reporting zones.

	Maturity of methodology (x0.36)	Validation (x0.71)	Represent-ativeness (x2)	Directness (x0.71)	Measured error (x0.71)		
Indicator categories							
Phys-chem	3	3	1*, 1.5	3	1#, 2		
Nutrients	3	3	1*, 1.5	3	1#, 2		
Chl-*a*	3	3	1*, 1.5	3	1#, 2		
Pesticides$	3	2.1	1	2.5	2		
Water quality Index						**Final score**	**Rank**
Daintree	3	2.9	1.4	2.8	2	**9.4**	**3**
Dickson Inlet	3	3	1	3	1	**8.1**	**2**
Barron	3	3	1	3	2	**8.8**	**3**
Trinity Inlet	3	3	1.5	3	2	**9.8**	**3**
Russell-Mulgrave	3	2.9	1	2.8	2	**8.6**	**3**
Johnstone	3	2.9	1	2.8	1.3	**8.1**	**2**
Moresby, Hinchinbrook Channel	3	3	1.5	3	2	**9.8**	**3**

$Pesticide scores apply to Daintree, Russell-Mulgrave and Johnstone estuaries. *The lower representativeness score applies to Dickson Inlet, Barron, Russell-Mulgrave and Johnstone estuaries due to a lower frequency of sampling events for their monitoring programs. #The lower measured error score applies to Dickson Inlet and the Johnstone estuary due to differences in quality assurance and quality control of the monitoring program. Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are the sum of the weighted confidence criteria. **Rank based on final score:** 1 (very low): 4.5 – 6.3; 2 (low): >6.3 – 8.1; 3 (moderate): >8.1 – 9.9; 4 (high): >9.9 – 11.7; 5 (very high): >11.7 – 13.5.

5.2. Habitat and Hydrology

The habitat and hydrology index consists of estuary fish barriers, flow, riparian extent, mangrove and saltmarsh extent, mangrove habitat and seagrass condition (for estuaries where it is known to be a significant habitat). Of these, three are longer-term indicators that are intended to be updated every four years: mangrove and saltmarsh extent (updated for 2021-22), riparian extent (updated for 2021-22) and fish barriers (Hinchinbrook Channel updated for 2022-23, Daintree, Dickson Inlet and Barron updated for 2021-22). The indicator for shoreline mangrove habitat was introduced in 2020-21 and provides measures of condition to complement mangrove extent reporting. Initially, shoreline mangrove habitat was reported for the Daintree, Dickson Inlet, Barron, Trinity Inlet and Russell-Mulgrave estuaries. For 2021-22 shoreline mangrove habitat assessments were completed for all estuaries except the Johnstone.

The Program Design (WTHWP 2018) provides the full schedule for when new data are to be presented for longer-term indicators that are reported for periods longer than a year. The fish barrier results were incorporated from 2015-16, and the flow indicator, which commenced in 2016-

17, has been updated annually. Seagrass indicators for Trinity Inlet and Moresby River have been updated each year.

The habitat and hydrology index scores and grades for all reporting years are presented in Table 28. The index scores have remained fairly consistent over reporting years with little change in grades (Table 28). For 2022-23 the largest change in score was for Hinchinbrook Channel, which remained 'good' and increased from 65 to 72 due to improvement in the fish barrier indicator.

Table 28 Estuary habitat and hydrology index grades and scores for all years.

Estuary	22-23	21-22	20-21	19-20	18-19	17-18	16-17	15-16
Daintree	59	59	59	60	60	60	60	60
Dickson Inlet	65	65	72	74	74	74	74	74
Barron	55	55	54	54	45	43	45	41
Trinity Inlet	59	54	54	57	55	50	50	48
Russell-Mulgrave	67	67	67	69	65	75	69	67
Johnstone	56	56	63	62	54	63	58	51
Moresby	56	52	56	58	54	51	53	54
Hinchinbrook Channel	72	65	65	71	71	72	72	72

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available.

Note that for the 2021-22 habitat extent reporting, the 2019 mangrove and saltmarsh extent data, and estuary riparian extent data was obtained from the most recent Regional Ecosystem mapping (Version 12.2). The habitat extent data for 2013 and 2017 was based upon previous versions of the Regional Ecosystem mapping. Some slight differences of habitat extent between version releases can occur due to updates in mapping accuracy which is not related to actual change in habitat extent.

Mangrove and saltmarsh

Mangrove and saltmarsh habitat extent

The mangrove and saltmarsh habitat extent indicator was last updated in 2021-22 for all estuary zones. The procedures for scoring and grading habitat extent are outlined in Section 4.2 for basins and the same approach is used for estuaries. More details of the methods and procedures are provided in the methods technical report (WTW 2024).

The mangrove and saltmarsh extent loss from preclearing for 2019, 2017 and 2013, and the scores and grades for 2019 are shown in Table 29. The results show the historic loss of extent due to development which is particularly evident in the most urbanised reporting zones of the Barron graded 'poor' and Trinity Inlet graded 'moderate' (Mitchell *et al*. 2009). More recently mangrove communities in the Barron and Trinity Inlet estuaries have been effectively managed to ensure no recent major new clearing and to allow for some revegetation. There has been no recent loss in extent of mangroves and saltmarsh in any of the estuaries with extent remaining unchanged between 2017 and 2019 (Table 29) and between 2013 and 2017 (WTW 2022). The Daintree, Russell-Mulgrave, Moresby and Hinchinbrook Channel were graded 'very good' whilst Dickson Inlet and Johnstone were graded 'good'. The assessment of area remaining for mangroves and saltmarsh as separate vegetation types (Table 30) shows that historically saltmarsh has lost more extent as a percentage of pre-clearing than mangroves across all estuaries.

Table 29 Mangrove and saltmarsh percent loss from pre-clearing for 2017 and 2019, change in extent between 2017 to 2019, and 2019 score and grade.

Estuary	Mangrove and saltmarsh extent loss from pre-clearing		Change	Score and grade
	2017 loss (%)	2019 loss (%)	2017-2019 (%)	2019
Daintree	1.6	1.6	0	93
Dickson Inlet	8.0	8.0	0	75
Barron	29.0	29.0	0	42
Trinity Inlet	20.9	20.9	0	53
Russell-Mulgrave	0.5	0.5	0	97
Johnstone	13.7	13.7	0	63
Moresby	4.0	4.0	0	84
Hinchinbrook Channel	4.3	4.3	0	83

Mangrove and saltmarsh extent (% loss): Very Poor = >50% | Poor =>30 to 50% | Moderate = >15 to 30% | Good = >5 to 15% | Very Good ≤5%. **Standardised scoring range:** Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. Note: these results are for mangrove and salt marsh extent, not condition of mangrove and saltmarsh habitat.

Table 30 Mangrove and saltmarsh pre-clearing, and 2019 area and extent remaining, presented as separate vegetation type.

	Mangroves			Saltmarsh		
Estuary	Area pre-clearing (km^2)	Area 2019 (km^2)	Extent remaining (%)	Area pre-clearing (km^2)	Area 2019 (km^2)	Extent remaining (%)
Daintree	22.6	22.2	98.6	0.1	0.0	41.5
Dickson Inlet	9.7	9.9	101.9	3.2	2.0	62.0
Barron	14.0	10.5	74.8	1.1	0.2	22.7
Trinity Inlet	38.9	32.3	83.0	4.7	2.2	47.0
Russell-Mulgrave	6.6	6.5	99.5	0.0	0.0	n/a
Johnstone	3.0	2.6	86.3	0.0	0.0	n/a
Moresby	32.2	31.0	96.4	0.7	0.5	76.3
Hinchinbrook Channel	180.7	175.0	96.8	16.1	13.3	83.0

Both mangrove and saltmarsh habitats are affected by changing climactic conditions including trends in rainfall and sea level. Rainfall and sea level can alter the extent of each of these habitats and also influence their proportion of relative cover. Changes in rainfall trends have been shown to increase mangrove extent in response to higher rainfall and cause die back in response to lower rainfall, with an opposing effect on tidal saltmarsh extent (Duke et al. 2019). Rises in sea level have been shown to impact tidal wetlands by reducing their seaward extent and causing landward migration, where topography allows (Albert et al. 2017).

Mangrove habitat

The shoreline mangrove habitat indicator was not updated for 2022-23. The shoreline mangrove habitat indicator is comprised of the following three measures and their associated features (listed in brackets): habitat structure (cover, stand density, stand maturity), canopy cover (cover) and habitat impact (mangrove damage, shoreline modification). The results from the seven estuaries that had shoreline mangrove assessments completed for 2021-22 are presented in Table 31 and the results from the first round of assessments completed for 2020-21 (Daintree, Dickson Inlet, Barron, Trinity Inlet and Russell-Mulgrave), are presented in Table 32. The 2021-22 assessments provide a more complete dataset for those estuaries that had assessments completed for 2020-21, as detailed in the methods (WTW 2024), noting that updated scores represent an increase in the length of the shoreline surveyed only with no other methodological changes. It is recommended that the 2021-2022 scores are used as a baseline that more accurately reflects the state and condition of shoreline mangrove habitats in Wet Tropics estuaries.

A full description of the shoreline mangrove habitat indicator is available from the WTW website.

Table 31 Shoreline mangrove habitat indicator, measure and feature results for 2021-22.

	Habitat structure				Canopy cover	Habitat impact			
	Cover	Density	Maturity	**Struct-ure**	Cover	Damage	Modif-ication	**Impact**	**Mangrove habitat**
Daintree	84	82	90	**85**	**66**	94	92	**93**	**81**
Dickson Inlet	75	75	80	**76**	**61**	48	37	**43**	**60**
Barron	79	79	82	**80**	**70**	79	60	**70**	**73**
Trinity Inlet	60	88	80	**76**	**70**	82	29	**55**	**67**
Russell-Mulgrave	73	74	80	**75**	**61**	75	69	**72**	**70**
Johnstone	nd	nd	nd	**nd**	**nd**	nd	nd	**nd**	**nd**
Moresby	86	90	90	**89**	**72**	100	72	**86**	**82**
Hinchinbrook Channel	96	81	85	**87**	**66**	99	94	**97**	**83**

Standardised scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data or insufficient data was available.

For 2021-22 the shoreline mangrove habitat indicator score was lowest for Dickson Inlet (60), which was graded 'moderate' condition, and highest for Hinchinbrook Channel (83) which was graded 'very good' condition. The Moresby and Daintree estuaries were also graded 'very good', whilst the Barron, Trinity Inlet and Russell-Mulgrave were graded 'good'.

The scores and grades for the estuaries assessed for 2020-21 are presented in Table 32 for reference. Given the adjustments to the 2021-22 estuary assessments, including increased length of shoreline surveyed as outlined in the methods (WTW 2024), differences in scores between assessment years may not reflect ecological change. It should also be noted that due to sampling errors inherent in ecological data collection there can be variations in scores between years that are unrelated to changes in actual condition. This should be considered when comparing results between assessments which repeat the same length and locations of shorelines surveyed. The time frame of change for the different measures should also be considered when comparing results between assessments. The measures of canopy cover, which captures change in the leaf canopy, and

habitat impact, which captures human related loss, can change substantially year by year, whilst the habitat structure measure has a slower rate of change since it captures tree growth, position and density.

Table 32 Shoreline mangrove habitat indicator, measure and feature results for 2020-21.

	Habitat structure				Canopy cover	Habitat impact			Mangrove habitat
	Cover	Density	Maturity	Struct-ure	Cover	Damage	Modif-ication	Impact	
Daintree	90	97	95	**94**	**64**	100	83	**91**	**83**
Dickson Inlet	74	69	73	**72**	**71**	57	40	**48**	**64**
Barron	72	86	81	**80**	**71**	82	67	**75**	**75**
Trinity Inlet	59	86	76	**74**	**65**	59	29	**44**	**61**
Russell-Mulgrave	71	65	75	**70**	**56**	64	67	**66**	**64**
Johnstone	nd	nd	nd	**nd**	**nd**	nd	nd	**nd**	**nd**
Moresby	nd	nd	nd	**nd**	**nd**	nd	nd	**nd**	**nd**
Hinchinbrook Channel	nd	nd	nd	**nd**	**nd**	nd	nd	**nd**	**nd**

Standardised scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data or insufficient data was available.

Mangroves occur in low-energy coastal environments and are vulnerable to extreme weather events such as floods and cyclones. In 2019, record flooding in the Daintree River caused severe damage to shoreline mangrove habitats, particularly areas upstream of the lower estuary. Although habitat structure scored highly for the Daintree, the lower score for canopy cover, which measures canopy density, reflects the impacts of extreme weather events. The estuaries south of the Daintree River have had no recent climatic events that can cause declines in shoreline mangrove habitat. For these estuaries it is likely that loss of habitat structure and canopy cover is linked to estuary modification and elevated nutrient, sediment, and chemical pollution from catchment urban and agricultural land use (McKenzie 2021). The low score for canopy cover in the Russell-Mulgrave River where dynamic shoreline processes in Mutchero Inlet are causing mangrove shoreline habitat retreat, and narrow shoreline fringing mangroves along the Mulgrave estuary are impacted by a lack of estuary vegetation buffer zone exposing estuary habitats to impacts from adjacent agricultural land use (McKenzie 2021).

Habitat impact scores represent the degree of catchment and estuary land use modification and level of human estuary influence, with estuaries in more developed and populated areas typically having lower (worse) habitat impact scores. For 2021-22 Dickson Inlet received a ‘moderate’ habitat impact grade and the lowest score (43) reflecting the relatively high levels of mangrove habitat damage and modification along shorelines, whilst Hinchinbrook Channel, which is the largest system and has relatively low levels of human disturbance along shorelines, had the least amount of habitat impact recorded.

Key messages: mangrove habitat

- The shoreline mangrove habitat indicator score was lowest for Dickson Inlet (60), which was graded 'moderate’ condition and has relatively high levels of shoreline development.

- Hinchinbrook Channel scored highest for the shoreline mangrove habitat indicator (83) with a grade of 'very good' and low levels of shoreline disturbance and modification.

Mangrove and saltmarsh extent and mangrove habitat

When combining the shoreline mangrove habitat indicator and the mangrove and saltmarsh extent indicator into the indicator category for mangrove and saltmarsh habitat condition and extent (Table 33), Trinity Inlet and Barron River estuaries were graded 'moderate', whereas Dickson Inlet was graded 'good' and the Daintree, Russell-Mulgrave, Moresby and Hinchinbrook Channel systems were graded 'very good'. The Johnstone estuary was represented only by the mangrove and saltmarsh extent indicator score.

Table 33 Mangrove habitat and extent indicator category results.

	Shoreline mangrove habitat	Mangrove and saltmarsh extent	Habitat condition and extent
Daintree	81	93	87
Dickson	60	75	67
Barron	73	42	57
Trinity	67	53	60
Russell-Mulgrave	70	97	84
Johnstone	**nd**	63	63
Moresby	82	84	83
Hinchinbrook Channel	83	83	83

Standardised scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. nd indicates no data or insufficient data was available.

Estuarine riparian extent

The estuarine riparian extent indicator was last updated in 2021-22 using the most recent release of the Regional Ecosystem data set (version 12.2: 2019 remnant and pre-clearing mapping). The procedures for scoring and grading habitat extent are outlined in Section 4.2 for basins and the same approach is used for estuaries. More details of the methods and procedures are provided in the methods technical report (WTW 2024).

The estuarine riparian vegetation extent scores and grades for 2019 are shown in Table 34 and report on the changes in extent and not the condition of the riparian vegetation.

Table 34 Estuarine riparian vegetation preclear area, percent loss from pre-clearing to 1997, 2013 2017 and 2019 and change in area for 1997 to 2019 and 2013 - 2019.

	Riparian extent area	Percent riparian extent loss since pre-clearing and riparian extent area (km²)*				Riparian extent change (km²)		Score and grade
Estuary	**Pre-clear-ing (km²)**	**1997**	**2013**	**2017**	**2019**	**1997 - 2019**	**2013 - 2019**	**2019**
Daintree	3.7	45 (2.0)	43 (2.1)	43(2.1)	43(2.1)	+0.1	0	28
Dickson Inlet	0.7	25 (0.5)	24 (0.5)	24 (0.5)	24 (0.5)	0	0	49
Barron	2.0	48 (1.1)	48 (1.1)	48 (1.1)	48 (1.1)	0	0	22
Trinity Inlet	9.2	19 (7.5)	17 (7.7)	16 (7.7)	16 (7.7)	+0.2	0	58
Russell-Mulgrave	5.7	47 (3.0)	47 (3.0)	47 (3.0)	47 (3.0)	0	0	24
Johnstone	4.5	77 (1.0)	77 (1.1)	77 (1.1)	77 (1.1)	+0.1	0	9
Moresby	2.2	12 (1.9)	12 (1.9)	12 (1.9)	12 (1.9)	0	0	66
Hinchinbrook Channel	11.1	22 (8.7)	22 (8.8)	22 (8.8)	22 (8.8)	+0.1	0	53

Riparian extent (% loss): Very Poor = >50% | Poor =>30 to 50% | Moderate = >15 to 30% | Good = >5 to 15% | Very Good ≤5%. **Standardised scoring range:** Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. *Riparian area extent (km²) shown in brackets. Note: These results are for riparian extent (woody vegetation), not condition of riparian vegetation.

The grades ranged from 'very poor' for Johnstone to 'good' for Moresby. The results relate to historic loss of extent from pre-clearing to 2019 due to development including agricultural land use. The results show that since the first Queensland Herbarium assessments occurred in 1997, riparian extent in 2019 has increased slightly for the Daintree, Trinity Inlet, Johnstone and Hinchinbrook Channel whilst no change in extent has occurred between 2013 to 2019.

Fish barriers

The fish barrier indicator was updated for 2022-23 for the Hinchinbrook Channel estuary and captured remediation works involving construction of fishways completed at five sites which were previously verified as fish barriers. The update resulted in a grade improvement from 'moderate' (scoring 60) to 'good' (scoring 80) for the Hinchinbrook Channel fish barrier indicator (Table 35). The 2022-23 update followed previous updates to the fish barrier indicator using data from the Regional Lands Partnership fish barrier project covering the Daintree, Mossman and Barron lower catchments (Moore *et al.* 2022), and for 2020-21 covering the Hinchinbrook Channel using data from the Fish Homes and Highways project (Moore *et al.* 2021). Trinity Inlet, Russel-Mulgrave, Johnstone and Moresby estuaries have not been updated since the 2015-16 assessment. Table 35 provides the scores and grades of the 2015-16 assessments for all estuaries and the updated 2022-23, 2021-22 and 2020-21 assessments. Across estuaries the most recent grades for estuary fish barriers ranged from 'moderate' (Barron) to 'very good' (Russell-Mulgrave and Johnstone). The lowest score for barrier density was Moresby and the lowest score for percentage of stream to first barrier was the Barron ('moderate'). There were no low passability barriers in the estuary assessment areas and all estuary zones scored 100 ('very good') for 'stream length to first low passability barrier'.

Table 35 Results for fish barrier indicators in estuaries for the 2022-23 update (Hinchinbrook Channel), the 2021-22 update (Daintree, Dickson Inlet, Barron), the 2020-21 update (Hinchinbrook Channel), and the initial 2015-16 assessment. Assessments applied on Priority 3, 4 and 5 waterways as indicated.

Estuary	Reporting year	Barrier density (km per barrier on Priority 3, 4 and 5 waterways)	Stream length to the first barrier (% of total stream length) on Priority 3 and 4 waterways)	Stream length (% of total length) to the first low passability barrier on Priority 4 waterways	Fish barriers (standardised score)
Daintree	2021-22	5.8	75.2	no low pass barriers	61
	2015-16	6.5	76.2	no low pass barriers	61
Dickson Inlet	2021-22	15.0	81.3	no low pass barriers	80
	2015-16	No barriers	No barriers	no low pass barriers	100
Barron	2021-22	3.5	67.1	no low pass barriers	60
	2015-16	11.8	55.6	no low pass barriers	61
Trinity Inlet	2015-16	5.8	74.1	no low pass barriers	61
Russell-Mulgrave	2015-16	29.6	88.0	no low pass barriers	81
Johnstone	2015-16	19.8	90.7	no low pass barriers	81
Moresby	2015-16	2.6	82.1	no low pass barriers	61
Hinchinbrook Channel*	2022-23	17.8	68.1	no low pass barriers	80
	2020-21	15.2	11.9	no low pass barriers	60
	2015-16	28.6	71.2	no low pass barriers	80

Barrier density (km): Very Poor = 0 to 2 km | Poor = >2 to 4 km | Moderate = >4 to 8 km | Good = >8 to 16 km | Very Good >16 km.

Stream to 1st barrier (%): Very Poor = 0 to <40% | Poor = 40 to <60% | Moderate = 60 to <80% | Good = 80 to <100% | Very Good 100%

Stream to 1st low passability barrier (%): Very Poor = 0 to 60% | Poor = >60 to 80% | Moderate = >80 to 90% | Good = >90 to <100% | Very Good 100%

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

The total stream length of priority 3 and 4 waterways and the number of barriers identified in the assessments for each estuary are presented in Table 36 based upon their most recent assessment.

Table 36 Total stream length of priority 3 and 4 waterways, and number of identified barriers for the most recent estuary fish barrier assessments.

Estuary and assessment year	Total stream length of priority 3 and 4 waterways	Number of barriers
Daintree (2021-22)	151	26
Dickson Inlet (2021-22)	15	1
Barron (2021-22)	60	17
Trinity Inlet (2015-16)	58	10
Russell-Mulgrave (2015-16)	266	9
Johnstone (2015-16)	197	10
Moresby (2015-16)	13	5
Hinchinbrook Channel (2022-23)	517	29

Hinchinbrook Channel 2022-23 update.

The 2022-23 update for the Hinchinbrook Channel estuary fish barrier improved the scores for 'barrier density' and the 'Stream length to the first barrier' measures calculated from the 2020-21 update based on the Fish Homes and Highways project(see below). The improved scores were the direct consequence of remediation works on fish barriers as part of the Fish Homes and Highways project. The Fish Homes and Highways project included funding for works to improve the passage of fish across barriers selected from prioritised fish barrier sites. These works included five sites with verified barriers within the Hinchinbrook Channel estuary zone. The most substantial change in score was for 'Stream length to the first barrier' measure due to remediation of the rock weir barrier on the main channel of the Herbert River at Gedges Crossing through the construction of a rock fishway which has connected the 250 km of upstream waterways that have no barriers to the downstream reaches of the Herbert River. The other four fish barrier remediation works included three sites on priority waterways which connected a further 40 km of upstream waterways that have no barriers (two sites on Lannercost Creek and one site on Five Mile Creek) whilst the remaining site was on Lagoon Creek, which is in the estuary waters which are not included for the 'Stream length to the first barrier' measure. The addition of the five fishway sites also reduced the 'barrier density' measure from 34 to 29 across the assessable estuary waterways and increased the km per barrier value from 15.2 to 17.8.

The fish barrier remediation works completed through the Fish Homes and Highways project are reported in Terrain NRM (2024) and include sites outside of the assessable area of Hinchinbrook Channel estuary zone. Information from the report on the sites included in the fish barrier indicator is presented in Appendix H and shows images of the sites before and after the fish barrier remediation works.

Daintree, Dickson Inlet and Barron 2021-22 update.

The 2021-22 update of fish barriers for the Daintree, Dickson Inlet and Barron estuaries added verified fish barriers in all three estuaries to those included in the 2015-16 assessment. These additional barriers are not recent developments and were present during the 2015-16 assessment, but the mapping methods used in the initial assessment did not identify them. The updated grades and scores for fish barriers in the three estuary zones are presented in Table 35. None of the additional barriers were low passability and the grade for 'stream percentage to the first low passability barrier' for all three estuary zones has remained 'very good'. The 2021-22 assessment included field visits to previously inaccessible sites which were classed as barriers in the 2015-16 assessment based on Google Earth satellite imagery. From the field visits three sites listed as barriers were removed for the Daintree and one for the Barron. In addition, one site listed as a barrier for the Barron was removed after confirmation it was not located on a priority waterway when using the Queensland Globe watercourse mapping.

For the Daintree 2021-22 assessment five barriers were added. These barriers were not discernible as barriers using the original mapping and waterway layer for the 2015-16 assessment. All five are minor barriers on smaller waterways (priority 3) except the minor barrier at the mouth of Orsova creek which is a priority 4 waterway, and this barrier was immediately upstream of a much more substantial barrier on Stewart Creek. A total of 26 barriers were identified and included in the updated assessment for the Daintree estuary. These updates resulted in the 'km stream length per

barrier' to decrease from 6.5 to 5.8 and the 'stream length to first barrier as a percentage of total stream length' to decrease from 76.2% to 75.2% however these changes did not alter the score, which remained on 61, or grade, which remained 'good' (Table 35).

Dickson Inlet had no barriers identified in the 2015-16 assessment but the use of the Queensland Globe inland waters watercourse layer expanded the waterways classified as priority. This additional mapping identified a single minor barrier on Crees Creek, which is a low gradient stream order 2 waterway, and resulted in a 'km stream length per barrier' of 15 ('good') and a 'stream length to first barrier as a percentage of total stream length' of 81.3% ('good') (Table 35). Overall Dickson Inlet declined from a score of 100 ('very good') to 81 ('good').

The 2021-22 assessment added 13 verified barriers for the Barron estuary. A total of 17 barriers have now been identified on priority waterways for the Barron estuary area. 10 of the additional barriers were identified due to the use of the Queensland Globe inland waters watercourse layer which included priority waterways (stream order 3 and 4) not displayed on the layer used for the 2015-16 assessment. The other three barriers were located on an unnamed stream order 1 waterway but which was within estuary waters (priority 5) close to Cairns Airport. The increase of identified barriers to 17 in the Barron estuary resulted in the 'km stream length per barrier' decreasing from 11.8 ('good') to 3.5 ('poor') whilst the 'stream length to first barrier as a percentage of total stream length' increased from 55.6% ('poor') to 67.1% ('moderate') due to field verification of a suspected but previously inaccessible barrier on Freshwater Creek which was confirmed as a bridge. Overall, the Barron estuary declined from 'good' (61) to 'moderate' (60) as a result of the updated assessment (Table 35).

Hinchinbrook Channel 2020-21 update.

The 2020-21 update of fish barriers for the Hinchinbrook Channel estuary, based upon assessments conducted for the Fish Homes and Highways project (Moore *et al.* 2021), added 16 verified fish barriers to the 18 fish barriers verified in the 2015-16 assessment. These additional barriers were not recent developments and were present during the 2015-16 assessment, but the mapping methods used in the initial assessment did not identify them. The updated 2020-21 grades and scores for fish barriers in the Hinchinbrook Channel are presented in Table 35. Due to the higher number of verified fish barriers the grade for barrier density declined from 'very good' to 'good'. None of the additional barriers were low passability and the grade for 'stream percentage to the first low passability barrier' has remained 'very good'. Of the additional barriers seven were upstream of barriers identified in 2015-16 and three were located in the estuary network (priority 5 waterways) meaning they did not contribute to the scoring for 'stream percentage to first barrier' (WTW 2022). The remaining five additional barriers all contributed to lowering the scores for 'stream percentage to first barrier'. The most significant of these was a rock weir on the Herbert River used as a pump site located approximately 29 km upstream of the Herbert River mouth. Whilst this barrier was drowned out during higher flows and was not visible from satellite imagery during these occasions (as was the case for the imagery data set used for the 2015-16 assessment), the head-loss during lower flows (~1 m) was a barrier to fish passage. The total assessable stream length for the Hinchinbrook Channel estuary is 517 km and this barrier had a total of 250 km of connected waterways upstream without fish barriers..

Summary

The estuary fish barrier results show that the movement of fish from freshwater to estuary in the Wet Tropics is less impacted by physical barriers than other regions (for example Mackay Whitsunday (Moore 2016)) and reflect the absence of low passability man-made barriers, such as dams and weirs, in the estuary reporting zones. However, the actual connectivity of the waterway network may be affected by other impacts such as biological, chemical, and environmental barriers for example instream invasive weeds and poor water quality.

Key messages: fish barriers: Hinchinbrook Channel 2022-23 update

- The scores for 'barrier density' and the 'Stream length to the first barrier' measures for the Hinchinbrook Channel estuary area increased since the last assessment in 2020-21, and the indicator grade improved from 'moderate' to 'good'.
- The improved scores were the direct consequence of remediation works as part of the Fish Homes and Highways project which included five fish barrier sites within the Hinchinbrook Channel estuary area.
- The most substantial change in score was for 'Stream length to the first barrier' measure due to remediation of the rock weir barrier on the main channel of the Herbert River at Gedges Crossing.
- The construction of a rock fishway connected the 250 km of upstream waterways that have no barriers to the downstream reaches of the Herbert River.
- The other four fish barrier remediation works connected a further 40km of upstream waterways that have no barriers.

Flow

The flow indicator includes an assessment of the rainfall type for the reporting year and then compares the flows from the reporting year with modelled pre-development flows from past years with the same rainfall type. This means that the flow metrics for the reporting year provide scores based upon previous years with similar rainfall totals. The results are to be interpreted within the context of the prevailing rainfall conditions for the reporting year. The Barron, Russell-Mulgrave and Johnstone estuaries were all graded as 'good' for flows during 2022-23, and the basins draining into the three estuaries were classified with a 'wet' rainfall type for the Barron and Mulgrave, 'average' for the Russell, and 'dry' for the Johnstone (Table 37).

For the Barron estuary the score remained 79 since the previous year. Flows to the Barron estuary are assessed from the Myola gauging station on the Barron River and the Freshwater Creek gauging station. The Myola flow assessment site represents approximately 90% of the gauged catchment draining to the Barron estuary and the score from each site is weighted by proportion of catchment area before aggregation. The score for the Myola flow assessment site remained 80 and Freshwater Creek remained 61 (Appendix C Table 84) since 2021-22. Both sites had high scores for measures of low flows and cease to flow, and for the third year in a row at the Freshwater Creek site these flow categories were not substantially altered from modelled pre-development in their capacity to provide key ecological values, unlike most previous years. Freshwater Creek serves as a water supply for the Cairns area, with Copperlode Dam and water extraction infrastructure located upstream of

the flow assessment site, and this water resource development has been linked to poorer scores across all flow categories in past years.

Flows for the Russell-Mulgrave declined to 'good' but most measures of flow across the three sites scored highly. The Johnstone's score was unchanged and, consistent with the previous year, the South Johnstone site scored maximums for eight of the ten flow measures and the North Johnstone site scored maximums for six out of ten flow measures.

Details of the scores for each flow assessment site and the 10 measures of flow that constitute the site scores are provided in Appendix C Table 84. In all other Wet Tropics estuaries, the flow indicator was not assessable due to the lack of modelled pre-development data and additionally the lack of flow assessment sites for Dickson Inlet, Moresby and Hinchinbrook Channel.

Table 37 Rainfall type and number of flow assessment sites for 2022-23, and standardised estuary flow indicator score and grade for 2022-23 and the previous years.

Estuary	Rainfall type	Number of assessment sites	Flow	Flow					
			22-23	21-22	20-21	19-20	18-19	17-18	16-17
Daintree	-	-	nd	nd	nd	nd	nd	nd*	nd*
Dickson Inlet	-	-	nd	nd	nd	nd	nd	nd	nd
Barron	Wet	3	79	79	75	93	57	49	59
Trinity Inlet	-	-	nd	nd	nd	nd	nd	nd	nd
Russell-Mulgrave	Average/Wet	3	79	81	84	75	57	98	74
Johnstone	Dry	2	71	71	98	95	65	98	81
Moresby	-	-	nd	nd	nd	nd	nd	nd	nd
Hinchinbrook Channel	-	-	nd	nd	nd	nd	nd	nd	nd

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data or insufficient data was available.

Further information on the methods applied for the flow indicator are available in the full report for the flow indicator project (Stewart-Koster *et al.* 2018) and in the Wet Tropics Report Card methods technical report (WTW 2024). Both are available from the WTW website (wettropicswaterways.org.au).

Key messages: flow

- The Barron and Johnstone estuaries remained graded 'good' whilst the Russell-Mulgrave declined from 'very good' to 'good' The grade of 'good', indicated flows to the estuaries were not substantially altered from reference condition.
- All measures of low flow and cease to flow conditions at the Freshwater Creek site continued to score high for a third year in a row.

Seagrass

Seagrass condition scores and grades for 2022-23 and previous reporting years are presented in Table 38. The 2022-23 seagrass site scores and grades for the two reported estuaries are presented in Table 39. Note that the seagrass site score is the minimum indicator value, unless species composition is zero, in which case it is the average of species composition and the next lowest scoring indicator. The estuary condition score is the average of the site scores.

Table 38 Estuary seagrass condition score and grade for 2022-23 and previous years.

Estuary	22-23	21-22	20-21	19-20	18-19	17-18	16-17	15-16
Daintree	-	-	-	-	-	-	-	-
Dickson Inlet	nd	nd	nd	nd	nd	nd	nd	nd
Barron	-	-	-	-	-	-	-	-
Trinity Inlet	58	38	42	54	46	31	30	21
Russell-Mulgrave	-	-	-	-	-	-	-	-
Johnstone	-	-	-	-	-	-	-	-
Moresby	14	0	18	25	8	0	7	13
Hinchinbrook Channel	nd	nd	nd	nd	nd	nd	nd	nd

Seagrass score (QPSMP): ■ Very Poor = 0 to <21| ■ Poor = 20 to <41 | ■ Moderate = 40 to <61 | ■ Good = 60 to <81 | ■ Very Good = 81 – 100. For further information on calculation of scores refer to the methods technical report (WTW 2024). ^ - indicates that it does not occur at the location. nd indicates no data available.

Estuarine seagrass condition improved in both monitored estuary zones with condition in Trinity Inlet improving from 'poor' to 'moderate' and reaching the highest score since 2015-16, whilst seagrass in the Moresby estuary remained 'very poor' but increased in score from 0 the previous year to 14.

Table 39 Estuary seagrass site scores and grades for 2022-23.

Estuary	Site	Biomass	Area	Species composition	Site score and grade
Trinity Inlet	CN20	58	29	90	29
	CN19	68	89	97	68
	CN33	78	89	100	78
Moresby	MH1	68	0	100	0
	MH2	0	0	0	0
	MH3	37	3	100	3
	MH4	69	43	0	22
	MH5	66	46	100	46

Seagrass score (QPSMP): ■ Very Poor = 0 to <21 | ■ Poor = 20 to <41 | ■ Moderate = 40 to <61 | ■ Good = 60 to <81 | ■ Very Good = 81 – 100. Note that the seagrass site score is the minimum indicator value, unless species composition is zero, in which case it is the average of species composition (0) and the next lowest scoring indicator.

Trinity Inlet (1 intertidal meadow (CN20), 2 subtidal meadows (CN19, CN33)).

- Improvement in condition was due to biomass increases in subtidal meadows CN19 and CN33.
- Ongoing poor condition in the intertidal meadow CN20 is due to reduced area cover relative to baseline conditions.

Moresby Estuary – Mourilyan Harbour (4 intertidal meadows (MH1 – MH4), 1 subtidal meadow (MH5))

- Overall seagrass condition remained very poor, but overall condition in 4 of the monitoring meadows improved from last year.

- Seagrass biomass increased in 4 of the 5 monitoring meadows; for 3 meadows biomass condition improved from very poor in 2022 to good in 2023. Meadow area also increased in 4 meadows.
- MH1 improvements are due to active restoration of *Zostera muelleri* – this has led to increased biomass and species composition scores for the meadow, but area remains very poor due to the small size of restored patches.

Substantial fluctuations in seagrass meadow condition scores have occurred in the Moresby estuary in recent years. This is largely a consequence of the instability and generally poor condition of these seagrass communities as they struggle to recover from widescale loss following TC Yasi more than a decade ago. The colonising *Halophila* spp. which characterise meadow 3, 4 and 5 are highly variable in biomass and distribution, reflected in the substantial fluctuations in meadow condition between years. Overall seagrass condition in meadows 1 and 2 in the Moresby estuary are heavily influenced by the presence/absence of *Zostera muelleri* which has not returned to Meadow 2 (Reason *et al.* 2023*).* The ongoing restoration project, which has trialled the transplanting of *Zostera muelleri* over several years in meadow 1, has demonstrated some recent success and improvement of meadow condition, adding further variability of scores.

Key messages: estuary seagrass

- Estuarine seagrass condition improved from 'poor' to 'moderate' in Trinity Inlet and reached its highest score since 2015-16,
    - Biomass increased at subtidal meadows whilst area cover at the intertidal meadow remained low.
- Moresby estuary remained 'very poor' but increased in score from 0 the previous year to 14.
    - Overall condition in 4 of the 5 monitoring meadows improved from last year.

Moresby Estuary Restoration Update:

Seagrass restoration was scaled-up in the Wet Tropics in 2023 through a BHP funded project led by TropWATER, JCU who partnered with Traditional Owner groups (Gimuy Walubarra Yidinji, Yirrganydji, Mandubarra and Goondoi), and volunteers from OzFish, high schools, university students and landcare. A six week campaign in August and September saw approximately 8,000 seagrass (*Zostera muelleri*) propagules collected, processed and planted into restoration meadows. Establishment of the propagules will be monitored over the coming year to assess survival following the recent floods in the area following Tropical Cyclone Jasper. The project will continue for a further three years. Restoration activities were also conducted at Trinity Inlet meadow sites.

Recommendations for estuary seagrass (Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER), James Cook University)

- Address poor spatial representation at meadow scale. We recommend additional meadow scale monitoring in some zones. Monitoring at this larger scale shows a clearer picture of seagrass condition at scales appropriate to the regional report card. Recommended locations include:
    - Northern estuaries to complement Trinity Inlet monitoring (Dickson Inlet)
    - Southern estuaries (Hinchinbrook). The Hinchinbrook region is a particular priority. Baseline mapping by Girringun Aboriginal Corporation and TropWATER in the past 2 years has identified potential monitoring locations.

Habitat and hydrology index

The scores and grades for estuary habitat and hydrology indicators, indicator categories and the index for 2022-23 are presented in Table 40. The indicators, indicator categories and indices for previous reporting years are presented in Appendix G Table 122 to Table 128.

Table 40 Results for estuary habitat and hydrology (H&H) indicator categories and index for the 2022-23.

Estuary	Mangrove & saltmarsh	Riparian extent	Flow	Fish barriers	Seagrass	H&H index
Daintree	87^	28	nd	61	-~	59
Dickson Inlet	67^	49	nd	80	nd	65
Barron	57^	22	79	60	-	55
Trinity Inlet	60^	58	nd	61	58	59
Russell-Mulgrave	84^	24	79	81	-	67
Johnstone	63	9	71	81	-	56
Moresby	83^	66	nd	61	14	56
Hinchinbrook Channel	83^	53	nd	80	nd	72

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. ~ - indicates that it does not occur at the location. nd indicates no data available. ^ indicates the estuaries that include the shoreline mangrove habitat indicator introduced in 2020-21.

Confidence

Confidence scores are presented below. Confidence scores (1 – 3) have been weighted according to the 2017 updated methods for assessing confidence (WTHWP 2017).

Confidence scores for estuary seagrass monitoring are provided in Table 41. Confidence in species composition is slightly lower due to the maturity of the methodology, which has been peer reviewed but not published.

Table 41 Confidence associated with the seagrass indicators in estuary reporting zones.

	Maturity of methodology (x0.36)	Validation (x0.71)	Represent-ativeness (x2)	Directness (x0.71)	Measured error (x0.71)
Biomass	3	3	2	3	2
Area	3	3	2	3	2
Sp. Composition	3	3	2	3	1
Seagrass	3	3	2	3	1.7

Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis.

Confidence in the results for the five habitat and hydrology indicators for estuaries are presented in Table 42. Note: riparian extent in estuarine zones is assessed using a different method to freshwater zones and scores differently for confidence.

Table 42 Confidence associated with habitat and hydrology indicator results in the estuary reporting zones.

	Maturity of methodology (x0.36)	Validation (x0.71)	Represent-ativeness (x2)	Directness (x0.71)	Measured error (x0.71)	Score	Rank
Estuary fish barriers	1	2	3	2	2	10.6	4
Riparian extent	2	2	2	1	2	8.2	3
Mangrove & saltmarsh extent	2	2	2	1	2	8.2	3
Mangrove habitat	3	2	2	3	1	9.3	3
Seagrass*	2.7	3	2	3	1.7	10.6	4
Flow#	1	2	3	1	1	9.2	3
Habitat and hydrology index (Trinity Inlet and Moresby	**1.9**	**2.3**	**2.3**	**1.8**	**2.0**	**9.5**	**3**
Habitat and hydrology index (Barron, Russell-Mulgrave, Johnstone)	**1.7**	**2.0**	**2.5**	**1.3**	**1.7**	**9.1**	**3**
Habitat and hydrology index (other estuaries	**1.7**	**2.0**	**2.4**	**1.3**	**2.0**	**9**	**3**

*Seagrass applies to Trinity Inlet and Moresby only; #Flow applies to Barron, Russell-Mulgrave and Johnstone only. Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are the sum of the weighted confidence criteria. **Rank based on final score:** 1 (very low): 4.5 – 6.3; 2 (low): >6.3 – 8.1; 3 (moderate): >8.1 – 9.9; 4 (high): >9.9 – 11.7; 5 (very high): >11.7 – 13.5.

5.3. Overall estuary scores and grades

The index and overall scores and grades for 2022-23 are presented in Table 43, and the overall estuary scores and grades for each reporting year are presented in Table 44. For 2016-17 to 2022-23 the overall score is aggregated from the water quality and habitat and hydrology indices. For 2014-15 and 2015-16 the estuaries represented by the habitat and hydrology index only were Moresby and Dickson Inlet, respectively. When comparing overall scores and grades between years it is important to note that differences relate to the addition of indicators as well as changes in scores over time. The habitat and hydrology index scores represent the addition of indicators for fish barriers in 2015-16, flow in 2016-17 and shoreline mangrove habitat for select estuaries from 2020-21. For habitat and hydrology, the flow indicator scores (reported for Barron, Russell-Mulgrave and Johnstone), seagrass indicator scores for Trinity Inlet and Moresby, and the water quality index scores for all estuaries have been updated annually.

Table 43 Estuary index and overall scores and grades for 2022-23.

Estuary	Water quality	Habitat and hydrology	Overall
Daintree	78	59	**68**
Dickson Inlet	72	65	**69**
Barron	45	55	**50**
Trinity Inlet	69	59	**64**
Russell-Mulgrave	70	67	**68**
Johnstone	66	56	**61**
Moresby	71	56	**63**
Hinchinbrook Channel	73	72	**72**

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

For 2022-23 all estuaries were 'good' except for the Barron which remained 'moderate'. The Moresby estuary improved from moderate the previous year, due to improvement of water quality and seagrass condition.

Table 44 Estuary overall scores and grades for all years.

Estuary	22-23	21-22	20-21	19-20	18-19	17-18	16-17	15-16	14-15
Daintree	68	69	73	76	70	72	70	70	nd
Dickson Inlet	69	68	77	77	79	77	69	74*	nd
Barron	50	51	62	57	53	54	55	46	62
Trinity Inlet	64	64	64	63	56	57	64	66	59
Russell-Mulgrave	68	69	73	75	68	70	72	72	75
Johnstone	61	61	70	69	65	65	65	57	nd
Moresby	63	60	66	70	66	65	67	66	53*
Hinchinbrook Channel	72	69	72	78	74	77	81	78	nd

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. *Estuaries do not include the water quality index and represent habitat and hydrology index only.

6. INSHORE MARINE

Reporting for the inshore zone includes results for water quality, coral and seagrass. The inshore zone includes enclosed coastal, open coastal and mid-shelf marine water types, extending east to the boundary with the offshore waters (Figure 17). This is consistent with the inshore zoning used by the Marine Monitoring Program (MMP) in the Wet Tropics region for their annual inshore monitoring reports, for example see Gruber *et al.* (2020).

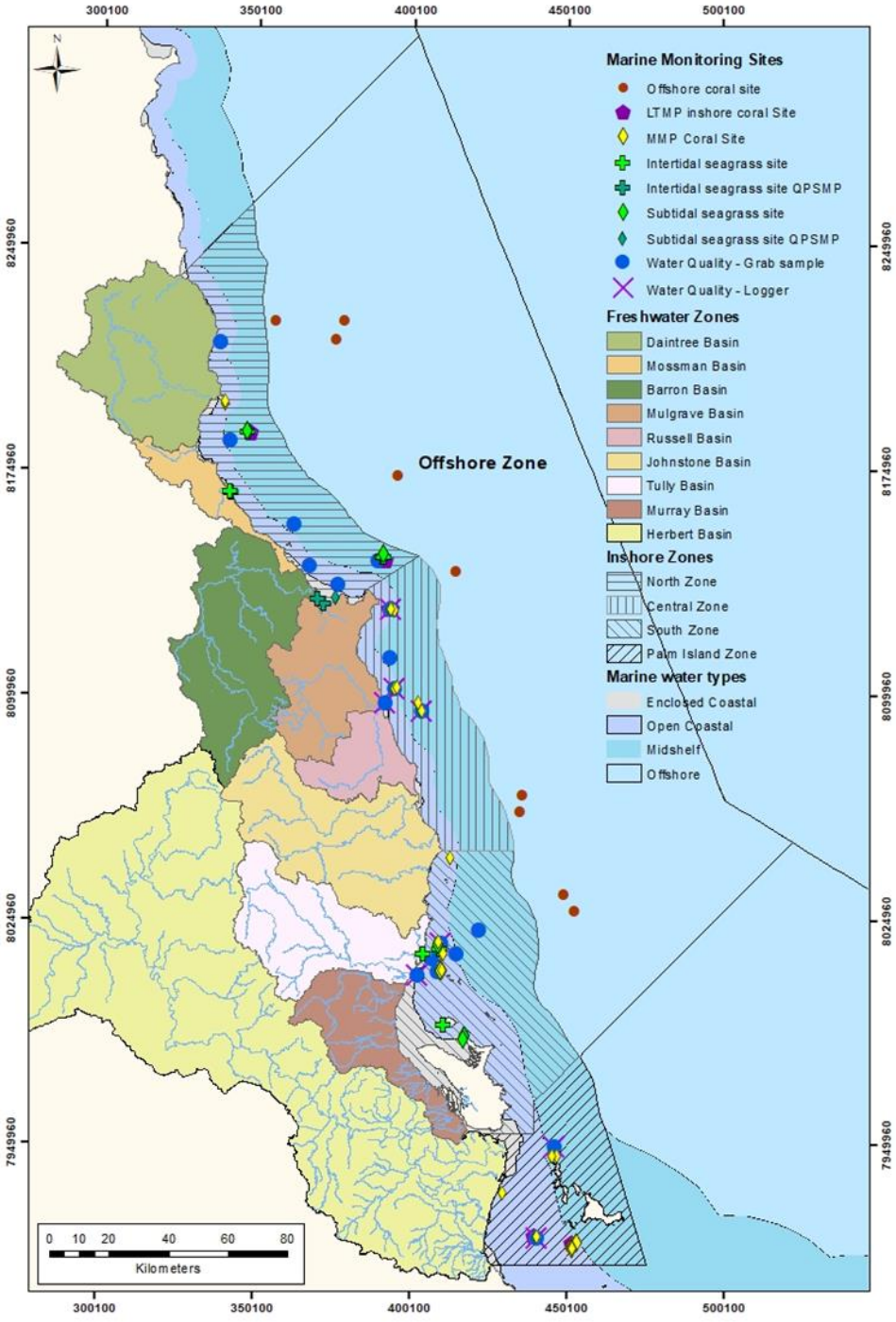

Figure 17 Reporting zones and monitoring sites for the inshore and offshore marine environments.

6.1. Water Quality

Inshore water quality index scores for all years are presented in Table 45 and the water quality indicator, indicator category and index scores for 2022-23 are presented in Table 46. On Table 46 an indicator category score may not be equal to the average of the contributing indicator scores for indicator categories that have multiple indicators (water clarity and nutrients). This is because the zone indicator category score is not calculated as the average of the zone indicator scores, instead, the indicator categories are first calculated for each site and then the site scores are averaged to provide the zone score. Inshore water quality indicator, indicator category and index scores for previous years are presented in Appendix G Table 129 to Table 135. The 2022-23 water quality indicator annual means for all inshore water quality monitoring sites and the indicator scores before standardisation are presented in Appendix B (Table 78 and Table 79). All inshore water quality scores are calculated from *in-situ* data from the MMP. The methods for scoring inshore marine water quality are provided in the methods technical report (WTW 2024).

The water quality index scores for all zones improved from the previous year with the most substantial increase occurring for the South zone (60 to 75) which also improved in grade from 'moderate' to 'good'. The grades for all other zones were unchanged from the previous year, with the North zone remaining 'very good', and the Central and Palm Island zones remaining 'good'. Reporting of pesticide risk for all zones was available for the first time since 2018-19. The recommencement of pesticide monitoring improved overall water quality index scores because of the typically high scores for the pesticide risk metric at inshore sites.

Table 45 Inshore water quality index grades and scores for all years.

Zone	22-23	21-22	20- 21	19-20	18-19	17-18	16-17	15-16
North	82	81	72	91	85	66	69	79
Central	71	62	60	74	58	53	58	64
South	75	60	52	72	44	47	47	60
Palm Island	75	68	62	65	60	53	64	69

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

Pesticide monitoring for inshore zones using passive samplers recommenced in 2022-23 following a suspension of monitoring in recent years. A list of pesticides assessed for inshore zones is presented in the methods technical report (WTW 2024). All zones had very low risk of pesticide toxicity and were graded 'very good'. The high scores were similar to those of previous years which were all very low risk except for the Central zone in 2016-17 which was low risk (Appendix G Table 129 to Table 135.

Scores for water clarity (averaged from TSS and turbidity scores) increased in all zones except the North zone which declined from 'very good' to 'good'. Palm Island zone had the most substantial increase and improved from 'good' to 'very good', with TSS increasing from 74 to 93. Note that turbidity is monitored using loggers, which are present at both Palm Island zone sites, a subset of sites in the Central and South zones and that loggers are not deployed in the North zone. Chlorophyll *a* grades declined for the North zone ('very good' to 'good'), and for the Central and Palm Island zones (both 'good' to 'moderate'), with the South zone unchanged on 75 ('good').

Table 46 Inshore marine water quality indicator, indicator category and index results for 2022-23.

Zone	Water clarity			Chl *a*	Nutrients				Pest-icides	Water quality
	TSS	Tur-bidity	**Water clarity**	Chl *a*	NOx	PN	PP	**Nutrients**	Risk metric	
North	78	nd	**78**	**76**	98	60	62	**74**	**100**	**82**
Central	84	71	**80**	**52**	65	30	65	**55**	**98**	**71**
South	66	63	**68**	**75**	69	23	61	**59**	**98**	**75**
Palm Island	93	83	**87**	**52**	84	29	67	**63**	**100**	**75**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. Nd indicates no data available. Note that the water clarity and nutrient indicator scores and indicator category scores (presented in bold) are calculated from the annual data for each site first and then site values are averaged to give the indicator or indicator category zone scores. For each zone the indicator category scores are averaged to provide the WQ score (also presented in bold).

Nutrient scores increased for the Central, South and Palm Island zones with the South zone improving from 'poor' to 'moderate'. Notable improvement occurred for NO_x (oxidised nitrogen) in all zones with the North zone increasing from 87 to 93 (remaining 'very good'), and the grade improving for the Central zone ('poor' to 'good'), the South zone ('moderate' to 'good'), and the Palm Island zone ('good' to 'very good'). Grades for NO_x have improved substantially in all zones over recent years (Figure 18) which reflects decreases of their annual mean NO_x concentrations. Particulate nitrogen (PN) declined in the North zone from 'good' to 'moderate', and improved in the South zone from 'very poor' to 'poor'. Particulate phosphorus (PP) remained 'good' at all four zones.

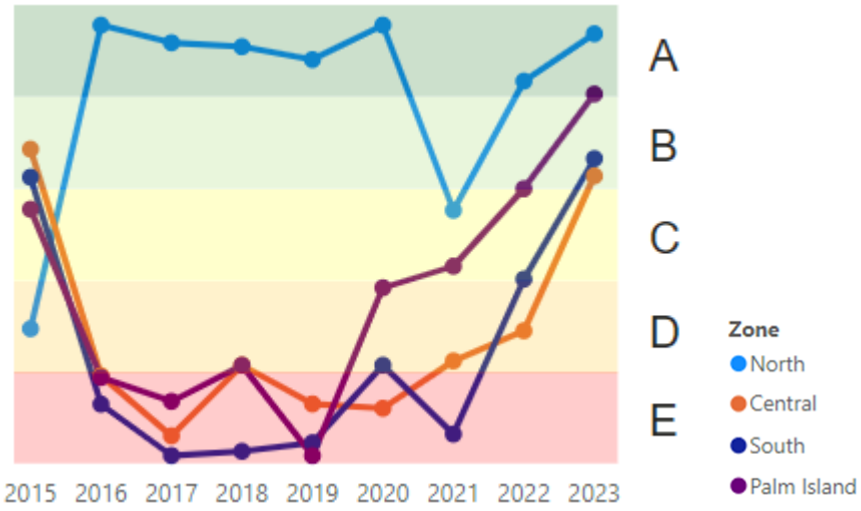

Figure 18 Oxidised nitrogen indicator grades of the four inshore zones for all reporting years. (E – very poor (0-20), D – poor (21-40), C – moderate (41-60), B – good (61-80), A – very good (81-100))

The drivers behind improvement of inshore water quality indicators, including the scores for NO_x over recent years, are not yet determined (Gruber *et al*. 2024). Further work is required to explore oceanographic and climatic factors, as well as the role of land use practice change through analysis of comparative trends in catchment load reduction from the Great Barrier Reef Catchment Loads Monitoring Program (Gruber *et al*. 2024).

Some spatial and temporal patterns of nutrient and TSS concentrations were apparent in the North, Central and South zones (Appendix B Table 78; refer to site locations in Figures 34 – 37 of the methods technical report (WTW 2024)) with concentrations correlating to proximity of sites to major

river mouths and periods of high rainfall. In the North zone the highest PN, PP and TSS annual mean concentrations occurred at sites closer to the open coastal waters of the Barron River mouth with concentrations declining toward northerly open coastal sites and lowest at the easterly site in mid-shelf waters. No spatial pattern for NO_X concentrations was evident. Concentrations of nutrients and TSS tended to be higher for samples taken in the wet season (February) compared to samples taken in the late dry season (November) and early dry season (June) across all sites. For the Central and South zones highest annual mean concentrations of nutrients (NO_X, PN and PP) and TSS occurred closest to the mouths of Russell-Mulgrave and Tully rivers, respectively, with concentrations tending to decrease with distance of sites from the river mouths along the northerly direction of the currents and eastwards to mid-shelf waters. Highest concentrations of NO_X and PN tended to occur during the wet season, but also notably high concentrations occurred at some sites during July, corresponding with the unusually high rainfall for that month across the Wet Tropics region (Figure 3). For TSS and PP a seasonal pattern was not evident. There were no spatial or temporal patterns of nutrient and TSS concentrations evident from the two Palm Island sites.

Key messages: water quality

- Water quality index improved in all zones for the second consecutive year with the most substantial improvements in the Central and South zones.
- Pesticide monitoring for all four inshore zones using passive samplers recommenced in 2022-23 following a suspension of monitoring in recent years.
- The reporting of pesticide monitoring improved overall water quality index scores because of the typically high scores due to the low pesticide risk at inshore sites.
- Scores for water clarity increased in all zones except the North zone which declined from ‘very good’ to ‘good’. Palm Island zone had the most substantial increase and improved from ‘good’ to ‘very good’.
- The scores for NO_x improved substantially in all zones, with the North zone remaining ‘very good’ and the other three zones improving in grade.
- Grades for NO_x have improved substantially in all zones over recent years which reflects the decline of their annual mean NO_x concentrations.
- The North, Central and South zones displayed spatial trends in water quality with highest concentrations of nutrients and TSS and occurring at sites closest to the river mouths and higher concentrations correlating to periods of high rainfall.

In 2020 the guideline values for oxidised nitrogen (NOx) were updated for coastal and marine waters of the Wet Tropics and scheduled in the Environmental Protection (Water and Wetland Biodiversity) Policy 2019—the EPP (Water and Wetland Biodiversity) (DES 2020). For 2022-23 the guideline values have remained unchanged for the purposes of scoring inshore marine waters for the Wet Tropics report card, and this provides inshore marine water quality reporting that is consistent and comparable with all previous years. An account of recent inshore oxidised nitrogen guideline updates, and the effect of changes on indicator scores using results up to 2021-22 is provided in Appendix B (p. 115). Inshore marine water quality guideline values used for scoring will be reviewed in the upcoming program design review (2023-25) which will allow for application of the most appropriate guidelines and a consistent approach across regional report cards.

Confidence

Confidence for the inshore marine water quality results for all zones are shown in Table 47. The lower confidence score for pesticides is due to the method being recently developed which has received less peer review than the more established methods for other water quality indicators. Confidence scores (1 – 3) have been weighted according to the 2017 updated methods for assessing confidence (WTHWP 2017) (Maturity of Methodology 0.36, Validation 0.71, Representativeness 2, Directness 0.71, Measured error 0.71).

Table 47 Confidence associated with the water quality indicators for inshore marine zones.

	Maturity of methodology (x0.36)	Valid-ation (x0.71)	Represent-ativeness (x2)	Direct-ness (x0.71)	Measured error (x0.71)	Final	Rank
Nutrients	3	3	1	3	3	9.5	3
Chl-*a*	3	3	1	3	3	9.5	3
Water clarity	3	3	1	3	3	9.5	3
Pesticides	1	3	1	3	2	8.0	2
Water quality index	2.5	3	1	3	2.8	9.1	3

Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are the sum of the weighted confidence criteria. **Rank based on final score:** 1 (very low): 4.5 – 6.3; 2 (low): >6.3 – 8.1; 3 (moderate): >8.1 – 9.9; 4 (high): >9.9 – 11.7; 5 (very high): >11.7 – 13.5.

6.2. Coral

The grades and scores for the coral condition index for all years are presented in Table 48. For 2022-23 the coral index grades for all zones remained 'moderate' with the scores declining for the Central and South zones and increasing for the North and Palm Islands zones, since the previous year.

Table 48 Inshore marine coral index scores and grades for all years.

Inshore Zone	22-23	21-22	20-21	19-20	18-19	17-18	16-17	15-16
North	54	51	44	44	44	51	46	46
Central	55	58	63	61	60	61	57	60
South	56	60	61	62	62	55	60	55
Palm Island	47	45	49	53	52	49	49	49

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

For 2022-23 the coral indicators and condition index for each inshore zone are presented in Table 49, whilst the coral indicator and condition index scores for each site are presented in Appendix F (Table 98) for reference. The following assessment of inshore coral condition is based on findings from the Marine Monitoring Program report for inshore coral (Thompson *et al.* 2024) where more detailed assessment of the coral condition for sites in the Wet Tropics inshore zones is provided.

Table 49 Inshore marine coral indicators and index scores and grads for 2022-2023.

Inshore Zone	Juvenile	Macroalgae	Cover	Change	Composition	Coral index
North	37	47	68	69	50	54
Central	39	44	73	60	58	55
South	61	41	55	49	75	56
Palm Island	41	40	51	42	63	47

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

During 2022-23 in the Wet Tropics region there were no severe disturbance events to inshore coral communities such as cyclones, extensive and prolonged high seawater temperatures, or major floods.

Sea surface summer temperatures for the inshore zones were within range for low likelihood of coral bleaching for almost the entire area (Figure 5). The only inshore area that reached sea surface temperatures with a higher likelihood of coral bleaching was the far south of the Palm Island inshore zone which reached the threshold of a bleaching risk warning. Sea surface temperature anomalies were considerably lower than the previous year.

The discharge for all major rivers in the region was fairly close to long-term averages except for the Daintree River which was substantially higher than its long-term average (Figure 4).

Crown-of thorns starfish were only observed in the Central zone, consistent with the previous year. At one site the densities were above outbreak levels, and evidence of feeding impacts were observed at four sites. Over recent years their population and impact on coral has been reduced by the Crown-of-thorns Starfish Control Program, although size range data from the survey and control programs indicates the continued recruitment of crown-of-thorns starfish. More information on the Crown-of-thorns Starfish Control Program including latest results is available from the project dashboard.

North zone

- Coral cover score increased from 65 to 68 and the grade remained 'good'. Coral cover in the zone has gradually risen since 2015, despite impacts from the 2019 Daintree River flooding events. Higher cover of the hard coral *Acropora* is present across all reefs compared to 2019.
- Cover change was graded 'good', consistent with the previous year, and has improved since 2020-21 due to recovery of hard coral cover across all reefs.
- Composition score increased substantially from 30 (poor) to 50 (moderate) reflecting the re-emergence of *Acropora* at all reefs in the zone.
- Macroalgae remained moderate whilst the score decreased from 55 to 47. Macroalgae scores varied substantially across depths and reefs with Low Isles and Snapper South (2 m) graded 'very good' (low levels of macroalgal species in the algal community), and Snapper North (2 m) and Snapper South (5 m) graded 'very poor' (high levels of macroalgae).
- Juvenile coral grade remained 'poor' but substantial variation of juvenile numbers was observed across reefs. At Snapper South (2 m) there was notable increase of *Acropora* juveniles, whilst juvenile numbers for most genera declined at Low Isles.

Central zone

- Coral cover grade remained 'good'. Coral cover increased at Fitzroy Island, Franklands East and Frankland West (2 m), whilst a decline in coral cover occurred at High Island, and was likely due to crown-of-thorns predation.
- Cover change declined to 'moderate' after seven years of grading 'good', however recovery of hard coral cover has continued at predicted rates. This indicator has been variable between reefs over the years.
- Composition remained 'moderate' with minimal change in score since the previous year.
- Macroalgae remained 'moderate' but the score decreased substantially from 59 to 44. In this zone red macroalgae species tend to dominate more than the typical brown macroalgae species and high representation of red macroalgae in the benthic algal community at High East, Franklands West, Franklands East (5 m) and Fitzroy West (2 m) has resulted in very low macroalgae scores at these reefs.

- Juvenile coral grade remained 'poor', with minimal change in score since the previous year.

South zone

- Coral cover grade remained moderate. Since the previous year, coral cover score increased at all sites except Bedarra (2 m and 5 m) and Dunk South (5 m) which decreased.
- Cover change declined from 'good' to 'moderate', with the score decreasing from 64 to 49. The reefs at 5 m have had the greatest reduction in change and the causes have been linked to higher levels of disease.
- Composition remained 'good' with no change in score since the previous year.
- Macroalgae improved from 'poor' (scoring 40) to just within the lower threshold of 'moderate' (scoring 41). Levels of macroalgae varied considerably between reefs, with lowest scores occurring at Dunk North and Bedarra (both at 2 m) due to high cover of brown algae species.
- Juvenile coral grade remained 'good' but the score declined from 67 to 61. Densities of juveniles have declined as high numbers of juveniles recorded in previous years have grown out of the juvenile size class.

Palm Island zone

- Coral cover grade remained 'moderate' and the score increased from 47 to 51. Hard coral cover increased on reefs at the Palms East, Lady Elliot, Havannah North, Pandora North, and Havannah sites since the previous year.
- Cover change remained 'moderate' with the score decreasing from 47 to 42. Except for Lady Elliot and Havannah North all reefs had sites that declined in cover change score since the previous year.
- Composition improved from 'moderate' to 'good' at Havannah (2 m).
- Macroalgae remained 'poor.' The lowest scores were recorded at Havannah, Havannah North, Pandora North, Lady Elliot (2 m) and Pandora (2 m) and the macroalgae was dominated by brown algae species.
- Juvenile coral grade improved from 'poor' in the previous year to just within the lower threshold of 'moderate' (scoring 41). Whilst juvenile density varies considerably across reefs, an increase in density occurred at all reefs except Havannah North.

Key messages: inshore coral

- For 2022-23 in the Wet Tropics region there were no severe disturbance events to inshore coral communities such as cyclones. Sea surface summer temperatures for the inshore zones were within range for low likelihood of coral bleaching for almost the entire area.
- Crown-of thorns starfish were only observed in the Central zone, consistent with the previous year. At one site the densities were above outbreak levels, and evidence of feeding impacts were observed at four sites.
- For 2022-23 the coral index grades for all zones remained 'moderate' with the scores declining for the Central and South zones and increasing for the North and Palm Islands zones, since the previous year.
- In the North zone composition score increased substantially from 30 ('poor') to 50 ('moderate'), mainly due to the re-emergence of *Acropora* at all reefs in the zone. Macroalgae remained moderate whilst the score decreased from 55 to 47. Macroalgae cover varied substantially across depths and reefs.
- In the Central zone coral cover grade remained 'good'. Cover change declined after seven years of grading 'good' to 'moderate', however recovery of hard coral cover has continued

at predicted rates. Macroalgae remained 'moderate' but the score decreased substantially from 59 to 44 due to very high cover at several reefs.

- In the South zone cover change declined from 'good' to 'moderate', and the causes have been linked to higher levels of disease. Macroalgae improved from 'poor' to 'moderate', whilst juvenile coral score declined from 67 to 61. Densities of juveniles have declined due mostly to growth of corals out of the juvenile size class.
- In the Palm Islands zone coral cover grade remained 'moderate' and the score increased from 47 to 51. The cover of hard coral increased on several reefs since the previous year. Composition improved from 'moderate' to 'good' due to an increase at a single reef. Juvenile coral grade improved from 'poor' to 'moderate' with an increase in juvenile density occurring at most sites.

Confidence

Confidence in the inshore marine coral results are shown in Table 50. Confidence scores (1 – 3) have been weighted according to the 2017 updated methods for assessing confidence (WTHWP 2017) (Maturity of Methodology 0.36, Validation 0.71, Representativeness 2, Directness 0.71, Measured error 0.71).

Table 50 Confidence scoring of the coral index for the inshore marine zones.

Maturity of methodology (x0.36)	Validation (x0.71)	Represent-ativeness (x2)	Directness (x0.71)	Measured error (x0.71)	Final	Rank
3	3	2	3	1	10.1	4

Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are the sum of the weighted confidence criteria. **Rank based on final score:** 1 (very low): 4.5 – 6.3; 2 (low): >6.3 – 8.1; 3 (moderate): >8.1 – 9.9; 4 (high): >9.9 – 11.7; 5 (very high): >11.7 – 13.5.

6.3. Seagrass

The methods for reporting seagrass including the combined display approach for presenting results from the two seagrass programs (MMP and QPSMP) are provided in the methods technical report (WTW 2024). The inshore marine zone seagrass condition scores and grades for 2022-23 and previous years are presented in Table 51. The site scores and grades for the two reported inshore zones are presented in Table 52. Note that for the QPSMP the seagrass site score is the minimum of the indicator values unless species composition is zero, in which case it is the average of species composition (0) and the next lowest scoring indicator, whilst for the MMP the seagrass site score is the average of the indicator values. The condition score for an inshore zone is the average of the site scores. Seagrass indicator and condition scores for previous years are presented in Appendix G Table 143 to Table 149.

Table 51 Inshore marine zone seagrass condition results for 2022-23 and previous years.

Inshore zone	22-23	21-22	20-21	19-20	18-19	17-18	16-17	15-16
North	64#	60#	57#	46	53	46	30	30
Central				nd	nd	nd	nd	nd
South	36#	40#	40#	35	35	23	6	18
Palm Island				nd	nd	nd	nd	nd

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available. #The MMP updated seagrass condition indicators for 2020-21 with the removal of tissue nutrient status and replacement of reproductive effort with resilience. For further information on calculation of seagrass scores refer to methods technical report (WTW 2022). **Note:** as from 2016-17 results for inshore seagrass are provided by MMP as whole numbers within the 0-100 scoring range for zones that are represented solely by MMP seagrass data (South inshore zone). This ensures consistent reporting by the WT report card and MMP for scores that are on the boundary between grades and for which grades may be affected by the method used for the rounding of decimal places.

The inshore seagrass scores are likely to be influenced by the monitoring programs that are present. Given that the QPSMP and MMP designs and indicators differ, the condition assessments are not directly comparable due to the different seagrass characteristics that are measured, and the different monitoring approaches. It is recommended to refer to the technical reports from each monitoring program to assist the interpretation of the results in more detail. For the QPSMP refer to Reason *et al*. (2023) and for the MMP refer to the latest 'Marine Monitoring Program: Annual Report for inshore seagrass monitoring' available at https://elibrary.gbrmpa.gov.au/jspui/.

Table 52 Seagrass site scores and grades calculated from indicators from QPSMP and MMP for 2022-23.

Inshore zone	Site code	Habitat/depth	QPSMP			MMP		Site score and
			Biomass	Area	Species compo-sition	Percent cover	Resil-ience	
North	CN13	Coast/intertidal	85	92	98	nd	nd	85
	YP1 & YP2	Coast/intertidal	nd	nd	nd	100	75	88
	CN34	Coast/intertidal	72	83	88	nd	nd	72
	CN11	Coast/subtidal	84	91	99	nd	nd	84
	GI1 & GI2	Reef/intertidal	nd	nd	nd	69	65	67
	LI1	Reef/intertidal	nd	nd	nd	25	6	16
	GI3	Reef/subtidal	nd	nd	nd	100	100	100
	LI2	Reef/subtidal	nd	nd	nd	0	5	3
South	LB1 & LB2	Coast/intertidal	nd	nd	nd	0	15	8
	MS1 & MS2	Coast/subtidal	nd	nd	nd	63	nd	63
	DI1 & DI2	Reef/intertidal	nd	nd	nd	13	94	53
	GOI#	Reef/subtidal	nd	nd	nd	nd	nd	nd
	DI3	Reef/subtidal	nd	nd	nd	13	30	21

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available. Note that for the QPSMP the seagrass site score is the minimum of the indicator values, whilst for the MMP the seagrass site score is the average of the indicator values.

Inshore seagrass in the North zone improved from 'moderate' condition the previous year to 'good' in 2022-23, whilst seagrass in the South zone remained 'poor' with the score decreasing from 40 previous year to 36 in 2022-23. The North zone has reached its highest score since the report card commenced in 2016 (reporting 2014-15) and the increasing trend in score over this time indicates a general recovery from past disturbances.

North zone

Location of MMP sites and QPSMP meadows – Cairns (3 meadows: CN11, CN13, CN34), Yule Point (2 averaged intertidal sites: YP1, YP2), Green Island (2 averaged intertidal sites: GI1, GI2; 1 subtidal site: GI3), Low Isles (1 intertidal site: LI1; 1 subtidal site: LI2).

- Seagrass condition at inshore QPSMP monitoring meadows (Cairns Harbour) remained in good or very good condition. The average grades for all condition indicators (biomass, area, species composition) were good or very good (same as previous year).
- Overall condition grades were unchanged from last year – good at Green Island intertidal and very good at Green Island subtidal, and very poor at two Low Isles sites.
- Seagrass at the Low Isles sites remained very poor for the fifth year. The subtidal site declined from 15% cover last year to 0% cover this year. Poor water quality linked to catchment run-off is suspected as contributing to the impacts on seagrass condition at the Low Isles sites (Len McKenzie, pers. comm. 2024).

South zone

Location of MMP sites – Lugger Bay (2 averaged intertidal sites: LB1, LB2), Missionary Bay (2 averaged subtidal sites: MS1, MS2), Dunk Island (2 averaged intertidal sites: DI1, DI2; 1 subtidal site: DI3), Goold Island: GOI (suspended site). No QPSMP meadows.

- Percent cover declined from poor to very poor condition at both Dunk Island sites.
- Lugger Bay resilience decreased from poor to very poor, and percent cover remained 0%.
- No meadow scale monitoring occurs in this zone - all seagrass monitoring is at smaller scale transect sites.

Key messages: inshore seagrass

- Seagrass in the North zone improved from 'moderate' to 'good' and reached its highest score since the report card commenced in 2016.
- Seagrass in the South zone remained 'poor' with the score decreasing from 40 previous year to 36 in 2022-23.

Recommendations for inshore seagrass (Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER), James Cook University)

- *Address poor spatial representation at meadow scale.* We recommend additional meadow scale monitoring in some zones. Monitoring at this larger scale shows a clearer picture of seagrass condition at scales appropriate to the regional report card. Recommended locations include:
    a. Central zone inshore waters
    b. South zone inshore water bodies. The Hinchinbrook region is a particular priority. Baseline mapping by Girringun Aboriginal Corporation and TropWATER in the past 2 years has identified potential monitoring locations.

The following projects may provide opportunities for additional long-term meadow scale monitoring of seagrass for the northern coastal area of the South zone.

Girringun Healing Country project (2022-2024)

This GBRF-funded project is a collaboration between Girringun Aboriginal Corporation and seagrass and dugong experts from TropWATER James Cook University and Charles Darwin University. The

project used a two-way knowledge approach, incorporating indigenous knowledge and western science and technology in the Girringun TUMRA region to enhance our understanding of culturally and environmentally significant dugong populations and seagrass habitat, focussing on the northern Hinchinbrook area. Seagrass was mapped in 2022-2023 and dugong surveys conducted.

Girringun Blue Carbon project (2024-2025)

This GBRF-funded project is a collaboration between Girringun Aboriginal Corporation, TropWATER James Cook University, University of Queensland and Charles Darwin University. This project will use recent learnings of mapping and drone monitoring from the Girringun Healing Country grant to better understand the health of coastal ecosystems and establishing carbon estimates in our sea country. The project aims to estimate the contribution of carbon stored in Girringun sea country and build recognition for the role that coastal Indigenous groups have in reducing climate impacts and managing climate.

Confidence

Confidence in the inshore seagrass results is shown in Table 53 for the two monitoring programs. Confidence scores (1 – 3) have been weighted according to the 2017 updated methods for assessing confidence (WTHWP 2017) (Maturity of Methodology 0.36, Validation 0.71, Representativeness 2, Directness 0.71, Measured error 0.71).

Table 53 Confidence scoring of seagrass indices used in the MMP and QPSMP monitoring for inshore marine zones.

	Maturity of methodology (x0.36)	Validation (x0.71)	Represent-ativeness (x2)	Directness (x0.71)	Measured error (x0.71)	Final	Rank
MMP Seagrass index	2.5	3	1	3	2	**8.6**	**3**
QPSMP Seagrass index	3	3	1	3	2	**8.8**	**3**

Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are the sum of the weighted confidence criteria. **Rank based on final score:** 1 (very low): 4.5 – 6.3; 2 (low): >6.3 – 8.1; 3 (moderate): >8.1 – 9.9; 4 (high): >9.9 – 11.7; 5 (very high): >11.7 – 13.5.

6.4. Inshore fish

Whilst there is no current reporting for inshore fish due to the lack of appropriate monitoring and indicators, the Integrated Monitoring and Reporting (IMR) Reef Fish Monitoring Program, funded by GBRF and led by the Australian Institute of Marine Science (AIMS) in collaboration with University of the Sunshine Coast (UniSC), James Cook University (JCU) including TropWATER and Marine Data Tech is expected to provide outputs that provide a framework for reporting on marine fish for regional report cards. The framework will use long-term monitoring data from the LTMP reef fish surveys and specifically developed indicators of marine fish, which can address the monitoring gap. A summary of recent activities from the project is provided below.

- Annual underwater visual surveys of reef fishes and benthic communities on the fringing reef slopes of eight inshore island groups.
- Bi-annual surveys of fishes in nursery seascapes in the central GBR (Mission Beach to Townsville) in collaboration with Traditional Owners and Indigenous rangers using stereo Remote Underwater Video Systems (RUVS) and stereo Baited Remote Underwater Video

Systems (BRUVS). These surveys have identified a number of potential seagrass monitoring locations in the Girringun TUMRA and at Palm Islands.

- Annual surveys of reef fishes in deep-water inter-reef habitats throughout the GBR using stereo BRUVS, supplemented by Remotely Operated Videos (ROVs) where feasible.
- Development of indictors of reef fish status and trend in collaboration with GBRMPA and QDAF.

6.5. Overall inshore marine scores and grades

The index and overall inshore marine scores and grades for 2022-23 are presented in Table 54 and the overall scores and grades for previous years are presented in Table 55. The scores for inshore zones increased from the previous year for all zones. The North zone remained 'good', the Central and Palm Island zones improved from 'moderate' to 'good', and the South zone remained 'moderate'.

Table 54 Inshore index and overall scores and grades for 2022-23.

Inshore zone	Water Quality	Coral	Seagrass	Fish	Overall
North	82	54	64	nd	66
Central	71	55	nd	nd	63
South	75	56	36	nd	55
Palm Island	75	47	nd	nd	61

Standardised scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. nd indicates no data available.

Table 55 Inshore overall scores and grades for all years.

Inshore zone	22-23	21-22	20-21	19-20	18-19	17-18	16-17	15-16
North	66	64	57	60	60	54	48	52
Central	63	60	61	67	59	57	57	62
South	55	53	51	56	47	41	37	44
Palm Island	61	56	55	59	56	51	57	59

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

7. OFFSHORE MARINE

The location of the offshore marine reporting zone and monitoring sites are shown in Figure 17.

7.1. Water Quality

The 2022-23 reporting period was the third year with no water quality monitoring program in place to allow for reporting on offshore water quality. For years previous to 2020-21 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 56). The scores were similar for all reporting years. The water quality indicators and index for previous years are presented in full in Appendix G Table 150 to Table 153.

Table 56 Results for the water quality indicators and index for 2021-22 and the water quality index for previous years

Water quality indicator		Water quality index		Water quality index						
Chlorophyll-*a*	Water clarity (TSS)	21-22		21-22	20-21	19-20	18-19	17-18	16-17	15-16
nd	nd	nd		nd	nd	98.7	99.1	99.0	99.5	99.4

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no or insufficient data available.

During 2019-20 there were limitations in the technical support for maintaining the MWQ processing scripts and satellite data streams. Consequently, the more recent data for the 2019-20 time series may be of lower quality than earlier time series data and the confidence criteria for validation was lowered from 2 to 1. In early 2021 the Bureau of Meteorology advised that the MWQ dashboard had been decommissioned and that the underlying data preparation workflow was being discontinued. Alternative data sources are to be identified for reporting offshore water quality as from the 2023-24 reporting year.

7.2. Coral

The offshore coral indicator and index scores (Table 57) were based upon the surveys of the Long-Term Monitoring Program (LTMP) between August 2022 and May 2023 and represented nine separate reefs in the Wet Tropics region as specified in the methods technical report (WTW 2024). The 2022-23 coral indicator and condition index scores for each reef are presented in Appendix F (Table 99).

The LTMP sampling design was updated for 2021-22 onward (see Report Card update in Appendix G p.166), which means the offshore zone indicator and index results are no longer directly comparable with reported results from years previous to 2021-22. The back-calculation of results using the updated survey design (Table 154) are now used for comparison with the results of 2021-22 onwards, consequently all results for offshore coral reporting as from 2021-22 are now evaluated in relation to previous years using the back-calculated results from the updated survey design. The

offshore coral indicator and index scores for years prior to 2021-22 are still presented in Appendix G Table 154 since they were the scores and grades that represented the offshore zone for the previous report cards.

Sea surface summer temperatures for the offshore zone were within range for low likelihood of coral bleaching for most of the area (Figure 5). The only offshore areas that reached sea surface temperatures with a higher likelihood of coral bleaching was the far north and south-west of the zone which reached the threshold of a bleaching risk warning. Sea surface temperature anomalies were considerably lower than the previous year.

The juvenile density indicator score decreased from the previous year but remained 'very good' with the score decreasing from 91 to 84, whilst coral cover improved from 'poor' (scoring 39) to 'moderate' scoring (43), and coral change increased in score from 52 to 53 with the grade remaining 'moderate'. Despite changes in scores for all three indicators the score for the coral index did not change, with the grade remaining 'good'.

Table 57 Results for coral indicators and index for 2022-23.

Coral indicators			Coral index
Juveniles	Coral Cover	Coral Change	22-23
84	43	53	**61**

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

Since the previous year's survey of the nine reefs, six reefs had an increase in coral cover, one remained unchanged and the other two reefs (Mackay and Farquharson) had a slight decline; the density of juveniles increased at one reef and decreased at three reefs; whilst coral change increased at two reefs and decreased at three reefs.

The following information on results of the offshore coral for 2022-23 were sourced from online publications from the AIMS Long-Term Monitoring Program for surveys in the Wet Tropics region from the regional summaries https://apps.aims.gov.au/reef-monitoring/sector/list and reef transect results https://apps.aims.gov.au/reef-monitoring/reefs.

Hard coral cover along permanent transects in the offshore zones continued to increase in 2022-23 to its highest since 2017 and evidence of coral bleaching was minimal. Aerial and in-water surveys of the Reef following the 2020-21 summer when accumulated heat stress led to mass coral bleaching (Figure 19) have provided insight into the impacts of this event on coral cover. The severity and prevalence of bleaching was variable among reefs and approximately 10 percent of the surveyed reefs showed declines of coral cover directly attributable to the bleaching event. From Figure 19, the offshore reefs for the Wet Tropic offshore zone were outside the areas of highest bleaching risk (orange and red areas).

Many reefs in the offshore zone have been impacted by recent outbreaks of crown-of-thorns starfish. However, the 2022-23 reef surveys recorded no potential, incipient or active crown-of-thorns starfish outbreaks in the offshore zone. The Great Barrier Reef Marine Park Authority's Crown-of-thorns Starfish Control Program, which actively removes individual starfish, is likely to

have substantially contributed to the very low numbers. More information on the Crown-of-thorns Starfish Control Program including latest results is available from the project dashboard.

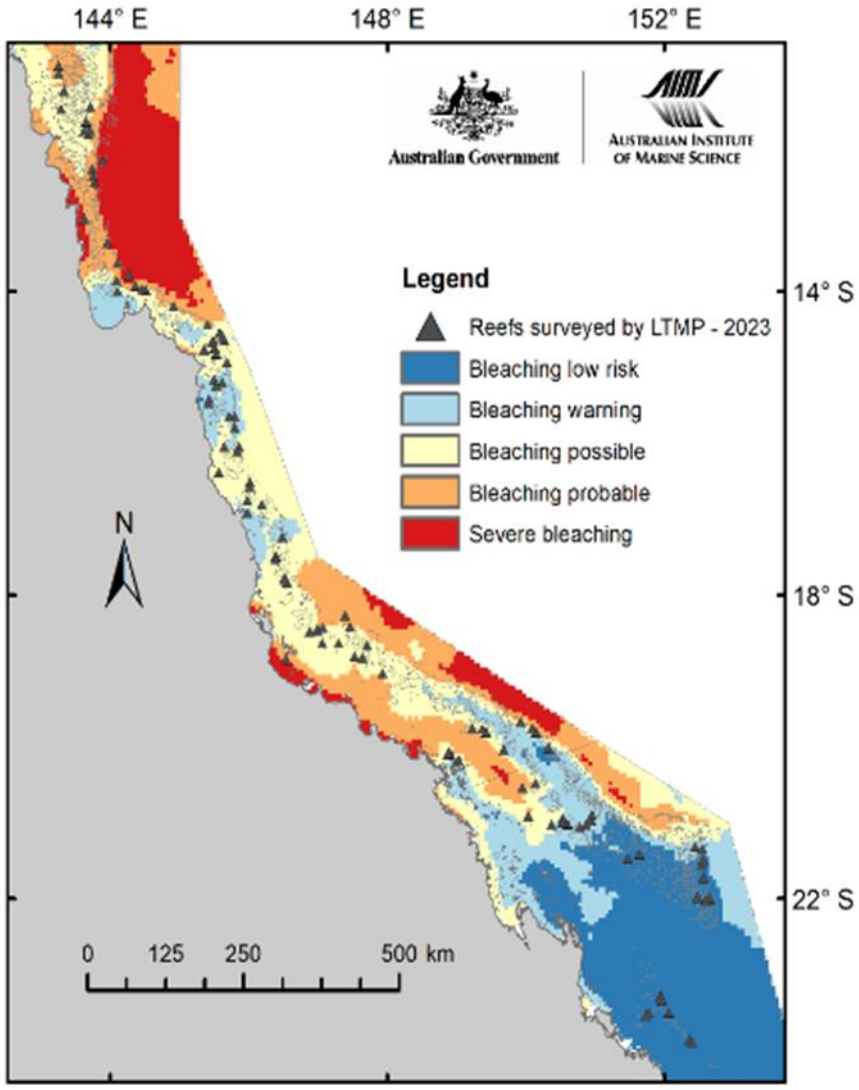

Figure 19 Exposure level of the 111 LTMP to accumulated heat stress during the austral summer of 2021-22, as reported in 2023. Bleaching low risk = 0 – 2 DHW, Bleaching warning =2 – 4 DHW, Bleaching possible= 4 – 6 DHW, Bleaching probable= 6 – 8 DHW and Severe bleaching >8 DHW. Data source: NOAA/NESDIS/STAR Coral Reef Watch program. Map sourced from AIMS 2023.

Key messages: offshore coral

- The score for juvenile density decreased, whilst the scores for coral cover and coral change increased. The coral index score did not change, and the grade remained 'good'.
- Hard coral cover increased to its highest level since 2016-17 for the offshore zone and the grade improved from 'poor' to 'moderate'.
- Impacts of coral bleaching from the 2020-21 summer accumulated heat stress event were minimal on surveyed reefs.
- The 2022-23 reef surveys recorded no potential, incipient or active crown-of-thorns starfish outbreaks in the offshore zone.

- All reefs have shown a general improvement in coral cover following impacts from heat stress and crown-of-thorns starfish between 2016 and 2018.

Confidence

Confidence in the offshore coral results is shown in Table 58.

Table 58 Confidence scoring of the coral index for the offshore marine zone.

Maturity of methodology (x0.36)	Validation (x0.71)	Represent-ativeness (x2)	Directness (x0.71)	Measured error (x0.71)	Final	Rank
3	3	2	3	1	10.1	4

Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are the sum of the weighted confidence criteria. **Rank based on final score:** 1 (very low): 4.5 – 6.3; 2 (low): >6.3 – 8.1; 3 (moderate): >8.1 – 9.9; 4 (high): >9.9 – 11.7; 5 (very high): >11.7 – 13.5.

7.3. Overall offshore marine score and grade

For 2022-23 there was insufficient data to provide an overall grade and score for the offshore zone (Table 59). To produce an overall grade and score at least two of the three indices are required, based on decision rules for aggregation (WTW 2024). In all previous years the grade for offshore water quality has been 'very good'. It is expected that offshore water quality monitoring can recommence for the 2023-24 reporting year and onwards, which will allow overall offshore marine scores and grades to be reported. Note that for years prior to 2021-22 the previous LTMP sampling design for the offshore coral surveys was used for scoring and grading the coral index. As from 2021-22 the LTMP has applied an updated sampling design for the coral surveys.

Table 59 Offshore marine scores and grades of indices for 2022-23 and overall scores and grades for 2019-20 and previous years.

Water quality	Coral	Fish	22-23
nd	**61**	nd	ID

21-22	20-21	19-20	18-19	17-18	16-17	15-16
ID	ID	70	73	75	83	84

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available. ID indicates insufficient data.

8. REFERENCES

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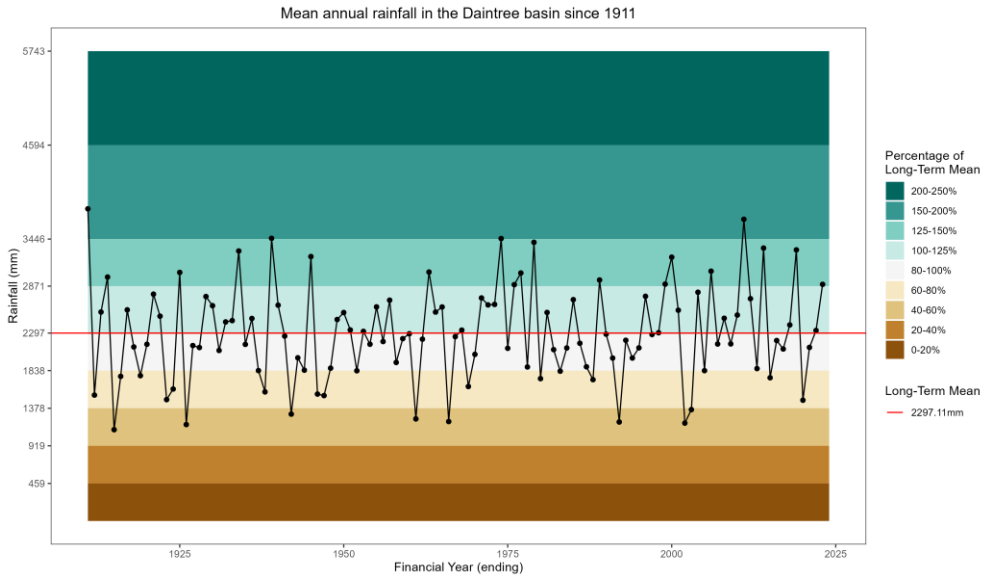
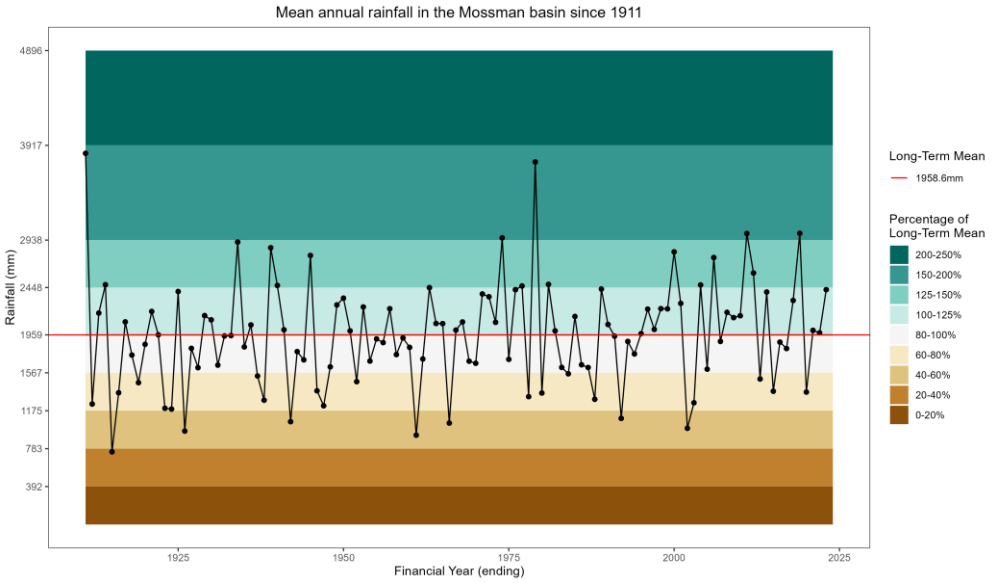
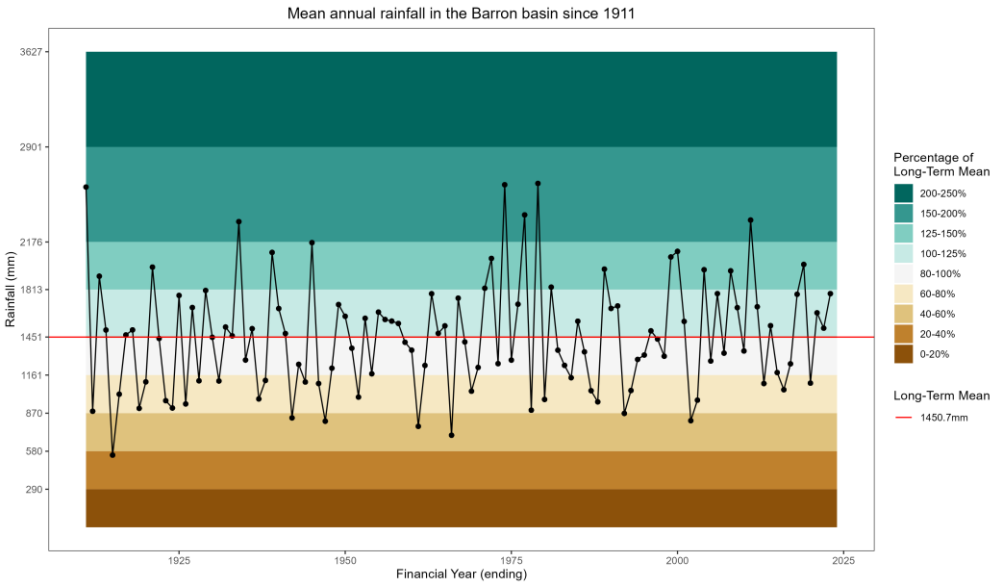
Appendix A. Long-term annual rainfall totals (1911 to 2023) for basin areas of the Wet Tropics

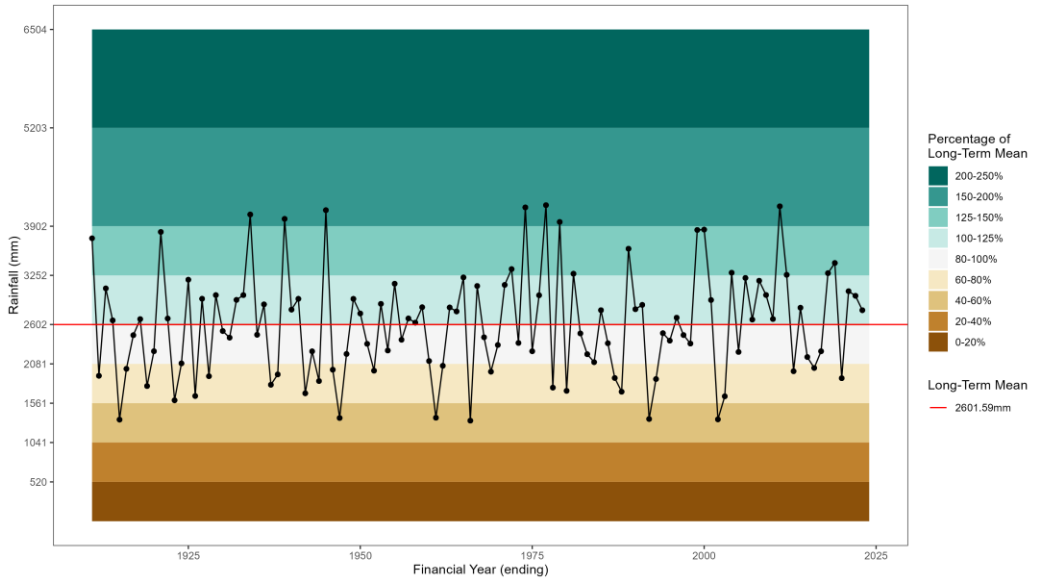




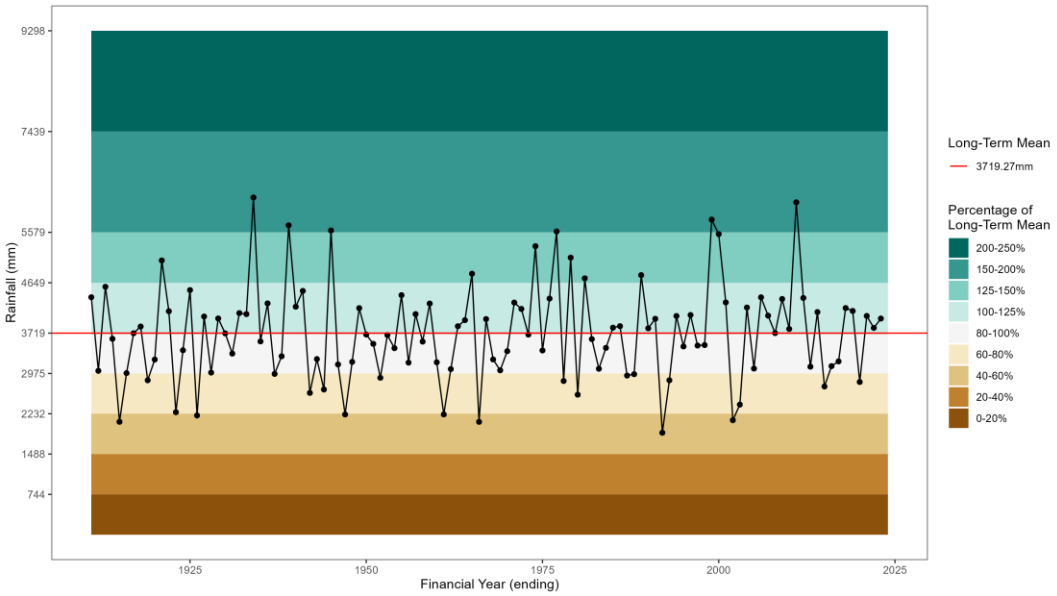


Wet Tropics Waterways

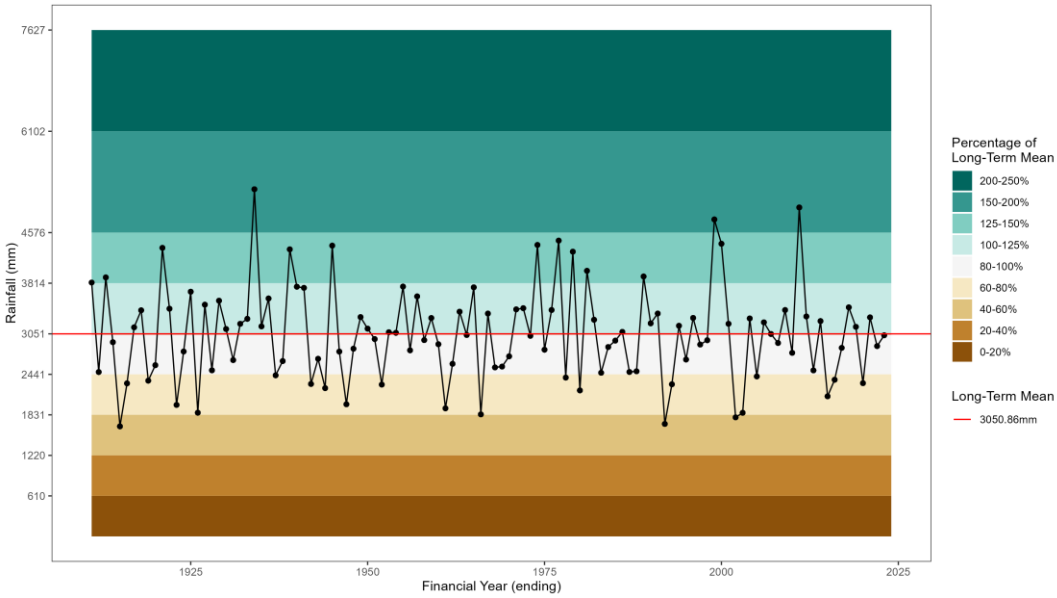
Mean annual rainfall in the Mulgrave basin since 1911



Mean annual rainfall in the Russell basin since 1911



Mean annual rainfall in the Johnstone basin since 1911



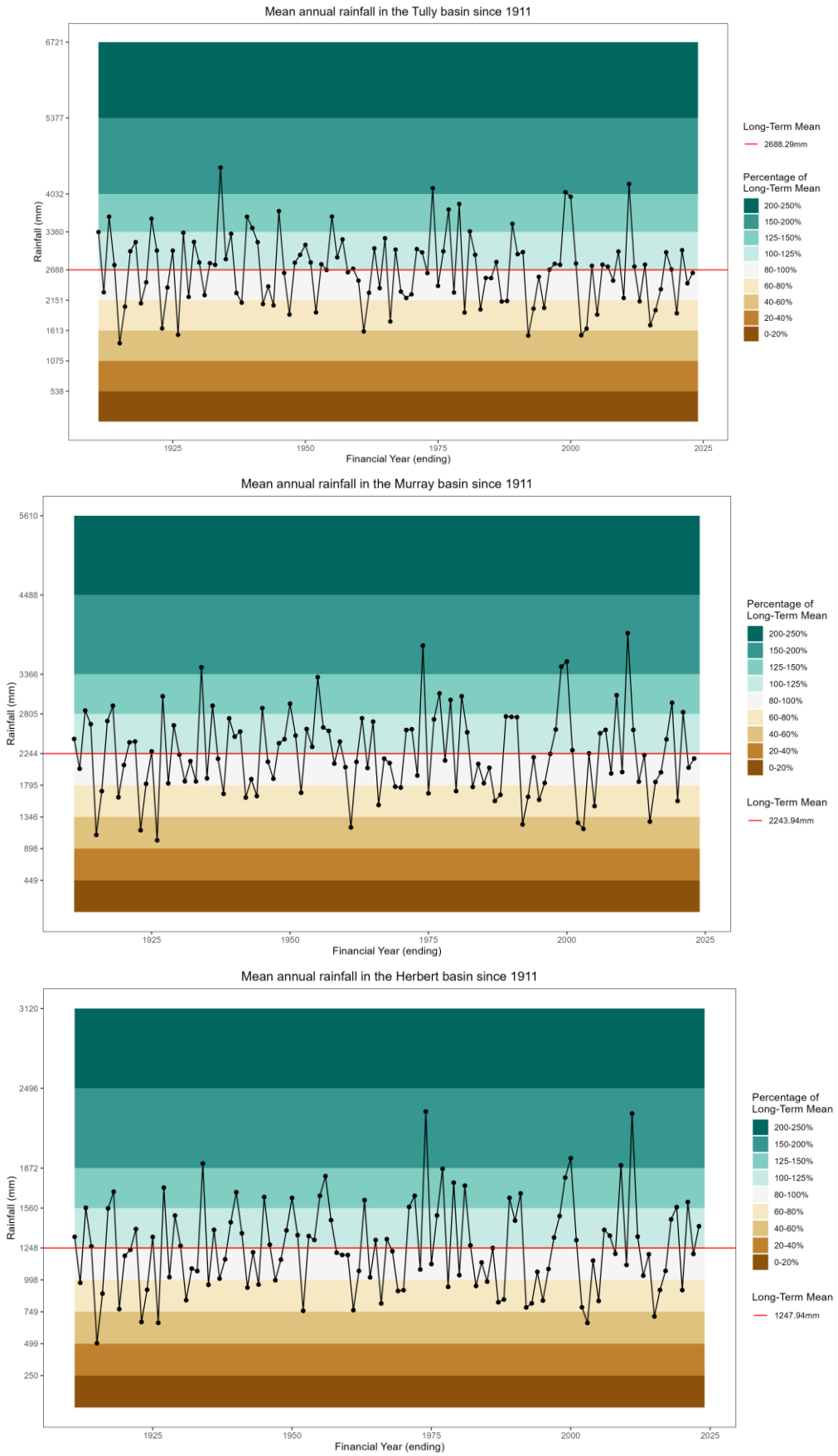


Figure 20. Annual rainfall totals, and long-term annual rainfall average (1911 to 2023) for basins of the Wet Tropics. Data sourced from the Bureau of Meteorology Australian Water Outlook .

Appendix B. Water quality data and scores for basins, estuaries and inshore marine reporting zones

Freshwater basins and estuaries

For each basin the high flow data and baseflow data were evaluated against the water quality objectives for high flow and baseflows at the moderately disturbed level of protection scheduled under the EPP (Water and Wetland Biodiversity) 2019 for Wet Tropics basins (DES 2020) (Table 60 to Table 69). Water quality objectives are referred to as guideline values (GV) to maintain clarity of terms throughout this report. As noted in the methods technical report (WTW 2024) the scheduled high flow guideline values (GVs) were set as the 80th percentile of historical data from the upper Tully Gorge reference site which has naturally low FRP concentrations. Concentrations of FRP are diluted during rainfall run-off events as it takes longer to become soluble than other nutrients, for example DIN. The "moderately disturbed" values for baseflow conditions are derived from 50th percentiles of impacted end of system catchment sites which drain agricultural areas where phosphorus is applied in the form of fertiliser. Consequently, the FRP GVs are lower for high flows than for baseflows.

In the basin water quality tables, the months are listed only if monitoring occurred for the flow type (high flow or low flow) for that month. Sampling intensity is greater during wet season events and sampling is generally once per month during the dry season. For months where more than one sample was taken the water quality data for both high flow and baseflow were calculated to monthly medians before the analysis, and consequently this procedure addressed any potential bias in the raw data relating to sampling intensity. The high flow and base-flow condition scores were multiplied by the proportion of days of the year that high flow or baseflow conditions occurred and were then summed to provide the annual condition score (Table 60 to Table 69). The methods technical document provides full details of the method (WTW 2024). Box and whisker plots of water quality indicator concentrations for high flow and base-flow conditions are presented in Figure 21 to Figure 23 and were conducted on all data points collected during the reporting period and not on the monthly values used for generating scores.

For estuaries chlorophyll *a*, turbidity, dissolved oxygen, DIN and FRP were evaluated against the scheduled guidelines for the water type at which the sampling site was located (moderately disturbed mid-estuary or lower estuary/enclosed coastal) in accordance with the EPP (Water and Wetland Biodiversity) 2019 for Wet Tropics basins (DES 2020). For estuaries with both mid- estuary and lower estuary/enclosed coastal water types the annual scores were multiplied by the proportion of data values within each water type and then condition scores were summed. The medians, condition scores and grades for each reporting zone are presented in Table 70 to Table 77 below.

The following scoring ranges and grading apply to freshwater basin and estuary water quality and are described in the methods technical report (WTW 2024).

- TSS, DIN FRP, turbidity, DO, Chl *a*: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = assigned 90.
- Sediment, nutrients, phys-chem, pesticides: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100

Table 60 Daintree Basin water quality monthly values and scores for 2022-23 reporting period.

High flows (>25 m³/s)	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
	Jul	9	0.047	0.005	
	Aug	13	0.152	0.003	
	Nov	91	0.209	0.003	
	Dec	21	0.067	0.004	
	Jan	16	0.087	0.005	
	Feb	70	0.092	0.005	
	Mar	45	0.085	0.004	
	Apr	10	0.097	0.004	
	Jun	2	0.026	0.004	
	Seasonal	16	0.087	0.004	212
GV (mg/L)		52	0.114	0.004	
SF (mg/L)		191	0.306	0.016	
80th %-tile (mg/L)		55	0.119	0.005	
Condition score		79.4	77.9	61.0	
Grade		G	G	G	

Base-flows	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
	Sep	2	0.020	0.005	
	Oct	2	0.022	0.006	
	Nov	1	0.008	0.004	
	May	3	0.028	0.005	
	Seasonal	2	0.021	0.005	153
GV (mg/L)		8	0.060	0.008	
SF (mg/L)		74	0.261	0.013	
80th %-tile (mg/L)		2	0.024	0.005	
Condition score		90.0	90.0	90.0	
Grade		VG	VG	VG	

Annual (high flow only)	**TSS**	DIN	FRP	**Nutrients**
Score	83.8	83.0	73.2	78.1
Grade	VG	VG	G	G

n(days) is the number of high flow days or base-flow days for the reporting period. GV is guideline value, SF is the scaling factor, 80th %-tile is the 80th percentile of the monitoring data, No.≤ GV is the number of data points less than or equal to the guideline value, and percentile ≤ GV is the percentile of data points less than or equal to the guideline value. Full explanation of terms and scoring method are provided in WTW 2024.

Table 61 Mossman Basin water quality monthly values and scores for 2022-23 reporting period.

Base-flows (Mossman US)	Monthly value (mg/L)	TSS	DIN	FRP
	Jul	1	0.1	0.005
	Aug	1	0.12	0.01
	Oct	1	0.1	0.005
	Dec	1	0.12	0.01
	Feb	6	0.09	0.01
	May	1	0.07	0.005
	Seasonal	1	0.100	0.008
GV (mg/L)		8	0.060	0.008
SF (mg/L)		74	0.261	0.013
80th %-tile (mg/L)		1	0.120	0.010
Condition score		90.0	48.8	65.0
Grade		VG	M	G

Base-flows (Mossman WWTP)	Monthly value (mg/L)	TSS	DIN	FRP
		1	0.110	0.010
	Aug	1	0.120	0.040
	Oct	1	0.100	0.020
	Dec	2	0.130	0.010
	Feb	4	0.090	0.010
	May	1	0.070	0.005
	Seasonal	1	0.105	0.010
GV (mg/L)		8	0.060	0.008
SF (mg/L)		74	0.261	0.013
80th %-tile (mg/L)		2	0.120	0.020
Condition score		90.0	47.3	36.5
Grade		VG	M	P

Base-flows (South Mossman)	Monthly value (mg/L)	TSS	DIN	FRP
		5	0.16	0.005
	Aug	5	0.23	0.005
	Dec	5	0.1	0.01
	Feb	21	0.28	0.01
	May	5	0.15	0.005
	Seasonal	5	0.160	0.005
GV (mg/L)		8	0.060	0.008
SF (mg/L)		74	0.261	0.013
80th %-tile (mg/L)		8	0.240	0.010
Condition score		78.1	30.6	72.9
Grade		G	P	G

Base-flows (Mossman DS)	Monthly value (mg/L)	TSS	DIN	FRP
	Jul	2	0.111	0.004
	Aug	2	0.152	0.013
	Oct	1	0.1165	0.004
	Dec	3	0.101	0.008
	Feb	8	0.184	0.008
	May	2	0.075	0.004
	Seasonal	2	0.114	0.006
GV (mg/L)		8	0.060	0.008
SF (mg/L)		74	0.261	0.013
80th %-tile (mg/L)		3	0.152	0.008
Condition score		90.0	44.7	90.0
Grade		VG	M	VG

Annual (base-flows)	**TSS**	DIN	FRP	**Nutrients**
Score	84.6	40.5	68.6	54.5
Grade	VG	M	G	M

GV is guideline value, SF is the scaling factor, 80th %-tile is the 80th percentile of the monitoring data, No.≤ GV is the number of data points less than or equal to the guideline value, and percentile ≤ GV is the percentile of data points less than or equal to the guideline value. Mossman US refers to sites MR2 and MR4 which are in close proximity upstream of the confluence with South Mossman River. Mossman WWTP refers to site MR4.1 which is just downstream of the Mossman wastewater treatment plant discharge point and just upstream of the confluence with the South Mossman River. SMR refers to the site on the South Mossman River just upstream of the confluence with the Mossman River (SMR1). Mossman DS refers to sites MR5 located on the Mossman River just downstream of the confluence with the South Mossman River. Site details and explanation of terms and scoring method are provided in WTW 2024.

Table 62 Barron Basin water quality monthly values and scores for 2022-23 reporting period.

High flows (>8.2 m³/s)	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
	July	58	0.152	0.011	
	Aug	7	0.127	0.004	
	Sep	5	0.131	0.006	
	Oct	7	0.076	0.005	
	Dec	17	0.201	0.015	
	Jan	104	0.092	0.026	
	Feb	52	0.103	0.009	
	Mar	33	0.084	0.006	
	Apr	10	0.459	0.010	
	May	4	0.200	0.005	
	Seasonal	14	0.124	0.006	290
GV (mg/L)		52	0.114	0.004	
SF (mg/L)		191	0.306	0.016	
80th %-tile (mg/L)		53	0.200	0.012	
Condition score		80.3	56.1	43.1	
Grade		G	M	M	

Base-flows	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
	Oct	nd	nd	nd	
	Nov	nd	nd	nd	
	Jan	nd	nd	nd	
	Oct	nd	nd	nd	
	Apr	nd	nd	nd	
	Seasonal	nd	nd	nd	75
GV (mg/L)		8	0.060	0.008	
SF (mg/L)		74	0.261	0.013	
80th %-tile (mg/L)		nd	nd	nd	
Condition score		nd	nd	nd	
Grade		nd	nd	nd	

Annual (high flow only, no baseflow data available)	**TSS**	DIN	FRP	**Nutrients**
	80.3	56.1	43.1	49.6
	G	M	M	M

n(days) is the number of high flow days or base-flow days for the reporting period. GV is guideline value, SF is the scaling factor, 80th %-tile is the 80th percentile of the monitoring data, No.≤ GV is the number of data points less than or equal to the guideline value, and percentile ≤ GV is the percentile of data points less than or equal to the guideline value. nd indicates no data available. Full explanation of terms and scoring method are provided in WTW 2024.

Table 63 Mulgrave Basin water quality monthly values and scores for 2022-23 reporting period.

High flows >30 m³/s	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
High flow	July	22	0.115	0.007	
	Aug	28	0.082	0.006	
	Sep	3	0.086	0.006	
	Dec	20	0.149	0.014	
	Jan	30	0.135	0.012	
	Feb	19	0.134	0.012	
	Mar	26	0.237	0.011	
	Apr	14	0.115	0.011	
	Seasonal	21	0.125	0.011	169
GV (mg/L)		52	0.114	0.004	
SF (mg/L)		191	0.306	0.016	
80th %-tile (mg/L)		27	0.143	0.012	
Condition score		90.0	57.6	25.4	
Grade		VG	M	P	

Base-flows	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
	Jul	1	0.212	0.004	
	Aug	2	0.218	0.004	
	Oct	1	0.174	0.005	
	Nov	5	0.029	0.002	
	Dec	2	0.009	0.001	
	Jan	nd	nd	nd	
	Mar	nd	nd	nd	
	Apr	nd	nd	nd	
	Jun	nd	nd	nd	
	Seasonal	2	0.198	0.004	196
GV (mg/L)		8	0.060	0.008	
SF (mg/L)		74	0.261	0.013	
80th %-tile		2	0.212	0.005	
Condition score		90.0	26.8	90.0	
Grade		VG	VP	VG	

Annual (high flow and baseflow)	**TSS**	DIN	FRP	**Nutrients**
Score	90.0	41.1	60.1	50.6
Grade	VG	P	M	M

n(days) is the number of high flow days or base-flow days for the reporting period. GV is guideline value, SF is the scaling factor, 80th %-tile is the 80th percentile of the monitoring data, No. ≤ GV is the number of data points less than or equal to the guideline value, and percentile ≤ GV is the percentile of data points less than or equal to the guideline value. nd indicates no data available. Full explanation of terms and scoring method are provided in WTW 2024.

Table 64 Russell Basin water quality monthly values and scores for 2022-23 reporting period.

High flows (>39.5 m^3/s)	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
	Jul	25	0.147	0.006	
	Aug	19	0.095	0.004	
	Sep	7	0.134	0.004	
	Dec	45	0.285	0.008	
	Jan	62	0.136	0.008	
	Feb	17	0.100	0.007	
	Mar	15	0.105	0.006	
	Apr	12	0.086	0.009	
	Jun	1	0.125	0.003	
	Seasonal	17	0.125	0.006	193
GV (mg/L)		52	0.114	0.004	
SF (mg/L)		191	0.306	0.016	
80th %-tile (mg/L)		33	0.140	0.008	
Condition score		90.0	57.4	50.8	
Grade		VG	M	M	

Base-flows	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
	Jul	1	0.191	0.007	
	Aug	3	0.155	0.001	
	Oct	1	0.087	0.001	
	Nov	2	0.048	0.0005	
	Dec	3	0.009	0.0005	
	Mar	nd	nd	nd	
	Apr	nd	nd	nd	
	Jun	nd	nd	nd	
	Seasonal	2	0.087	0.001	172
GV (mg/L)		8	0.060	0.008	
SF (mg/L)		74	0.261	0.013	
80th %-tile (mg/L)		3	0.162	0.002	
Condition score		90.0	52.7	90.0	
Grade		VG	M	VG	

Annual (high flow and baseflow)	**TSS**	DIN	FRP	**Nutrients**
Score	90.0	55.2	69.2	62.2
Grade	VG	M	G	G

n(days) is the number of high flow days or base-flow days for the reporting period. GV is guideline value, SF is the scaling factor, 80th %-tile is the 80th percentile of the monitoring data, No. ≤ GV is the number of data points less than or equal to the guideline value, and percentile ≤ GV is the percentile of data points less than or equal to the guideline value. nd indicates no data available. Full explanation of terms and scoring method are provided in WTW 2024.

Table 65 North Johnstone sub-basin water quality monthly values and scores for 2022-23 reporting period.

High flows (>31.6 m^3/s)	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
	Jul	27	0.114	0.009	
	Aug	14	0.086	0.005	
	Dec	26	0.136	0.009	
	Jan	46	0.122	0.009	
	Feb	22	0.146	0.007	
	April	28	0.108	0.006	
	May	1	0.067	0.002	
	Jun	1	0.102	0.003	
	Seasonal	24	0.111	0.007	237
GV (mg/L)		52	0.114	0.004	
SF (mg/L)		191	0.306	0.016	
80th %-tile (mg/L)		28	0.130	0.009	
Condition score		90.0	64.3	48.2	
Grade		VG	G	M	

Base-flows	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
	Jul	nd	nd	nd	
	Aug	nd	nd	nd	
	Sep	nd	nd	nd	
	Oct	1	0.022	0.005	
	Nov	1	0.023	0.003	
	Dec	nd	nd	nd	
	Seasonal	1	0.043	0.004	128
GV (mg/L)		8	0.060	0.008	
SF (mg/L)		74	0.261	0.013	
80th %-tile (mg/L)		1	0.023	0.005	
Condition score		90.0	90.0	90.0	
Grade		VG	VG	VG	

Annual (high flow and baseflow)	TSS	DIN	FRP	**Nutrients**
Score	90.0	73.3	62.9	68.1
Grade	VG	G	G	G

n(days) is the number of high flow days or base-flow days for the reporting period. GV is guideline value, SF is the scaling factor, 80th %-tile is the 80th percentile of the monitoring data, No. ≤ GV is the number of data points less than or equal to the guideline value, and percentile ≤ GV is the percentile of data points less than or equal to the guideline value. nd indicates no data available. Full explanation of terms and scoring method are provided in WTW 2024.

Table 66 South Johnstone sub-basin water quality monthly values and scores, and Johnstone combined scores for 2022-23 reporting period.

High flows (>15.0 m^3/s)	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
High flow	Jul	32	0.096	0.010	
	Aug	9	0.077	0.012	
	Dec	47	0.155	0.013	
	Jan	95	0.116	0.011	
	Feb	24	0.135	0.009	
	Mar	nd	nd	nd	
	April	54	0.147	0.010	
	May	1	0.054	0.006	
	June	1	0.078	0.007	
	Seasonal	28	0.106	0.010	240
GV (mg/L)		52	0.114	0.004	
SF (mg/L)		191	0.306	0.016	
80th %-tile (mg/L)		51	0.142	0.012	
Condition score		90.0	65.4	31.7	
Grade		VG	G	P	

Base-flows	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
	Aug	nd	nd	nd	
	Sep	nd	nd	nd	
	Oct	3	0.039	0.011	
	Nov	1	0.023	0.010	
	Dec	nd	nd	nd	
	Seasonal	2	0.031	0.010	125
GV (mg/L)		8	0.060	0.008	
SF (mg/L)		74	0.261	0.013	
80th %-tile (mg/L)		2	0.035	0.010	
Condition score		90.0	90.0	33.5	
Grade		VG	VG	P	

Annual (high flow and baseflow)	TSS	DIN	FRP	Nutrients
Score	90.0	73.8	32.3	53.1
Grade	VG	G	P	M

Johnstone combined Annual (high flow and base-flow)	TSS	DIN	FRP	Nutrients
Score	90.0	73.6	47.6	60.6
Grade	VG	G	M	M

n(days) is the number of high flow days or base-flow days for the reporting period. GV is guideline value, SF is the scaling factor, 80th %-tile is the 80th percentile of the monitoring data, No. ≤ GV is the number of data points less than or equal to the guideline value, and percentile ≤ GV is the percentile of data points less than or equal to the guideline value. nd indicates no data available. Full explanation of the terms and scoring method are provided in WTW 2024.

Table 67 Tully Basin water quality monthly values and scores for 2022-23 reporting period.

High flows (>61.2 m^3/s)	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
High flow	Jul	25	0.178	0.002	
	Aug	38	0.129	0.001	
	Nov	121	0.204	0.002	
	Dec	47	0.499	0.024	
	Jan	28	0.166	0.007	
	Feb	22	0.144	0.007	
	Mar	18	0.151	0.004	
	Apr	24	0.136	0.004	
	May	8	0.129	0.003	
	Jun	14	0.108	0.002	
	Seasonal	24	0.147	0.003	226
GV (mg/L)		52	0.114	0.004	
SF (mg/L)		191	0.306	0.016	
80th %-tile (mg/L)		39	0.183	0.007	
Condition score		90.0	50.4	65.5	
Grade		VG	M	G	

Base-flows	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
	Jul	3	0.150	0.001	
	Nov	2	0.064	0.001	
	Jun	2	0.146	0.001	
	Seasonal	2	0.146	0.001	139
GV (mg/L)		8	0.060	0.008	
SF (mg/L)		74	0.261	0.013	
80th %-tile (mg/L)		3	0.148	0.001	
Condition score		90.0	34.8	90.0	
Grade		VG	P	VG	

Annual (high flow and base-flow)	**TSS**	DIN	FRP	**Nutrients**
Score	90.0	44.4	74.8	59.6
Grade	VG	M	G	M

n(days) is the number of high flow days or base-flow days for the reporting period. GV is guideline value, SF is the scaling factor, 80th %-tile is the 80th percentile of the monitoring data, No. ≤ GV is the number of data points less than or equal to the guideline value, and percentile ≤ GV is the percentile of data points less than or equal to the guideline value. Full explanation of the terms and scoring method are provided in WTW 2024.

Table 68 Murray Basin water quality monthly values and scores for 2022-23 reporting period.

High flows (>8.0 m^3/s)	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
High flow	Jul	3	0.229	0.001	
	Oct	4	0.148	0.004	
	Dec	36	1.206	0.018	
	Jan	22	0.124	0.012	
	Feb	20	0.146	0.007	
	Mar	8	0.197	0.004	
	Apr	2	0.297	0.008	
	Seasonal	8	0.197	0.007	251
GV (mg/L)		52	0.114	0.004	
SF (mg/L)		191	0.306	0.016	
80th %-tile (mg/L)		22	0.283	0.011	
Condition score		90.0	34.6	45.7	
Grade		VG	P	M	

Base-flows	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
	Aug	3	0.166	0.002	
	Sep	16	0.107	0.002	
	Nov	18	0.050	0.002	
	May	2	0.195	0.004	
	Jun	4	0.163	0.002	
	Seasonal	4	0.163	0.002	114
GV (mg/L)		8	0.060	0.008	
SF (mg/L)		74	0.261	0.013	
80th %-tile (mg/L)		16	0.172	0.002	
Condition score		67.5	29.7	90.0	
Grade		G	P	VG	

Annual (high flow and base-flow)	**TSS**	DIN	FRP	**Nutrients**
Score	83.0	33.0	59.5	46.3
Grade	VG	P	M	M

n(days) is the number of high flow days or base-flow days for the reporting period. GV is guideline value, SF is the scaling factor, 80th %-tile is the 80th percentile of the monitoring data, No. ≤ GV is the number of data points less than or equal to the guideline value, and percentile ≤ GV is the percentile of data points less than or equal to the guideline value. Full explanation of the terms and scoring method are provided in WTW 2024.

Table 69 Herbert Basin water quality monthly values and scores for 2022-23 reporting period.

High flows (>44.2 m^3/s)	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
	Jul	19	0.143	0.007	
	Aug	11	0.114	0.002	
	Sep	10	0.134	0.002	
	Oct	180	0.455	0.025	
	Dec	81	0.097	0.007	
	Jan	72	0.041	0.009	
	Feb	46	0.060	0.008	
	Mar	15	0.091	0.005	
	Apr	5	0.175	0.002	
	May	4	0.175	0.001	
	Jun	13	0.168	0.003	
	Seasonal	15	0.134	0.005	163
GV (mg/L)		52	0.114	0.004	
SF (mg/L)		191	0.306	0.016	
80th %-tile (mg/L)		72	0.175	0.008	
Condition score		73.9	54.6	55.8	
Grade		G	M	M	

Base-flows	Monthly value (mg/L)	TSS	DIN	FRP	n (days)
	Jul	3	0.266	0.004	
	Aug	1	0.175	0.001	
	Sep	4	0.160	0.002	
	Oct	1	0.180	0.002	
	Nov	8	0.146	0.008	
	Dec	12	0.167	0.008	
	Jun	1	0.213	0.001	
	Seasonal	3	0.175	0.002	202
GV (mg/L)		8	0.060	0.008	
SF (mg/L)		74	0.261	0.013	
80th %-tile (mg/L)		7	0.206	0.007	
Condition score		90.0	26.1	90.0	
Grade		VG	P	VG	

Annual (high flow and base-flows)	**TSS**	DIN	FRP	**Nutrients**
Score	82.8	38.8	74.7	56.8
Grade	VG	P	G	M

n(days) is the number of high flow days or base-flow days for the reporting period. GV is guideline value, SF is the scaling factor, 80th %-tile is the 80th percentile of the monitoring data, No. ≤ GV is the number of data points less than or equal to the guideline value, and percentile ≤ GV is the percentile of data points less than or equal to the guideline value. nd indicates no data available. Full explanation of the terms and scoring method are provided in WTW 2024.

Figure 21 to Figure 23 provide box and whisker plots of water quality indicators for high flow and base-flow conditions (2022-23). The mid-line is the median, the cross is the mean and the box depicts the upper and lower quartiles. The whiskers are the lowest and highest datum within 1.5 IQR (interquartile range) and outliers are datum above or below 1.5 IQR. To present the complete variation of data, the analysis was conducted on all data points collected during the reporting period and not on the monthly values used for generating scores.

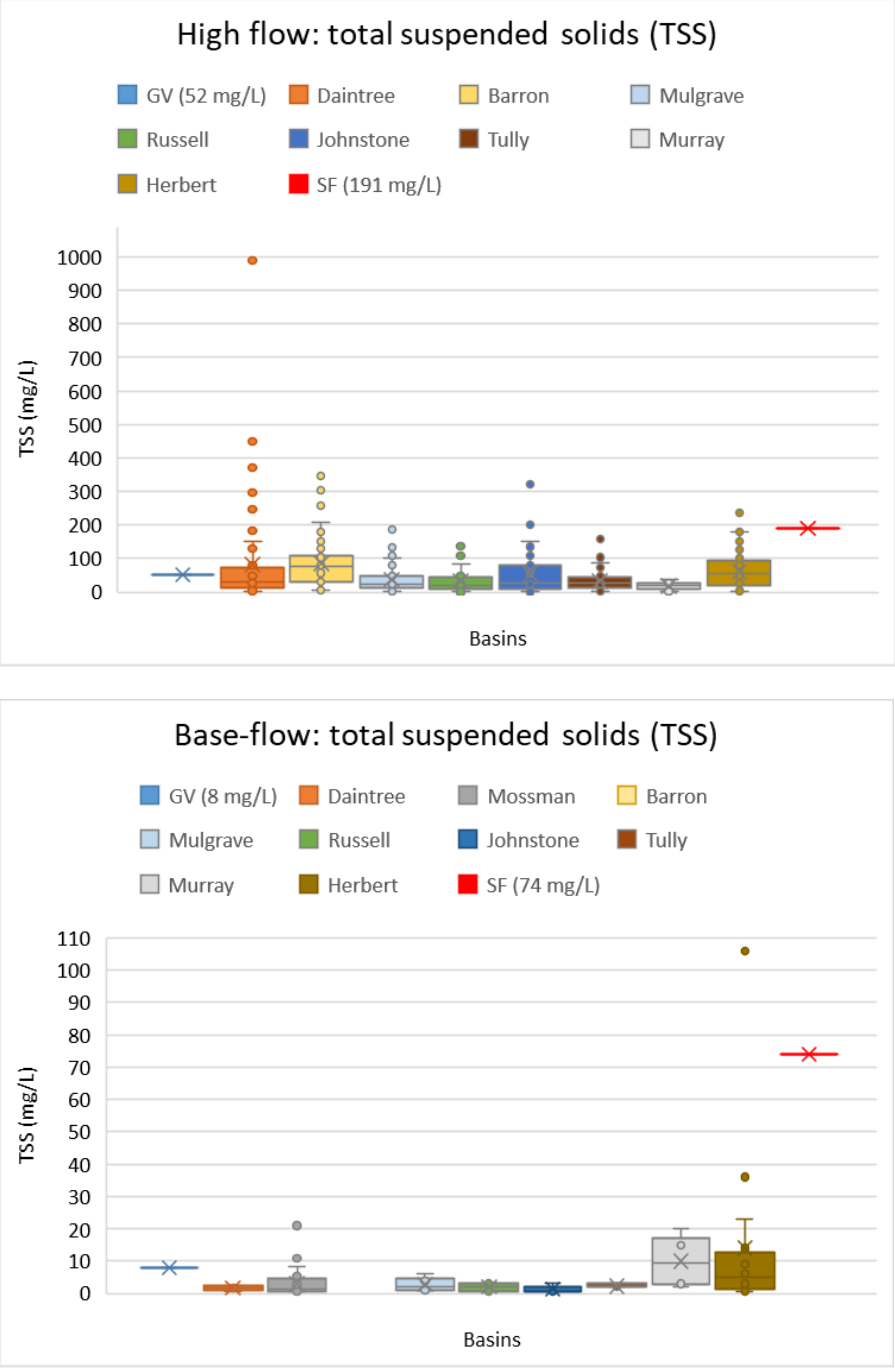
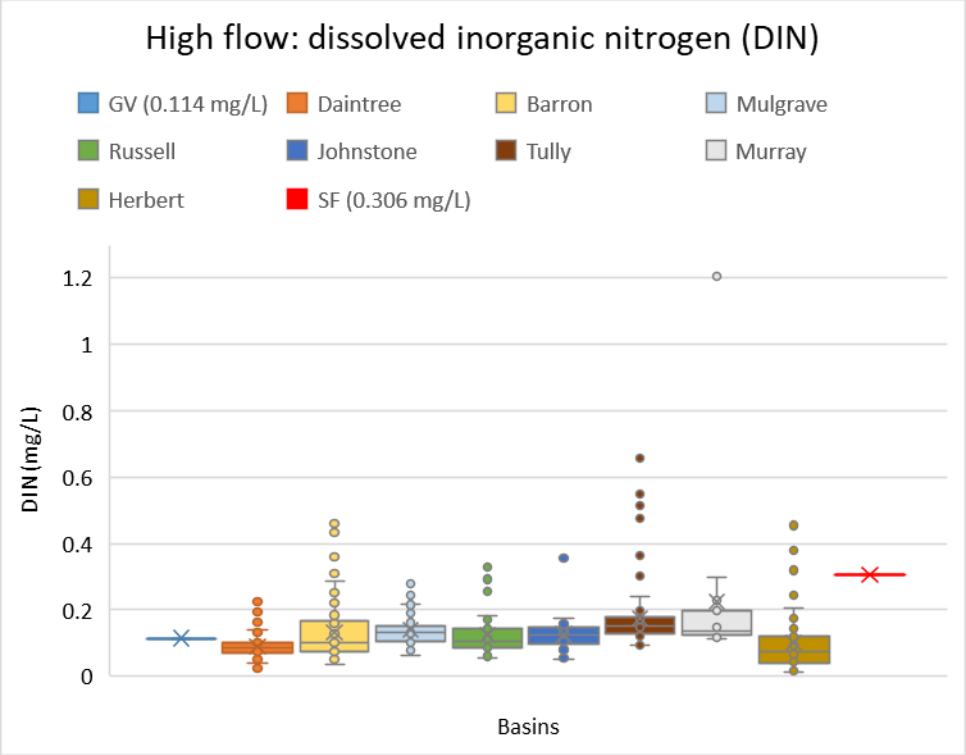


Figure 21 Box and whisker plots of total suspended solids (TSS) concentrations for base-flow and high flow conditions of basins. The mid-line is the median, the cross is the mean, the box depicts the upper and lower quartiles with 1.5 IQR (interquartile range) whiskers and outliers are above or below 1.5 IQR. The guideline value (GV) and scaling factor (SF) are presented.



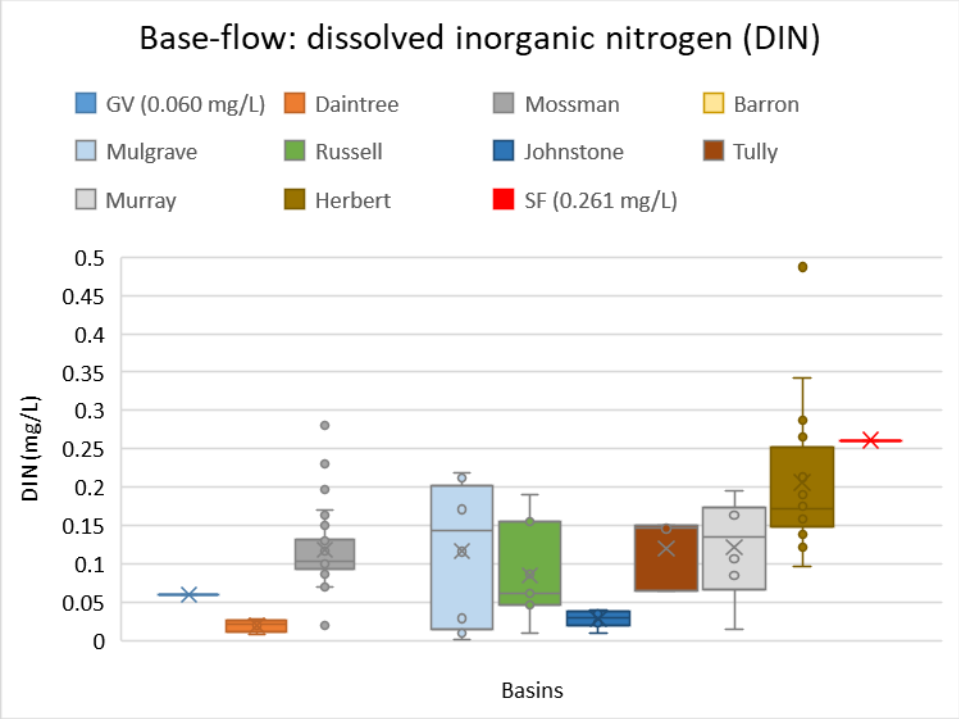
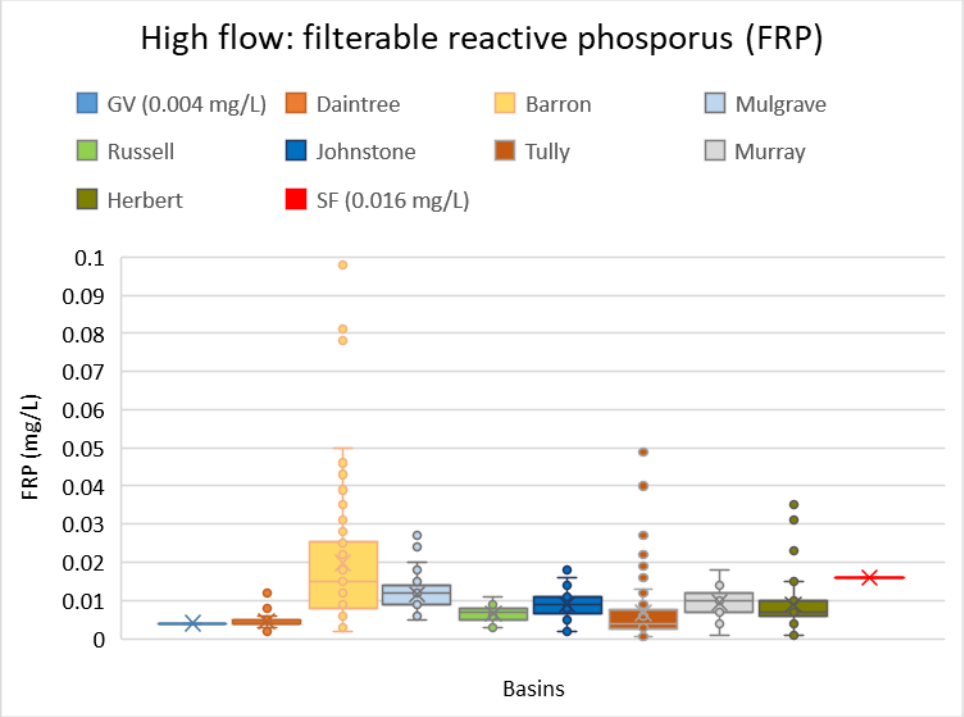


Figure 22 Box and whisker plots of dissolved inorganic nitrogen (DIN) concentrations for base-flow and high flow conditions of basins. The mid-line is the median, the cross is the mean, the box depicts the upper and lower quartiles with 1.5 IQR (interquartile range) whiskers and outliers are above or below 1.5 IQR. The guideline value (GV) and scaling factor (SF) are presented.



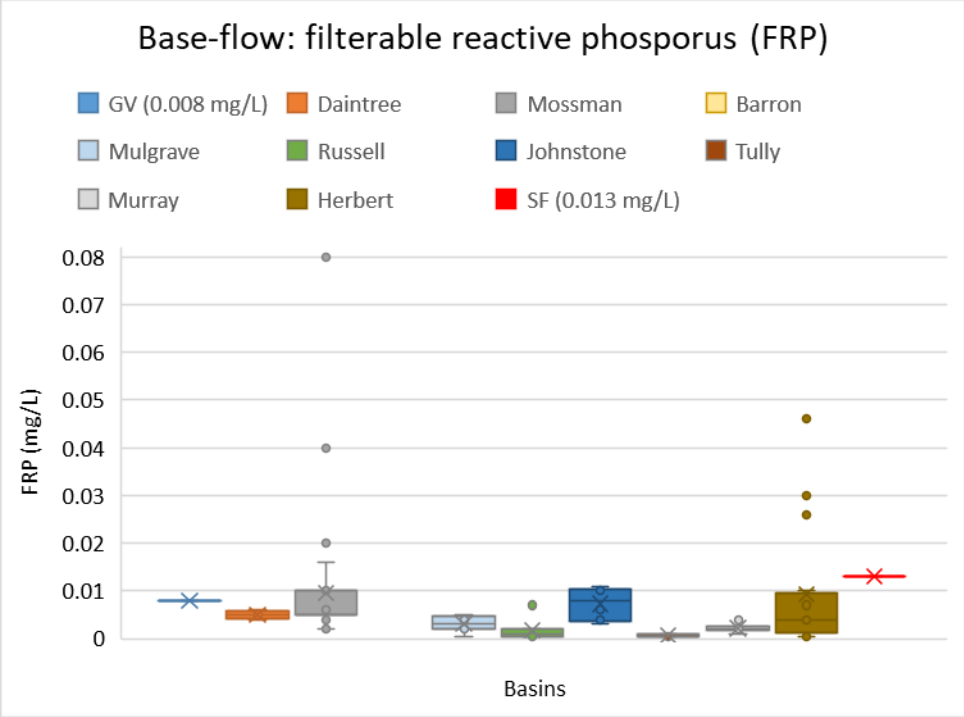


Figure 23 Box and whisker plots of filterable reactive phosphorus (FRP) concentrations for base-flow and high flow conditions of basins. The mid-line is the median, the cross is the mean, the box depicts the upper and lower quartiles with 1.5 IQR (interquartile range) whiskers and outliers are above or below 1.5 IQR. The guideline value (GV) and scaling factor (SF) are presented.

Basin pesticides: risk and chemical contribution

The results of relative contribution of pesticide chemicals are for the standard pesticide reporting sites which are part of GBRCLMP routine pesticide monitoring, as reported in section 4.1, and for additional sites monitored in 2022-23 and in 2021-22. The relative contribution of pesticide chemicals for current and previous years are presented in Figure 24 and Figure 25 for standard basin monitoring sites and in Figure 26 and Figure 27 for the additional sites.

For 2022-23 at the standard pesticide reporting sites, imidacloprid increased in relative contribution since 2021-22 at Mossman, Tully, and Herbert, and diuron increased in relative contribution since 2021-22 at Tully, Murray and Herbert. Despite some recent decline in the percent of species affected (pesticide risk) for 2022-23 this measure increased notably for Tully, Murray and Herbert but decreased at Johnstone (Coquette Point), compared to the previous year.

Land use and hydrology was used to explain the differences recorded for pesticide risk and relative chemical contributions for the four additional sites sampled in 2021-22 (WTW 2023), and those differences were similar in the 2022-23 results for the same four sites. The following summaries for each site describe the dominant land use and the pesticide risk including major chemical contributions (Figure 26 and Figure 27).

- Saltwater Creek sub catchment draining to the coral sea north of Mossman River. Stream order 5, headwaters draining natural rainforest environment and lowland land use dominated by sugarcane production. Pesticide risk was low (similar to Mossman River site) and major chemical contribution was diuron.
- Emerald Creek sub-catchment draining into the Barron River on the Atherton Tablelands. Stream order 4 with headwaters draining natural forested environment, lowland land use dominated by grazing and horticulture. Pesticide risk was moderate (increasing from very low in 2021-22) and major chemical contribution was imidacloprid.
- Fig Tree Creek tributary draining into the Mulgrave River near Deeral. Stream order 2 with catchment dominated by natural rainforest environment. Pesticide risk was very low and no discernible major chemical contribution.
- Catherina Creek tributary draining into the Herbert River downstream of Ingham. Stream order 2 with land use dominated by sugar cane, and upstream catchment of paddock drainage channels connected to creek. Pesticide risk very high and major chemical contributions were from diuron and imidacloprid.

Pesticide risk was highest at the Catherina Creek site which had the smallest area of catchment, the lowest capacity for catchment run-off, and greatest intensity of upstream agricultural land use. The lowest risk was at the Fig Tree Creek site which had a very low area of upstream agricultural land use with most catchment run-off draining from natural rainforest areas. The Emerald Creek site (moderate pesticide risk) and Saltwater Creek site (low pesticide risk) had considerably larger catchments with greater run-off capacity, and upstream land use which included substantial areas of natural environments. Differences in pesticide risk and contributing chemicals between these two sites were likely a reflection of the area, intensity, and type, of upstream agricultural land use.

References

WTW (Wet Tropics Waterways) 2023. Wet Tropics Report Card 2023 (reporting on data 2021-22). Waterway Environments: Results. Wet Tropics Waterways and Terrain NRM, Cairns.

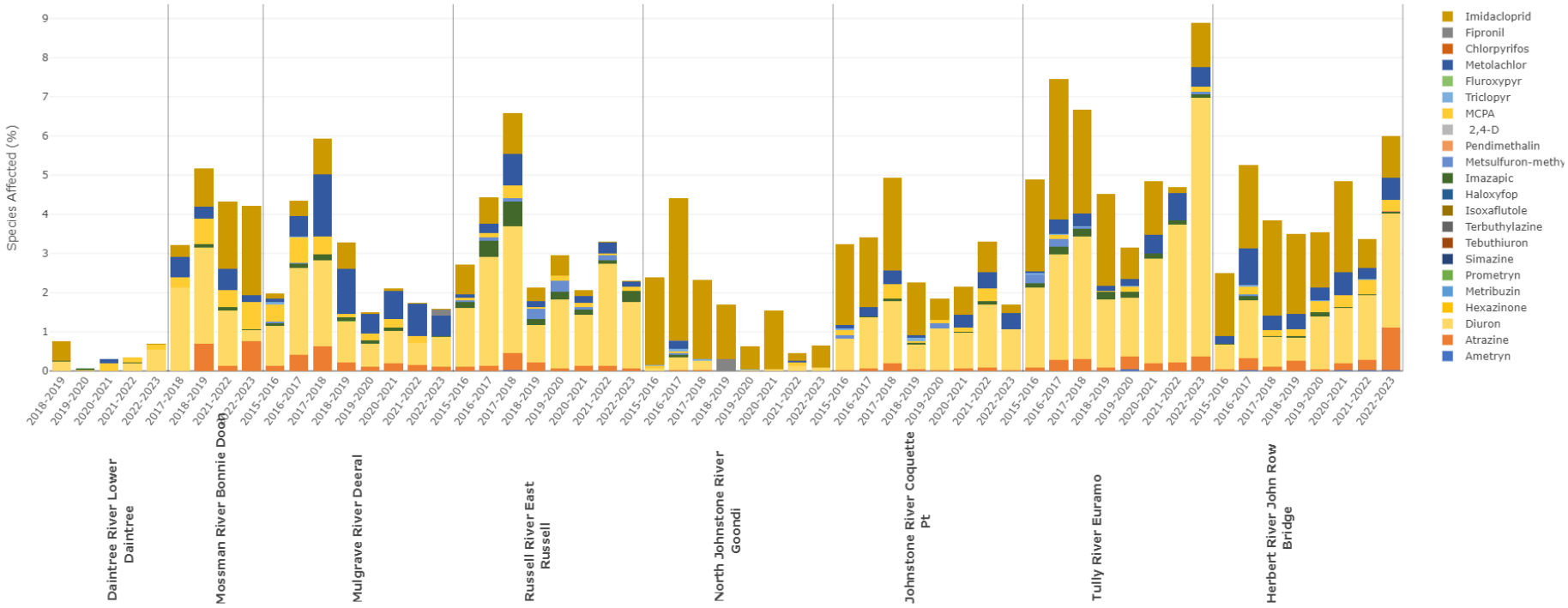


Figure 24 The relative contribution of pesticide types at standard basin reporting sites (Mossman, Mulgrave, Russell, North Johnstone, Johnstone River at Coquette Point, Tully and Herbert) for all available reporting years (top) Of the full suite of 22 pesticides only those that contributed >0.1% of the toxicity are shown (the remainder had negligible contribution to toxicity).

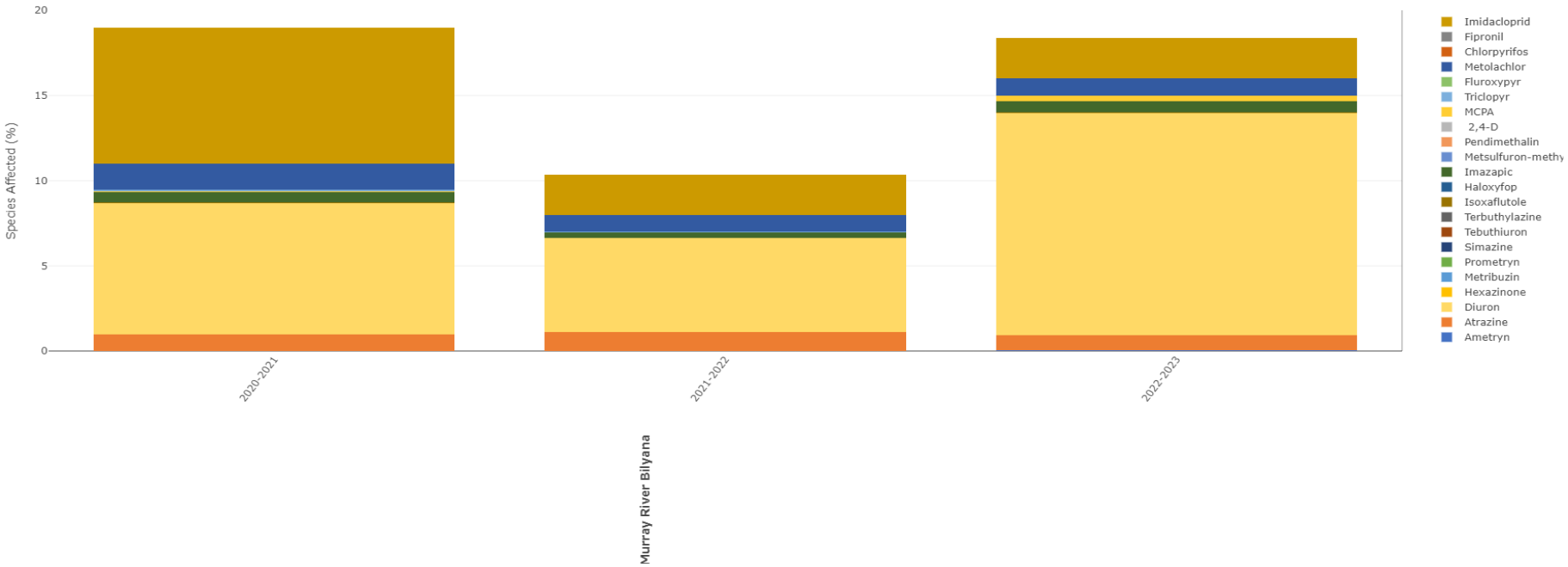


Figure 25 The relative contribution of pesticide types at standard Murray Basin reporting site for the last three years. Of the full suite of 22 pesticides only those that contributed >0.1% of the toxicity are shown (the remainder had negligible contribution to toxicity).

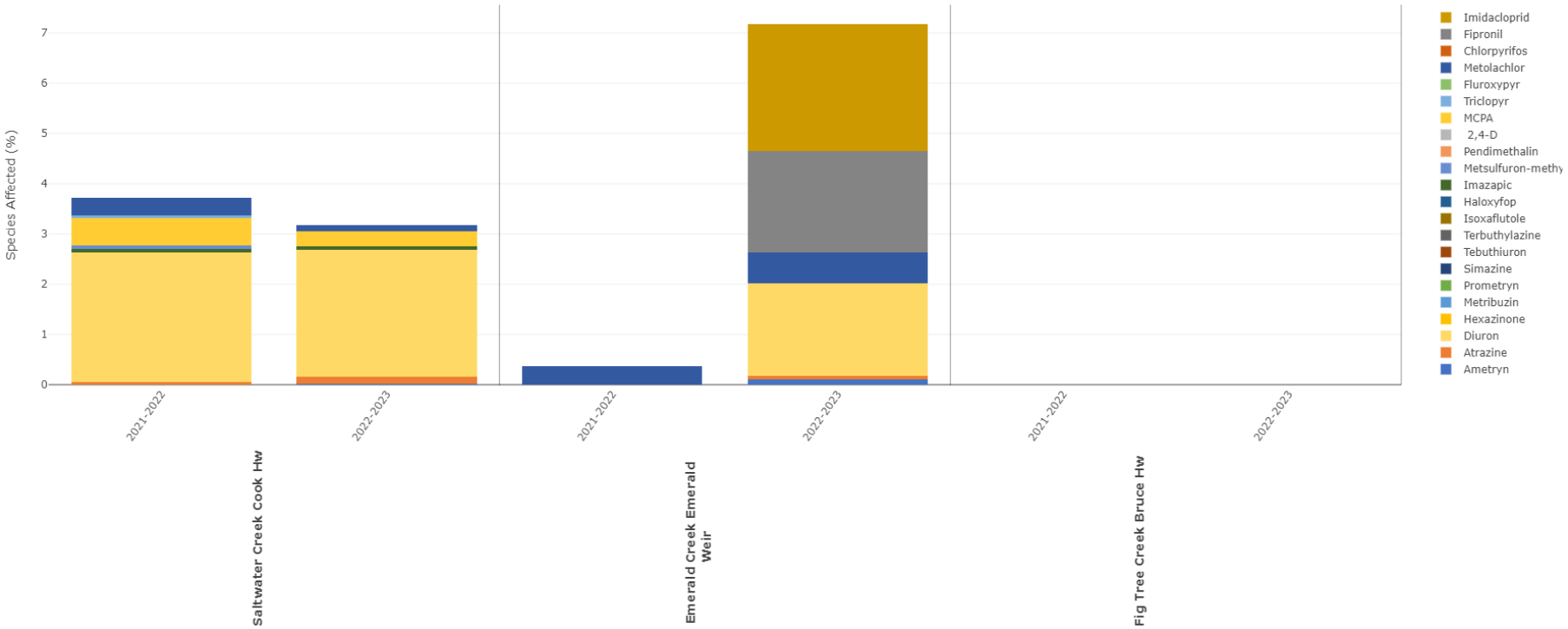


Figure 26 The relative contribution of pesticide types at additional pesticide monitoring sites for the last two years at Saltwater Creek, Emerald Creek and Fig Tree Creek (top). Of the full suite of 22 pesticides only those that contributed >0.1% of the toxicity are shown (the remainder had negligible contribution to toxicity).

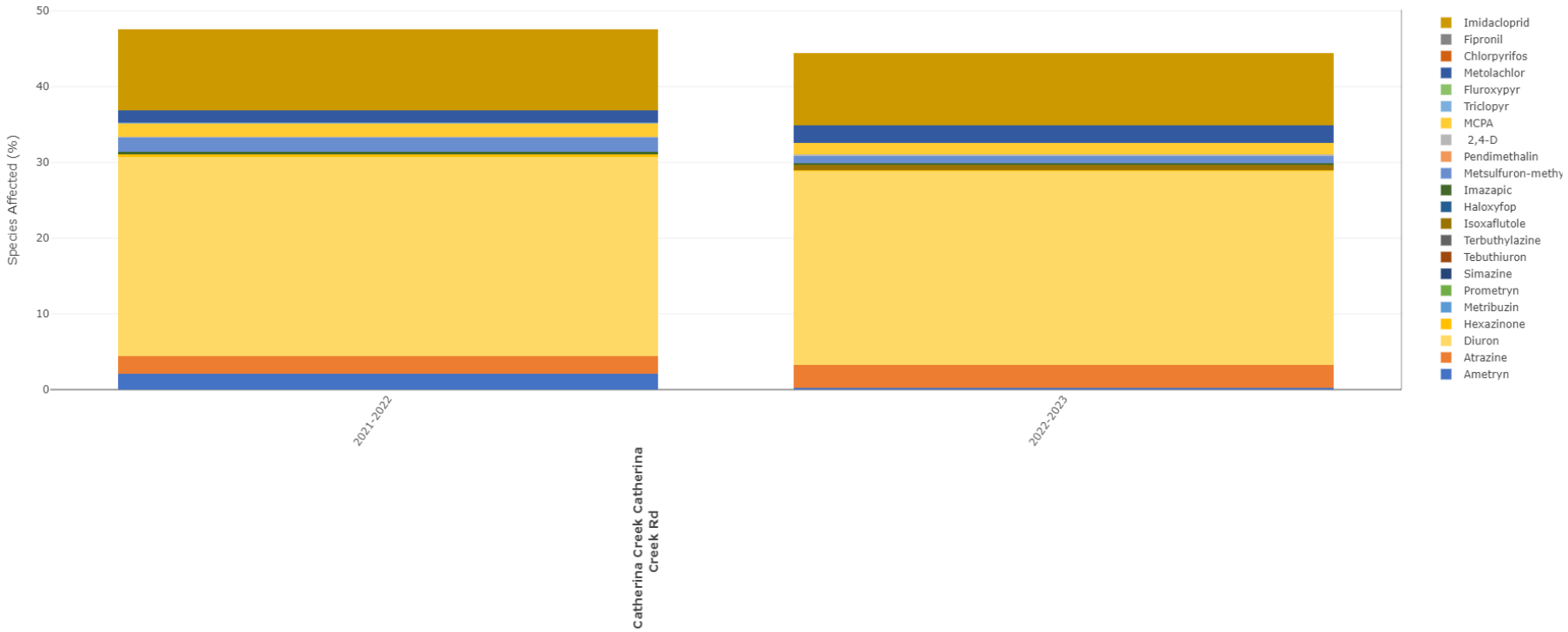


Figure 27 The relative contribution of pesticide types at the additional pesticide monitoring site for the last two years at Catherina Creek. Of the full suite of 22 pesticides only those that contributed >0.1% of the toxicity are shown (the remainder had negligible contribution to toxicity).

Table 70 Daintree estuary 2022-23.

Mid-estuary

	Chl *a* (µg/L)	DIN (mg/L)	FRP (mg/L)	Turbidity (NTU)	DO low (% sat.)	DO high (% sat.)
Annual Median	2.8	0.041	0.004	4.3	83.3	83.3
GV	3.0	0.045	0.005	10.0	80.0	105.0
SF	5.0	0.200	0.010	20.0	50.0	111.0
80th or 20th %-tile	3.6	0.084	0.005	7.5	78.6	88.4
	Chl *a*	DIN	FRP	Turbidity	DO low	DO high
Condition score	65.6	62.9	90.0	90.0	75.0	90.0
Grade	G	G	VG	VG	G	VG
n	36	36	36	30	36	36

Enclosed coastal

	Chl *a* (µg/L)	DIN (mg/L)	FRP (mg/L)	Turbidity (NTU)	DO low (% sat.)	DO high (% sat.)
Annual Median	2.4	0.006	0.002	2.2	92.7	92.7
GV	2.0	0.025	0.005	10.0	85.0	105.0
SF	5.0	0.200	0.010	20.0	50.0	111.0
80th or 20th %-tile	3.9	0.017	0.004	4.4	89.1	96.1
	Chl *a*	DIN	FRP	Turbidity	DO low	DO high
Condition score	53.1	90.0	90.0	90.0	90.0	90.0
Grade	M	VG	VG	VG	VG	VG
n	12	12	12	10	12	12

Total estuary

	Chl *a*	DIN	FRP	**Nutrients**	Turbid-ity	DO Low	DO High	**Phys/ Chem**	**Pest-icides**	**WQ**
Score	62.4	69.6	90.0	79.8	90.0	78.7	90.0	84.4	86	78.2
Grade	G	G	VG	G	VG	G	VG	VG	VG	G

n is the number of monthly values from all sites used to calculate the annual median. GV is guideline value, SF is the scaling factor, %-tile is the percentile of the monitoring data, No. ≤/≥ GV is the number of data points less/greater than or equal to the guideline value, and percentile ≤/≥ GV is the percentile of data points less/greater than or equal to the guideline value. Full explanations of the terms and scoring method are provided in WTW 2024. Condition scores weighted according to proportion of samples located in each water type: for nutrients, chlorophyll *a* and phys-chem mid-estuary = 0.75 and enclosed coastal = 0.25.

Table 71 Dickson Inlet 2022-23.

Mid-estuary

	Chl *a* (µg/L)	DIN (mg/L)	FRP (mg/L)	Turbidity (NTU)	DO low (% sat.)	DO high (% sat.)
Annual median	2.0	0.046	0.005	3.2	71.6	71.6
GV	3.0	0.045	0.005	10.0	80.0	105.0
SF	5.0	0.200	0.010	20.0	50.0	111.0
80th or 20th %-tile	2.5	0.060	0.006	5.5	48.7	75.6
	Chl *a*	DIN	FRP	Turbidity	DO low	DO high
Condition score	90.0	60.7	61.0	90.0	43.8	90.0
Grade	VG	M	G	VG	M	VG
n	10	17	17	18	18	18

Lower estuary

	Chl *a* (µg/L)	DIN (mg/L)	FRP (mg/L)	Turbidity (NTU)	DO low (% sat.)	DO high (% sat.)
Annual median	1.6	0.040	0.005	3.8	87.1	87.1
GV	2.0	0.025	0.005	10.0	85.0	105.0
SF	5.0	0.200	0.010	20.0	50.0	111.0
80th or 20th %-tile	2.1	0.060	0.007	7.6	82.4	90.8
	Chl *a*	DIN	FRP	Turbidity	DO low	DO high
Condition score	77.8	55.7	61.0	90.0	69.8	90.0
Grade	G	M	G	VG	G	VG
n	5	11	11	12	12	12

Total estuary

	Chl *a*	DIN	FRP	**Nutrients**	Turbidity	DO Low	DO High	**Phys/ Chem**	**Pest-icides**	**WQ**
Score	85.9	58.7	61.0	59.9	90.0	54.2	90.0	72.1	nd	72.6
Grade	VG	M	G	M	VG	M	VG	G		G

N is the number of monthly values from all sites used to calculate the annual median. GV is guideline value, SF is the scaling factor, %-tile is the percentile of the monitoring data, No. ≤/≥ GV is the number of data points less/greater than or equal to the guideline value, and percentile ≤/≥ GV is the percentile of data points less/greater than or equal to the guideline value. Full explanations of the terms and scoring method are provided in WTW 2024. Condition scores weighted according to proportion of samples located in each water type: for nutrients mid-estuary = 0.61 and lower estuary = 0.39, for chlorophyll *a* mid-estuary = 0.0.67 and lower estuary = 0.33, and phys-chem mid-estuary = 0.6 and lower estuary = 0.4. nd indicates no data or insufficient data available.

Table 72 Barron estuary 2022-23.

Mid-estuary

	Chl *a* (µg/L)	DIN (mg/L)	FRP (mg/L)	Turbidity (NTU)	DO low (% sat.)	DO high (% sat.)
Annual median	2.2	0.154	0.010	9.4	80.0	80.0
GV	3.0	0.045	0.005	10.0	80.0	105.0
SF	5.0	0.200	0.010	20.0	50.0	111.0
80th or 20th %-tile	6.0	0.179	0.012	17.0	74.3	89.7
	Chl *a*	DIN	FRP	Turbidity	DO low	DO high
Condition score	65.2	18.3	0.0	62.6	61.0	90.0
Grade	G	P	VP	G	G	VG
n	24	24	24	24	24	24

Lower estuary

	Chl *a* (µg/L)	DIN (mg/L)	FRP (mg/L)	Turbidity (NTU)	DO low (% sat.)	DO high (% sat.)
Annual median	2.4	0.069	0.008	13.0	85.9	85.9
GV	2.0	0.025	0.005	10.0	85.0	105.0
SF	5.0	0.200	0.010	20.0	50.0	111.0
80th or 20th %-tile	2.7	0.161	0.011	20.0	82.0	90.8
	Chl *a*	DIN	FRP	Turbidity	DO low	DO high
Condition score	52.8	45.6	24.4	42.6	65.4	90.0
Grade	M	M	P	M	G	VG
n	6	6	6	6	6	6

Total estuary

	Chl *a*	DIN	FRP	**Nutrients**	Turbidity	DO Low	DO High	**Phys/ Chem**	**Pest-icides**	**WQ**
Score	62.7	23.7	4.9	14.3	58.6	61.9	90.0	60.2	nd	45.8
Grade	G	P	VP	VP	M	G	VG	M		M

n is the number of monthly values from all sites used to calculate the annual median. GV is guideline value, SF is the scaling factor, %-tile is the percentile of the monitoring data, No. ≤/≥ GV is the number of data points less/greater than or equal to the guideline value, and percentile ≤/≥ GV is the percentile of data points less/greater than or equal to the guideline value. Full explanations of the terms and scoring method are provided in WTW 2024. Condition scores weighted according to proportion of samples located in each water type: for nutrients, chlorophyll *a* and phys-chem mid-estuary = 0.80 and lower estuary = 0.20. nd indicates no data or insufficient data available.

Table 73 Trinity Inlet 2022-23.

Mid-estuary

	Chl *a* (µg/L)	DIN (mg/L)	FRP (mg/L)	Turbidity (NTU)	DO low (% sat.)	DO high (% sat.)
Annual median	1.9	0.035	0.004	3.5	63.9	63.9
GV	3.0	0.045	0.005	10.0	80.0	105.0
SF	5.0	0.200	0.010	20.0	50.0	111.0
80th or 20th %-tile	3.3	0.061	0.006	6.4	52.0	73.6
	Chl *a*	DIN	FRP	Turbidity	DO low	DO high
Condition score	76.4	68.8	71.0	90.0	28.1	90.0
Grade	G	G	G	VG	P	VG
n	60	60	59	60	60	60

Lower estuary

	Chl *a* (µg/L)	DIN (mg/L)	FRP (mg/L)	Turbidity (NTU)	DO low (% sat.)	DO high (% sat.)
Annual median	1.6	0.017	0.003	4.0	80.3	80.3
GV	2	0.025	0.005	10.0	85.0	105.0
SF	5.000	0.200	0.010	20.0	50.0	111.0
80th or 20th %-tile	3.1	0.046	0.005	4.9	77.9	84.0
	Chl *a*	DIN	FRP	Turbidity	DO low	DO high
Condition score	66.6	66.4	90.0	90.0	52.6	90.0
Grade	G	G	VG	VG	M	VG
n	5	5	5	5	5	5

Total estuary

	Chl *a*	DIN	FRP	**Nutrients**	Turbidity	DO Low	DO High	**Phys/ Chem**	**Pest-icides**	**WQ**
Score	75.7	68.6	72.4	70.5	90.0	30.0	90.0	60.0	nd	68.7
Grade	G	G	G	G	VG	P	VG	M		G

n is the number of monthly values from all sites used to calculate the annual median. GV is guideline value, SF is the scaling factor, %-tile is the percentile of the monitoring data, No. ≤/≥ GV is the number of data points less/greater than or equal to the guideline value, and percentile ≤/≥ GV is the percentile of data points less/greater than or equal to the guideline value. Full explanations of the terms and scoring method are provided in WTW 2024. Condition scores weighted according to proportion of samples located in each water type: for nutrients, chlorophyll *a* and phys-chem mid-estuary = 0.92 and lower estuary = 0.08. nd indicates non data or insufficient data available.

Table 74 Russell-Mulgrave 2022-23.

Mid-estuary

	Chl *a* (µg/L)	DIN (mg/L)	FRP (mg/L)	Turbidity (NTU)	DO low (% sat.)	DO high (% sat.)
Annual Median	0.9	0.122	0.005	3.0	79.0	79.0
GV	3.0	0.045	0.005	10.0	80.0	105.0
SF	5.0	0.200	0.010	20.0	50.0	111.0
80th or 20th %-tile	2.4	0.232	0.006	3.9	72.2	87.8
	Chl *a*	DIN	FRP	Turbidity	DO low	DO high
Condition score	90.0	30.8	68.7	90.0	58.9	90.0
Grade	VG	P	G	VG	M	VG
n	5	5	5	5	4	4

Lower Estuary

	Chl *a* (µg/L)	DIN (mg/L)	FRP (mg/L)	Turbidity (NTU)	DO low (% sat.)	DO high (% sat.)
Annual median	1.2	0.074	0.006	3.2	83.0	83.0
GV	2.0	0.025	0.005	10.0	85.0	105.0
SF	5.0	0.200	0.010	20.0	50.0	111.0
80th or 20th %-tile	4.1	0.140	0.006	4.7	71.7	88.1
	Chl *a*	DIN	FRP	Turbidity	DO low	DO high
Condition score	66.5	43.8	54.8	90.0	57.4	90.0
Grade	G	M	M	VG	M	VG
n	6	6	6	6	5	5

Total estuary

	Chl *a*	DIN	FRP	**Nutrients**	Turbidity	DO Low	DO High	**Phys/ Chem**	**Pest-icides**	**WQ**
Score	82.2	35.2	64.0	49.6	90.0	58.4	90.0	74.2	76.3	70.6
Grade	VG	P	G	M	VG	M	VG	G	G	G

n is the number of monthly values from all sites used to calculate the annual median. GV is guideline value, SF is the scaling factor, %-tile is the percentile of the monitoring data, No. ≤/≥ GV is the number of data points less/greater than or equal to the guideline value, and percentile ≤/≥ GV is the percentile of data points less/greater than or equal to the guideline value. Full explanations of the terms and scoring method are provided in WTW 2024. Condition scores weighted according to proportion of samples located in each water type: for chlorophyll, nutrients and turbidity the mid-estuary = 0.67 and the lower estuary = 0.33; for dissolved oxygen the mid-estuary = 0.64 and the lower estuary = 0.36.

Table 75 Johnstone estuary 2022-23.

Mid-estuary

	Chl *a* (µg/L)	DIN (mg/L)	FRP (mg/L)	Turbidity (NTU)	DO low (% sat.)	DO high (% sat.)
Annual median	1.4	0.135	0.006	3.7	80.4	80.4
GV	3.0	0.045	0.005	10.0	80.0	105.0
SF	5.0	0.200	0.010	20.0	50.0	111.0
80th or 20th %-tile	1.8	0.200	0.007	14.1	74.9	86.9
	Chl *a*	DIN	FRP	Turbidity	DO low	DO high
Condition score	90.0	25.5	48.7	73.1	62.5	90.0
Grade	VG	P	M	G	G	VG
n	16	41	41	32	16	16

Total estuary

	Chl *a*	DIN	FRP	**Nutrients**	Turbidity	DO Low	DO High	**Phys/ Chem**	**Pest-icides**	**WQ**
Score	90.0	25.5	48.7	37.1	73.1	62.5	90.0	62.5	77.5	66.8
Grade	VG	P	M	P	G	G	VG	G	G	G

n is the number of monthly values from all sites used to calculate the annual median. GV is guideline value, SF is the scaling factor, %-tile is the percentile of the monitoring data, No. ≤/≥ GV is the number of data points less/greater than or equal to the guideline value, and percentile ≤/≥ GV is the percentile of data points less/greater than or equal to the guideline value. Full explanations of the terms and scoring method are provided in WTW 2024. nd indicates no data or insufficient data available.

Table 76 Moresby estuary 2022-23.

Mid-estuary

	Chl *a* (µg/L)	DIN (mg/L)	FRP (mg/L)	Turbidity (NTU)	DO low (% sat.)	DO high (% sat.)
Annual median	3.3	0.014	0.001	2.8	84.5	84.5
GV	3.0	0.045	0.005	10.0	80.0	105.0
SF	5.0	0.200	0.010	20.0	50.0	111.0
80th or 20th %-tile	5.4	0.093	0.0020	5.3	69.3	89.9
	Chl *a*	DIN	FRP	Turbidity	DO low	DO high
Condition score	50.7	68.8	90.0	90.0	66.9	90.0
Grade	M	G	VG	VG	G	VG
n	57	57	57	57	57	57

Lower Estuary

	Chl *a* (µg/L)	DIN (mg/L)	FRP (mg/L)	Turbidity (NTU)	DO low (% sat.)	DO high (% sat.)
Annual median	1.9	0.008	0.001	1.7	93.5	93.5
GV	2.0	0.025	0.005	10.0	85.0	105.0
SF	5.0	0.200	0.010	20.0	50.0	111.0
80th or 20th %-tile	4.0	0.011	0.003	4.7	89.2	95.9
	Chl *a*	DIN	FRP	Turbidity	DO low	DO high
Condition score	61.6	90.0	90.0	90.0	90.0	90.0
Grade	G	VG	VG	VG	VG	VG
n	12	12	12	10	12	12

Total estuary

	Chl *a*	DIN	FRP	**Nutrients**	Turbidity	DO Low	DO High	**Phys/ Chem**	**Pest-icides**	**WQ**
Score	52.6	72.5	90.0	81.3	90.0	70.9	90.0	80.5	nd	71.4
Grade	M	G	VG	VG	VG	M	VG	G		G

n is the number of monthly values from all sites used to calculate the annual median. GV is guideline value, SF is the scaling factor, 80th %-tile is the 80th percentile of the monitoring data, No. ≤/≥ GV is the number of data points less/greater than or equal to the guideline value, and percentile ≤/≥ GV is the percentile of data points less/greater than or equal to the guideline value. Full explanations of the terms and scoring method are provided in WTW 2024. Condition scores weighted according to proportion of samples located in each water type: for mid-estuary, chlorophyll, nutrients and phys-chem = 0.83; for lower estuary chlorophyll, nutrients and phys-chem = 0.17. nd indicates non data or insufficient data available.

Table 77 Hinchinbrook Channel 2022-23.

Enclosed coastal

	Chl *a* (µg/L)	DIN (mg/L)	FRP (mg/L)	Turbidity (NTU)	DO low (% sat.)	DO high (% sat.)
Annual Median	2.7	0.004	0.002	2.7	90.1	90.1
GV	2.0	0.025	0.005	10.0	85.0	105.0
SF	5.0	0.200	0.010	20.0	50.0	111.0
80th or 20th %-tile	4.3	0.010	0.003	5.8	83.4	94.2
	Chl *a*	DIN	FRP	Turbidity	DO low	DO high
Condition score	46.1	90.0	90.0	90.0	76.1	90.0
Grade	M	VG	VG	VG	G	VG
n	31	31	31	30	31	31

Total estuary

	Chl *a*	DIN	FRP	**Nutrients**	Turbidity	DO Low	DO High	**Phys/ Chem**	**Pest-icides**	**WQ**
Score	46.1	90.0	90.0	90.0	90.0	76.1	90.0	83.1	nd	73.0
Grade	M	VG	VG	VG	VG	G	VG	VG		G

n is the number of monthly values from all sites used to calculate the annual median. GV is guideline value, SF is the scaling factor, 80th %-tile is the 80th percentile of the monitoring data, No. ≤/≥ GV is the number of data points less/greater than or equal to the guideline value, and percentile ≤/≥ GV is the percentile of data points less/greater than or equal to the guideline value. Full explanations of the terms and scoring method are provided in WTW 2024. nd indicates non data or insufficient data available.

Inshore Marine

The annual means of inshore water quality indicators for sites within each reporting zones are presented in Table 78. The water quality scores for reach reporting zone before standardisation are presented in Table 79.

Table 78 Inshore marine water quality annual means and number of measurements taken by grab samples for each monitoring site for 2022-23.

Zone	Site	NO_x (µg/L)	PN (µg/L)	PP (µg/L)	TSS (mg/L)	Turbidity (NTU)	CHL *a* (µg/L))	No. Grab samples
North	C01	1.0	19.4	2.6	1.0		0.32	3
	C011	1.2	12.7	1.5	0.3		0.21	3
	C04	0.7	20.8	2.9	1.7		0.36	3
	C05	0.5	18.0	2.2	0.8		0.32	3
	C06	0.7	25.9	3.8	2.1		0.48	3
	C08	0.4	28.7	4.1	2.7		0.42	3
Central	RM1	1.3	19.0	2.0	0.7	1.1	0.40	5
	RM10	4.6	40.5	4.0	2.4	5.6	0.85	10
	RM3	1.6	26.6	2.5	1.2		0.41	9
	RM7	1.4	27.8	2.2	0.9	0.8	0.51	10
	RM8	1.8	33.2	2.7	1.4	0.9	0.43	10
South	TUL10 (EC)	7.1	52.8	5.7	4.1	5.0	0.98	10
	TUL2	1.9	28.4	2.0	1.0		0.26	10
	TUL3	2.0	30.2	2.7	1.6	2.7	0.65	10
	TUL5	1.6	26.4	2.6	2.1		0.34	10
	TUL6	1.9	38.0	3.9	3.1		0.43	10
	TUL8	1.5	32.4	3.2	2.0		0.34	9
Palm Is	BUR1	1.7	30.1	2.3	0.8	0.7	0.55	9
	BUR2	1.1	27.7	2.7	1.3	1.4	0.45	9

All sites are within open coastal waters except for TUL10 which is within enclosed coastal waters (EC). *indicates values derived solely from continuous logger measurements. #indicates values derived from continuous logger measurements and grab samples.

Table 79 Inshore marine water quality indicator scores for 2022-23 without standardisation.

	Water clarity		Chlorophyll *a*	Nutrients			Pesticides
Zone	TSS	Turbidity	CHL	NO_x	PN	PP	% species protected
North	0.44	nd	0.39	0.96	-0.01	0.06	100.0
Central	0.59	0.27	-0.14	0.11	-0.51	0.11	99.9
South	0.14	0.07	0.36	0.23	-0.62	0.01	99.9
Palm	0.83	0.57	-0.15	0.59	-0.53	0.17	100.0

Scoring range for water clarity, chlorophyll *a* and nutrients: Very Poor = <-0.66 to -1 | Poor = <-0.33 to -0.66 | Moderate = <0 to -0.33 | Good = 0 to 0.5 | Very Good = >0.5 to 1. **Pesticide risk metric scoring range:** Very Poor = <80% | Poor = <90 to 80% | Moderate = <95 to 90% | Good = <99 to 95% | Very Good = ≤99%. nd indicates no data or insufficient data available.

Update to scheduled oxidized nitrogen guideline values.

Since the Wet Tropics report card was developed in 2016 (reporting on 2014-15) the scoring and grading of inshore water quality (enclosed coastal, open coastal and mid-shelf waters) has applied the guideline values used for the MMP Long-term trend inshore water quality index as published in Lønborg et al. 2016, Waterhouse et al. 2017, and Gruber et al. 2019. These guideline values were the most appropriate at the time and were based on published GBRMPA (2010) and scheduled Queensland Government (DEHP 2009) guideline values.

In 2020 the guideline values for oxidised nitrogen (NOx) were updated for coastal and marine waters of the Wet Tropics and scheduled in the Environmental Protection (Water and Wetland Biodiversity) Policy 2019—the EPP (Water and Wetland Biodiversity) (DES 2020). The updates involved a change from using a mean to a median of the sample data concentration values for comparison against the guideline values, and a substantial lowering of the NO_x concentration guideline value for open coastal and mid-shelf waters (Table 80). This update followed similar changes of the NO_x guideline values used for the MMP long-term trend inshore water quality index, applied as from the 2018-19 report (Gruber et al. 2020, p. 186-187) which cited: "This value {2.0 µg L^{-1}} was determined to be too high and not reflective of NO_x concentrations in the Reef lagoon. From the 2018–19 report onwards, a revised NOx GV of 0.35 µg L^{-1} was used for this version of the Index (provided by the Authority).".

Table 80 Oxidised nitrogen (NO_x) guideline values used for the Wet Tropics report card and introduced with the 2020 scheduled update.

		Guideline values for NO_x (ug/L)	
Water type	**Zone**	**Report card (2016 -)**	**Updated scheduled (2020)**
Enclosed coastal	All inshore zones	10 (mean)	10 (median)
Open coastal	North, Central South Palm Island	2 (mean) 2 (mean)	0.35 (median) 0.28 (median)
Mid-shelf	All inshore zones	2 (mean)	0.31 (median)

Updated scheduled values were sourced from Schedule 1 amendments for the Wet Tropics basins coastal waters approved in 2020 (Environmental Protection (Water and Wetland Biodiversity) Policy 2019). The guideline values are compared to either the test data mean (as per Wet Tropics report card methods (WTW 2024) or the median (as per the Environmental Protection (Water and Wetland Biodiversity) Policy 2019).

The effect of using the updated scheduled NO_x guideline values for scoring the 2021-22 inshore water quality, compared to using the Wet Tropics report card guideline values, was to substantially lower the score for NO_x in all zones and also lower the nutrients and water quality scores for the North, Central and Palm Island zone (Table 81).

Note that the 2021-22 NO_x, nutrient and water quality scores show that for the South zone the NO_x score is lower, whilst the nutrient and water quality scores are higher, when using the scheduled guidelines compared to Wet Tropics report card guideline values. This is due to the method of score aggregation used for inshore water quality. The nutrient indicator category is not calculated as the average of the contributing indicator scores for the zone (as they are presented in Table 81 for NO_x, and Table 46 for PN and PP), it is calculated as the average of the contributing indicators for each site and then the site nutrient scores are averaged to produce the zone score.

Table 81 Water quality results for 2021-22 using updated scheduled guideline values for inshore waters of the Wet Tropics region.

Zone	NO_x	Nutrients	Water quality
North	0	50	72
Central	0	36	59
South	24	44	62
Palm Island	0	42	61

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100.

Comparing the guideline values for scoring the NO_x indicator over all reporting years shows that the North, Central and Palm Island scores were usually substantially lowered for each year when using the updated scheduled guidelines (Figure 28). In contrast, the South zone has years where using the updated scheduled guidelines increased the score compared to using the Wet Tropics report card guideline values (e.g. 2017, 2018 and 2019). This is because the South zone is the only zone that includes enclosed coastal sites (two sites pre-2020, one site from 2020 onwards), and the guideline value of 10 µg L^{-1} for enclosed coastal waters was not changed in the scheduled updates. Since the median concentration of the sampled data, instead of the mean, is used to compare with the updated scheduled guideline value (which typically yields a lower concentration value than the mean), the enclosed coastal site scores increased, and the score for the South zone when averaged from all contributing sites increased. As example of how the mean and median can differ, the 2021-22 NO_x sample data for the South zone enclosed coastal site had a mean of 16.23 µg/L, corresponding to 'very poor', and a median of 4.76 µg/L, corresponding to 'very good'.

Figure 28 Time series of the oxidised nitrogen indicator scores and grades for each inshore zone using the Wet Tropics report card guideline values (left) and the updated scheduled guideline values.

Due to the effect of using the updated scheduled guidelines on scoring the NO_x indicator, the guideline values have remained unchanged for the purposes of scoring inshore marine waters. This provides inshore marine water quality reporting that is consistent and comparable with all previous years. Inshore marine water quality guideline values used for scoring will be reviewed in the upcoming program design review (2023-25) which will allow for application of the most appropriate guidelines and a consistent approach across regional report cards.

Note that the above explanation is provided for reference and uses inshore water quality results from 2021-22. This was when the decision was made by the TWG and ISP reviews to retain the established Wet Tropics report card NO_x guideline values until the program design review, which is in progress, is completed in 2025.

Appendix C. Flow indicator detailed results

To account for rainfall variation the flow indicator method assesses the historical rainfall records within each basin. Sites used to provide rainfall data from either station (S) or point (P) locations from the SILO website for each basin are presented in Table 82. The 2022-23 rainfall types for each basin are presented in Table 83.

Table 82 Rainfall data site details.

Basin & data type	Location	Latitude	Longitude	Elevation (m)
Mossman P2	Lower catchment	-16.45	145.4	18
Mossman P1	Mid catchment	-16.4	145.35	76
Barron P1	Upper Barron	-17.35	145.5	788
Barron P2	Tinaroo Falls Dam,	-17.15	145.55	796
Barron S3	Walkamin	-17.08	145.43	594
Barron P3	Biboohra	-16.9	145.4	386
Barron P4	Kuranda Railway	-16.8	145.65	325
Barron P5	Clohesy	-16.9	145.55	406
Barron P6	Upper Freshwater	-16.95	145.7	249
Mulgrave P3	Mulgrave Mill	-17.10	145.8	52
Mulgrave P4	Mt Sophia	-17.15	145.9	8
Mulgrave P5	Deeral	-17.2	145.9	131
Mulgrave P1	Behana Creek	-17.2	145.8	705
Mulgrave P2	Upper-mid Mulgrave	-17.2	145.75	471
Russell P2	Happy Valley	-17.35	145.9	99
Russell P3	Babinda PO	-17.35	145.95	14
Russell P4	Bellenden Kerr bottom	-17.25	145.9	291
Russell P1	Upper-mid Russell	-17.45	145.85	172
Johnstone N P2	Topaz - Towalla	-17.45	145.7	602
Johnstone S S2	Exp Station	-17.61	146.0	18
Johnstone P3	Innisfail	-17.5	146.0	10
Johnstone P1	mid upper Johnstone	-17.6	145.75	474
Tully P2	Kombooloomba	-17.85	145.6	792
Tully P3	Kareeya	-17.75	145.6	469
Tully P4	Sugar Mill	-17.95	145.95	122
Tul P1	Mid Tully	-17.9	145.75	58
Herbert P2	Evelyn State Forest	-17.55	145.5	1056
Herbert P3	Mt. Garnet PO	-17.7	145.1	664
Herbert P4	Gunnawarra	-17.95	145.15	638
Herbert P5	Gleneagle	-18.15	145.35	601
Herbert P6	Elphinstone Pocket	-18.5	146.0	47
Herbert P7	Victoria Sugar Mill	-18.65	146.2	12
Herbert P1	Lower mid Herbert	-18.3	145.7	618
Murray P1	Upper Murray	-18.1	145.8	69
Murray P2	Muenga Creek at Sings	-18.2	145.9	199
Murray P3	US Murray and Muenga	-18.15	145.85	812

The data type used for rainfall was either a station (S) or grid cell (P) and was extracted from the SILO database at https://www.longpaddock.qld.gov.au/silo/point-data/

Table 83 Basin rainfall type for 2022-23.

Basin	Rainfall value	Climate Type	Rainfall data sites	
			Patched point	Data drill
Mossman	4	Wet	-	2
Barron	4	Wet	1	6
Murray	4	Wet	-	5
Russell	3	Average	-	4
Johnstone	2	Dry	1	3
Tully	2	Dry	-	4
Murray	3	Average	-	3
Herbert	3	Average	-	7

Note: rainfall value is assigned to the reporting year based upon rainfall records compared to historical average rainfall. The values are 1 – drought, 2 – dry, 3 average, and 4 – wet.

Table 84 presents the scores for all 10 flow measures, the 30th percentile and standardised score for each flow assessment site along with standardised score for each basin and estuary. Descriptions and definitions for each flow measure are presented in Table 85.

Table 84 Flow measure scores and summary scores for each flow assessment site for 2022-23.

	Gauging station number	CTF: Duration	CTF: Frequency	Below 10%ile: Duration	Below 10%ile: Frequency	Ratio dry/total	CV dry season	Above 50%ile: Duration	Above 50%ile: Frequency	Above 90%ile: Duration	Above 90%ile: Frequency	30th percentile	Standardised score	Gauge catchment (km^2)	Adjusted catchment (km^2)	Proportion	Satandardised score x proportion	Aggregated score	Climate type
Basin: Site																			
Mossman														106				61	Wet
Mossman River at Mossman	109001A	5	5	5	5	4	5	4	4	5	4	4.0	61	106		1.00	95.0		
Barron														2015				78	Wet
Barron River at Myola	110001D	5	5	5	5	1	5	5	5	5	3	5.0	80	1945	687	0.34	25.6		
Barron River at Mareeba	110002D	5	5	5	5	1	5	5	5	4	5	5.0	80	836	555	0.28	16.8		
Barron River at Picnic Crossing	110003A	5	5	5	5	1	5	1	5	5	5	5.0	80	228	101	0.05	3.8		
Mazlin Creek at Railway Bridge	110018A	5	5	5	5	4	4	4	5	5	5	4.7	75	53	53	0.03	2.0		
Barron River at Bilwon	110020A	5	5	5	5	1	5	5	5	4	4	4.7	75	1258	422	0.21	12.8		
Barron River at Goonara Creek	110021A	5	5	5	5	4	5	1	5	5	5	5.0	80	127	127	0.06	6.0		
Freshwater Creek at Redlynch Estate	110104A	5	5	4	5	5	5	5	4	1	4	4.0	61	70	70	0.03	2.8		
Mulgrave														520				75	Wet
Mulgrave River at The Fisheries	111005A	5	5	5	5	1	5	5	4	1	5	4.7	75	357	357	0.69	54.9		
Mulgrave River at Peets Bridge	111007A	5	5	5	5	1	5	5	5	2	4	4.7	75	520	163	0.31	25.1		
Russell														354				86	Average
Russell River at Bucklands	111101D	5	5	5	5	3	5	5	5	5	5	5.0	90	315	315	0.89	84.5		
Babinda Creek at The Boulders	111105A	4	4	5	5	4	5	5	5	5	4	4.0	61	39	39	0.11	6.7		
Johnstone														1403				72	Dry
Fisher Creek at Nerada	112002A	5	5	5	5	5	5	5	5	1	4	5.0	80	15	15	0.01	0.8		
North Johnstone River at Glen Allyn	112003A	5	5	5	5	5	4	5	4	4	4	4.0	61	165	165	0.12	11.2		
North Johnstone River at Tung Oil	112004A	5	5	5	5	5	4	4	5	4	4	4.0	61	925	745	0.53	53.1		

	Gauging station number	CTF: Duration	CTF: Frequency	Below 10%ile: Duration	Below 10%ile: Frequency	Ratio dry/total	CV dry season	Above 50%ile: Duration	Above 50%ile: Frequency	Above 90%ile: Duration	Above 90%ile: Frequency	30th percentile	Standardised score	Gauge catchment (km^2)	Adjusted catchment (km^2)	Proportion	Satandardised score x proportion	Aggregated score	Climate type
South Johnstone River at Upstream Central Mill	112101B	5	5	5	5	5	5	5	5	4	4	5.0	95	400	400	0.29	27.1		
Liverpool Creek at Upper Japoonvale	112102A	5	5	5	5	5	5	5	5	3	5	5.0	90	78	78	0.06	4.7		
Tully														1450				80	Dry
Cochable Creek at Powerline*	113004A	-	-	-	-	-	-	-	-	-	-	-	nd	95	95	0.07	6.6		
Tully River at Euramo	113006A	5	5	5	5	5	5	5	5	5	1	5.0	80	1450	1355	0.93	93.4		
Murray														309				75	Average
Murray River at Upper Murray	114001A	5	5	5	5	5	5	3	4	5	5	5.0	90	156	156	0.50	48.0		
Meunga Creek at Sing's	114002A	4	4	5	5	5	5	4	1	4	5	4.0	61	153	153	0.50	30.2		
Herbert														8581				73	Average
Herbert River at Ingham	116001F	5	5	5	5	5	5	5	5	3	4	5.0	90	8581	970	0.11	11.3		
Herbert River at Glen Eagle	116004C	5	5	5	5	5	4	4	5	4	4	4.0	61	5236	3977	0.46	34.8		
Herbert River at Abergowrie	116006B	5	5	5	5	5	5	5	5	1	1	5.0	80	7454	1868	0.22	20.7		
Gowrie Creek at Abergowrie	116008B	5	5	5	5	4	5	4	5	5	5	5.0	95	124	124	0.01	1.2		
Blencoe Creek at Blencoe Falls	116010A	5	5	5	5	5	4	4	5	5	4	4.7	75	226	226	0.03	2.0		
Millstream at Ravenshoe	116011A	5	5	5	5	5	5	5	2	5	5	5.0	85	89	89	0.01	0.9		
Cameron Creek at 8.7km	116012A	5	5	5	5	5	5	3	5	1	4	4.7	75	360	360	0.04	4.2		
Millstream at Archer Creek	116013A	4	4	5	5	5	4	5	5	4	5	4.0	61	308	219	0.03	1.6		
Wild River at Silver Valley	116014A	5	5	5	5	5	5	5	5	1	4	5.0	80	591	591	0.07	6.5		
Blunder Creek at Wooroora	116015A	5	5	5	5	5	5	5	5	5	4	5.0	95	127	127	0.01	1.2		
Rudd Creek@Gunnawarra	116016A	4	1	4	2	5	5	5	5	1	5	3.4	49	127	127	0.01	1.1		
Stone River at Running Creek	116017A	4	4	4	4	5	1	4	4	5	5	4.0	61	157	157	0.02	1.1		

	Gauging station number	CTF: Duration	CTF: Frequency	Below 10%ile: Duration	Below 10%ile: Frequency	Ratio dry/total	CV dry season	Above 50%ile: Duration	Above 50%ile: Frequency	Above 90%ile: Duration	Above 90%ile: Frequency	30th percentile	Standardised score	Gauge catchment (km^2)	Adjusted catchment (km^2)	Proportion	Satandardised score x proportion	Aggregated score	Climate type
Estuary: Site																			
Barron																		79	Wet
Barron River at Myola	110001D	5	5	5	5	1	5	5	5	5	3	5.0	80	1945	1945	0.97	72.4		
Freshwater Creek at Redlynch Estate	110104A	5	5	4	5	5	5	5	4	1	4	4.0	61	70	70	0.03	2.8		
Russell-Mulgrave																		79	Average-Wet
Mulgrave River at Peets Bridge	111007A	5	5	5	5	1	5	5	5	2	4	4.7	75	520	520	0.59	47.6		
Russell River at Bucklands	111101D	5	5	5	5	3	5	5	5	5	5	5.0	90	315	315	0.36	34.2		
Babinda Creek at The Boulders	111105A	4	4	5	5	4	5	5	5	5	4	4.0	61	39	39	0.04	2.7		
Johnstone																		71	Dry
North Johnstone River at Tung Oil	112004A	5	5	5	5	5	4	4	5	4	4	4.0	61	925	925	0.70	69.8		
South Johnstone River at Upstream Central Mill	112101B	5	5	5	5	5	5	5	5	4	4	5.0	95	400	400	0.30	28.7		

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. *The only 2022-23 data available for the Tully Basin was the end of system site at Euramo, the additional flow assessment site at Cochable

Table 85 Abbreviations, description, seasonality and hydrologic definitions of the measures used for the flow indicator.

Abbreviation	Description	Season	Hydrologic definition
Below 10%ile: Duration	Low flow Duration	July-Jan	Total duration of flows which remain equal to or below a lower threshold for the reporting period (annual).
Below 10%ile: Frequency	Low flow Frequency	July-Jan	Count of the number of occurrences during which the magnitude of flow falls to or below the threshold during the reporting period (annual).
CV dry season	Low flow variability	July-Dec	Coefficient of variation (stdev/mean) of daily flow for dry season.
Ratio dry/total	Driest six Months	July-Dec	Proportion of annual discharge contributed during the months July-December.
CTF: Duration	Cease to flow Duration	All year	Total duration of where flow ceases during the reporting period (annual).
CTF: Frequency	Cease to flow Frequency	All year	Count of the number of occurrences during which flow ceases during the reporting period (annual).
Above 50%ile: Duration	Medium flow Duration	All year	Total duration of flows which remain equal to or above the 50th percentile threshold for the reporting period (annual)
Above 50%ile: Frequency	Medium flow Frequency	All year	Count of the number of occurrences during which the magnitude of flow passes from below to equal or above the 50th percentile threshold during the reporting period (annual).
Above 90%ile: Duration	High flow duration	All year	Total duration of flows which remain equal to or above the 90th percentile threshold for the reporting period (annual)
Above 90%ile: Frequency	High flow Frequency	All year	Total count of flows which remain equal to or above the 90th percentile threshold for the reporting period (annual)

References

Stewart-Koster, B., Bofu Yu, B., Balcombe, S., Kennard, M., Marsh, N. 2018 Development of Report Card flow Indicators for the Mackay-Whitsunday and Wet Tropics regions. Australian Rivers Institute, Griffith University and Truii Pty Ltd. Brisbane.

Appendix D. Basin fish assessment: key to species and species present at each site survey

Table 86 Key to fish species codes (SppCode). Pest species codes are identified by an asterisk (*).

SppCode	Family	Genus	Species	Common name
AcaPac		*Acanthopagrus*	*pacificus*	Pikey bream
AmbMio	Ambassidae	*Ambassis*	*miops*	Flagtail perchlet
AmbSp1	Ambassidae	*Ambassis*	*sp. 1*	Northern perchlet
AmbVac	Ambassidae	*Ambassis*	*vachellii*	Vachell's glassfish
AmnPer	Terapontidae	*Amniataba*	*percoides*	Barred grunter
AngAus	Anguillidae	*Anguilla*	*australis*	Southern short-finned eel
AngMar	Anguillidae	*Anguilla*	*marmorata*	Giant mottled eel
AngObs	Anguillidae	*Anguilla*	*obscura*	Pacific short-finned eel
AngRei	Anguillidae	*Anguilla*	*reinhardtii*	Long-finned eel
AwaAcr	Gobiidae	*Awaous*	*acritosus*	Roman-nose goby
BunGyr	Eleotridae	*Bunaka*	*gyrinoides*	Bunaka
ButBut	Eleotridae	*Butis*	*butis*	Crimson-tipped gudgeon
CaiRho	Melanotaeniidae	*Cairnsichthys*	*rhombosomoides*	Cairns rainbowfish
CraSte	Atherinidae	*Craterocephalus*	*stercusmuscarum*	Fly-specked hardyhead
DenAus	Ambassidae	*Denariusa*	*australis*	Penny fish
EleFus	Eleotridae	*Eleotris*	*fusca*	Brown spine-cheek gudgeon
EleMel	Eleotridae	*Eleotris*	*melanosoma*	Black spine-cheek gudgeon
GamHol*	Poecilidae	*Gambusia*	*holbrooki*	Gambusia
GerFil	Gerreidae	*Gerres*	*filamentosus*	Silver biddy
GiuMar	Eleotridae	*Giurus*	*margaritacea*	Snake-head gudgeon
GloApr	Apogonidae	*Glossamia*	*aprion*	Mouth almighty
GloAur	Gobiidae	*Glossogobius*	*aureus*	Golden Flathead Goby
GloBel	Gobiidae	*Glossogobius*	*bellendensis*	Mulgrave goby
GloBic	Gobiidae	*Glossogobius*	*bicirrhosus*	Bearded flathead goby
GloGiu	Gobiidae	*Glossogobius*	*giuris*	Tank goby
GloIll	Gobiidae	*Glossogobius*	*illimus*	False Celebes goby
HepSpp	Terapontidae	*Hephaestus*	*fuliginosus/ tulliensis*	Sooty grunter/ Tully grunter
HypCom	Eleotridae	*Hypseleotris*	*compressa*	Empire gudgeon
HypSp1	Eleotridae	*Hypseleotris*	*sp. 1*	Northern carp gudgeon (undescribed)
KuhMar	Kuhlidae	*Kuhlia*	*marginata*	Spotted flagtail
KuhRup	Kuhlidae	*Kuhlia*	*rupestris*	Jungle perch
LatCal	Latidae	*Lates*	*calcarifer*	Barramundi
LeiEqu		*Leiognathus*	*equulus*	Common ponyfish
LeiUni	Terapontidae	*Leiopotherapon*	*unicolor*	Spangled perch
LutArg	Lutjanidae	*Lutjanus*	*argentimaculatus*	Mangrove jack
MegCyp	Megalopidae	*Megalops*	*cyprinoides*	Indo-Pacific tarpon
MelMac	Melanotaeniidae	*Melanotaenia*	*maccullochi*	McCulloch's rainbowfish
MelSpp	Melanotaeniidae	*Melanotaenia*	*spp.*	Eastern rainbowfish
MelTri	Melanotaeniidae	*Melanotaenia*	*trifasciata*	Banded rainbowfish
MesArg	Terapontidae	*Mesopristes*	*argenteus*	Silver grunter
MicBra	Syngnathidae	*Microphis*	*brachyurus*	Short-tailed pipefish

SppCode	Family	Genus	Species	Common name
MogAds	Eleotridae	*Mogurnda*	*adspersa*	Southern purple-spotted gudgeon
MonArg		*Monodactylus*	*argenteus*	Butter bream
MooSeh		*Moolgarda*	*seheli*	Bluespot mullet
MugCep	Mugilidae	*Mugil*	*cephalus*	Sea mullet
MugNot	Gobiidae	*Mugilogobius*	*notospilus*	Freshwater mangrove goby
NemEre	Clupeidae	*Nematalosa*	*erebi*	Bony bream
NeoAte	Plotosidae	*Neosilurus*	*ater*	Butter jew
NeoHyr	Plotosidae	*Neosilurus*	*hyrtlii*	Hyrtl's tandan
NotRob	Tetrarogidae	*Notesthes*	*robusta*	Bullrout
OphSp1	Synbranchidae	*Ophisternon*	*sp. (undescribed)*	Swamp eel
OreMos*	Cichlidae	*Oreochromis*	*mossambicus*	Mozambique tilapia
OxyAru	Eleotridae	*Oxyeleotris*	*aruensis*	Aru gudgeon
OxyLin	Eleotridae	*Oxyeleotris*	*lineolata*	Sleepy cod
OxyNul	Eleotridae	*Oxyeleotris*	*nullipora*	Poreless gudgeon
OxySel	Eleotridae	*Oxyeleotris*	*selheimi*	Northern sleepy cod
PelMar*	Cichlidae	*Pelmatolapia*	*mariae*	Spotted tilapia
PlaSub		*Planiliza*	*subviridis*	Greenback mullet
PoeRet*	Poecilidae	*Poecilia*	*reticulata*	Guppy
PorRen	Plotosidae	*Porochilus*	*rendahli*	Rendahl's tandan
PseGer	Pseudomugilidae	*Pseudomugil*	*gertrudae*	Spotted blue-eye
PseSig	Pseudomugilidae	*Pseudomugil*	*signifer*	Pacific blue-eye
RedBik	Gobiidae	*Redigobius*	*bikolanus*	Speckled goby
RedChr	Gobiidae	*Redigobius*	*chrysosoma*	Spot-finned goby
ScaArg	Scatophagidae	*Scatophagus*	*argus*	Spotted scat
SchHoe	Gobiidae	*Schismatogobius*	*hoesei*	Scaleless goby
SelMul		*Selenotoca*	*multifasciata*	Striped scat
SicLag	Gobiidae	*Sicyopterus*	*lagocephalus*	Red-tailed goby
StrKre		*Strongylura*	*krefftii*	Freshwater longtom
SynHog	Soleidae	*Synclidopus*	*hogani*	Hogan's sole
TanTro	Plotosidae	*Tandanus*	*tropicanus*	Wet Tropics tandan
ToxCha		*Toxotes*	*chatareus*	Seven-spot archerfish
ToxJac		*Toxotes*	*jaculatrix*	Banded archerfish
XipHel*	Poecilidae	*Xiphophorus*	*hellerii*	Swordtail
XipMac*	Poecilidae	*Xiphophorus*	*maculatus*	Platy

Table 87 Mossman Basin fish monitoring sites and species present from the most recent survey (2019-20). The numeral 1 indicates the species was sampled and the numeral 0 indicates the species was not sampled. Species marked with * are pest fish species.

Waterway	AmbMio	AngAus	AngMar	AngObs	AngRei	AwaAcr	BunGyr	EleFus	GloIll	HypCom	KuhMar	KuhRup	MelSpp	MicBra	MogAds	NotRob	*PoeRet	PseSig	RedBik	SchHoe	TanTro	*XipHel
Parker Creek	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0	0
South Mossman River	0	0	0	0	1	1	0	0	0	1	0	1	1	0	1	0	0	1	0	0	1	0
Spring Creek	0	1	0	0	1	0	0	0	0	1	0	0	1	0	1	0	0	1	0	0	0	0
Tributary of Ball Creek	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0
Spring Creek	0	0	1	1	1	0	0	0	1	1	0	1	1	0	0	0	0	1	0	1	0	0
Flin Creek	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	1
Cassowary Creek	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	1	0	0	1	0
Ball Creek	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	1	1	0	0	0	0
South Mossman River	0	0	0	0	1	1	1	0	1	1	0	1	1	1	1	0	0	1	0	1	1	0
Mossman River	0	0	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0	1	1	0
Mossman River	0	0	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	1	1	1	1	0
Mossman River	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	1	0	1	0	0	1	0
Mossman River	1	0	0	0	1	1	1	0	0	1	0	1	1	0	1	1	0	1	0	1	1	0

Table 88 Barron Basin fish monitoring sites and species present from the most recent survey (2019-20). The numeral 1 indicates the species was sampled and the numeral 0 indicates the species was not sampled. Species marked with * are pest fish species.

Waterway	AmbMio	AmnPer	AngMar	AngRei	AwaAcr	BunGyr	CraSte	EleMel	GloApr	GloAur	GloIII	HepSpp	HypCom	KuhRup	LeiUni	MelSpp	MogAds	NemEre	NeoAte	NeoHyr	OxyLin	OxySel	*PelMar	*PoeRet	PorRen	PseSig	RedBik	SchHoe	TanTro
Severin Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1
Davies Creek	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	1
Oaky Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	1	0	0	0	0	0
Wright Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1	1	1	1	0	0	0	1
Atherton Creek	0	0	0	1	0	0	1	0	1	0	0	1	0	0	1	1	1	0	1	0	0	0	0	1	0	0	0	0	0
Tinaroo Creek	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Varch Creek	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Poona Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Barron River	0	1	0	1	0	0	1	0	1	1	0	1	0	0	1	1	0	0	0	0	1	0	1	1	0	0	0	0	0
Freshwater Creek	1	0	1	1	1	1	0	1	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	1	0	1	1	1	0
Clohesy River	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	1	0	1	1	0	0	0	1	0	0	0	0	1

Table 89 Mulgrave Basin fish monitoring sites and species present from the most recent survey (2019-20). The numeral 1 indicates the species was sampled and the numeral 0 indicates the species was not sampled. Species marked with * are pest fish species.

Waterway	AmbMio	AmbSp1	AngMar	AngObs	AngRei	AwaAcr	BunGyr	CaiRho	CraSte	EleFus	EleMel	GerFil	GiuMar	GloApr	GloBel	GloGiu	GloIll	HepSpp	HypCom	KuhRup	LatCal	LutArg	MegCyp	MelSpp	MelTri	MesArg	MogAds	NemEre	NeoAte	NotRob	OxyAru	*PelMar	*PoeRet	PseSig	RedBik	SicLag	TanTro	*XipMac
Wright Creek	1	0	1	1	1	0	0	0	0	0	1	1	1	0	0	1	1	0	1	1	0	1	0	1	0	0	0	0	1	0	0	1	0	1	1	0	0	0
Little Mulgrave River	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	1	1	0	1	0
Mulgrave River	0	0	1	1	1	1	1	0	0	0	0	1	1	0	0	0	1	1	1	1	0	1	0	1	0	1	0	1	1	0	0	1	1	1	1	0	1	0
Gray Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Mulgrave River	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	1	1	0	0	1	0	0	0	0	0	0	0	1	1	1	1	0	1	0
Little Mulgrave River	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	1	0
Fishery Creek	0	0	1	0	1	1	0	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0
Tributary of Mulgrave River	0	0	1	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0
Middle Creek	1	0	0	0	1	1	1	0	0	0	1	0	1	0	0	0	1	0	1	1	0	0	0	1	1	0	1	0	0	0	0	0	1	1	0	0	1	1
McDonnell Creek	0	0	1	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	1	0	0	1	0
Tributary of Behana Creek	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0	0
Mulgrave River	0	1	0	0	1	1	1	0	1	0	0	0	1	1	1	0	1	1	1	1	0	1	1	1	0	1	0	1	1	0	0	1	0	1	1	0	1	0
Tributary of Behana Creek	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

Table 90 Russell Basin fish monitoring sites and species present from the most recent survey (2019-20). The numeral 1 indicates the species was sampled and the numeral 0 indicates the species was not sampled. Species marked with * are pest fish species.

Waterway	AmbMio	AmbSp1	AngMar	AngObs	AngRei	AwaAcr	BunGyr	CaiRho	CraSte	EleFus	EleMel	GiuMar	GloApr	GloBel	GloIll	HepSpp	HypCom	KuhRup	LatCal	LutArg	MelMac	MelSpp	MesArg	MogAds	NemEre	NeoAte	NotRob	OphSp1	OxyAru	*PelMar	*PoeRet	PorRen	PseSig	RedBik	SchHoe	SicLag	TanTro	*XipMac
Woopen Creek	0	0	0	0	1	1	0	0	1	0	0	0	0	1	0	1	1	1	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	1	0
Cane drain	0	1	1	0	1	1	0	1	1	1	0	1	0	0	0	0	1	0	0	0	1	1	0	1	0	1	0	0	1	0	1	0	1	0	0	0	0	1
Harvey Creek	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	1	1	0
Allison Creek	0	0	1	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0
Pugh Creek	0	0	1	0	1	0	0	1	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	0	1	0	0	0	1	0
Pugh Creek	0	0	1	0	1	0	0	1	1	0	0	0	1	1	1	1	1	0	0	0	0	1	0	1	0	0	0	1	1	0	0	0	1	0	1	0	1	0
Babinda Creek	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	0
Menzies Creek	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0
Tributary of Babinda Creek	0	0	0	0	1	1	0	1	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0
Cane drain	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	0	1	1	1	0	0	0	0	1
Russell River	0	1	0	0	1	1	1	0	1	0	0	1	1	0	1	1	1	0	1	0	0	1	0	1	0	1	1	0	1	1	0	0	1	0	0	0	1	1
Russell River	1	1	0	1	1	1	1	0	0	1	1	1	1	0	1	1	1	0	1	1	0	1	1	1	1	1	0	0	0	1	0	0	1	1	1	0	1	0
Russell River	0	0	0	0	1	1	0	0	1	0	0	0	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0
Chooky Chooky Creek	0	0	1	0	1	1	0	0	1	0	0	0	1	1	1	0	1	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	1	0	0	0	1	0

Table 91 Johnstone Basin fish monitoring sites and species present from the most recent survey (2019-20). The numeral 1 indicates the species was sampled and the numeral 0 indicates the species was not sampled. Species marked with * are pest fish species.

Waterway	AmbMio	AmbSp1	AngMar	AngRei	AwaAcr	BunGyr	CaiRho	CraSte	EleFus	EleMel	GiuMar	GloApr	GloIll	HepSpp	HypCom	KuhRup	MelSpp	MogAds	MugNot	NeoAte	OphSp1	OxyAru	*PelMar	*PoeRet	PseSig	RedBik	SchHoe	TanTro	*XipHel	*XipMac
Tributary of Malanda Creek	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0
Malanda Creek	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Cowley Creek	0	1	0	1	0	1	1	0	0	0	1	0	0	0	1	0	1	1	0	0	1	1	0	0	0	0	0	0	0	1
North Beatrice River	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	1	0
South Maria Creek	0	0	0	1	1	0	1	0	0	0	1	0	0	0	1	0	1	1	0	1	1	0	0	0	1	0	0	1	0	0
Eel Creek	0	0	0	1	0	1	0	0	0	0	1	0	0	0	1	0	1	1	0	1	0	0	1	0	1	0	0	0	0	1
Tributary of Mena Creek	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	1	0	1
Muston Creek	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0
Utchee Creek	0	0	1	1	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	0
Liverpool Creek	0	0	1	1	1	0	0	1	0	0	0	0	1	1	0	1	1	1	0	0	0	0	0	0	0	1	0	1	1	0	0
Fitzgerald Creek	1	0	0	1	0	0	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	0	0	1	0	1	0	1	0	0

Table 92 Tully Basin fish monitoring sites and species present from the most recent survey (2019-20). The numeral 1 indicates the species was sampled and the numeral 0 indicates the species was not sampled. Species marked with * are pest fish species.

Waterway	AmbMio	AmbSp1	AngMar	AngObs	AngRei	AwaAcr	BunGyr	CraSte	DenAus	EleFus	EleMel	GiuMar	GloApr	GloIll	HepSpp	HypCom	KuhRup	LatCal	MelMac	MelSpp	MogAds	NeoAte	NeoHyr	NotRob	OphSp1	OxyAru	OxyNul	*PelMar	*PoeRet	PorRen	PseGer	PseSig	RedChr	SchHoe	TanTro	*XiphMac
Cane drain	0	1	0	0	1	1	0	1	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Davidson Creek	0	1	0	0	1	1	0	1	0	0	0	0	1	1	1	1	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	1	1
Marquette Creek	0	1	0	0	1	1	0	0	0	0	0	0	1	1	1	1	0	0	0	1	1	0	1	1	0	1	0	0	0	0	0	1	0	1	1	1
Banyan Creek	0	1	0	0	1	1	0	1	0	0	0	0	0	1	1	1	1	1	0	1	1	0	0	1	0	1	0	1	0	0	0	1	0	0	1	0
Cane drain	0	1	0	0	0	0	0	1	1	0	0	0	1	0	1	0	0	0	1	1	1	0	1	0	0	0	1	0	0	1	1	0	0	0	0	1
Tributary of Python Creek	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hull River	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Tributary of Davidson Creek	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1	0	0	1	1	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0
Banyan Creek	1	0	0	0	1	1	0	0	0	0	0	0	1	1	1	1	0	0	0	1	1	0	1	1	1	1	0	1	1	0	0	1	0	0	1	0
Tributary of Tully River	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
Wongaling Creek	1	0	1	0	1	0	1	0	0	1	0	1	0	1	0	1	1	1	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0

Table 93 Murray Basin fish monitoring sites and species present from the most recent survey (2019-20). The numeral 1 indicates the species was sampled and the numeral 0 indicates the species was not sampled. Species marked with * are pest fish species.

Waterway	AmbMio	AmbSp1	AngRei	AwaAcr	CraSte	EleMel	GerFil	GiuMar	GloApr	GloIll	HepSpp	HypCom	KuhRup	LutArg	MegCyp	MelMac	MelSpp	MogAds	NeoAte	NeoHyr	NotRob	OphSp1	OxyNul	*PelMar	*PoeRet	PorRen	PseGer	PseSig	RedBik	SchHoe	TanTro	*XipMac
Stony Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cane drain	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	1	0	0	0	0	0	1
Scrubby Creek	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0
Tributary of Woodfield Creek	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0
Cane drain	0	1	1	0	1	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1
Dallachy Creek	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	1	0	1	0	0	0	0	0	1	0	0	1	0
Cane drain	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	1	1	1	0	1	0	1	1	1	0	1	1	0	0	0	0	0
Murray River	0	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	1	1	0	1	0	1	0	0	1	0	0	1	0	0	0	0
Murray River	0	1	1	1	1	0	0	0	1	1	1	1	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	1	0
Murray River	0	1	1	0	0	0	0	1	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
Meunga Creek	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	0	1	0	0	0	1	1	0	0	0	0	0	1	1	1	1	0
Tributary of Kennedy Creek	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tributary of Kennedy Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 94 Herbert Basin fish monitoring sites and species present from the previous survey (2019-20). The numeral 1 indicates the species was sampled and the numeral 0 indicates the species was not sampled. Species marked with * are pest fish species.

Waterway	AmbSp1	AmbVac	AmnPer	AngMar	AngObs	AngRei	AwaAcr	ButBut	CraSte	EleMel	*GamHol	GerFil	GiuMar	GloApr	GloGiu	GloIll	HepSpp	HypCom	HypSp1	KuhRup	LatCal	LeiUni	LutArg	MelSpp	MogAds	MugCep	NeoAte	NeoHyr	NotRob	OphSp1	*OreMos	*PoeRet	PorRen	PseSig	RedBik	RedChr	ScaArg	SynHog	TanTro	*XiphHel
Trebonne Creek	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Tributary of Herbert River	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Blunder Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Breakaway Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ashton Creek	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
White Adder Creek	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tributary of Jacky Jacky Creek	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hawkins Creek	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Mill Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wild River	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Stone River	1	0	1	1	0	1	1	0	1	0	0	0	0	1	0	1	0	1	0	0	0	1	0	1	1	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0
Spring Creek (North Branch)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Robinson Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Wigwam Creek	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0
Blunder Creek	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Anabranch of Rudd Creek	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Gowrie Creek	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

Waterway	AmbSp1	AmbVac	AmnPer	AngMar	AngObs	AngRei	AwaAcr	ButBut	CraSte	EleMel	*GamHol	GerFil	GiuMar	GloApr	GloGiu	GloIll	HepSpp	HypCom	HypSp1	KuhRup	LatCal	LeiUni	LutArg	MelSpp	MogAds	MugCep	NeoAte	NeoHyr	NotRob	OphSp1	*OreMos	*PoeRet	PorRen	PseSig	RedBik	RedChr	ScaArg	SynHog	TanTro	*XipHel
Wild River	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	1	0	1	1	0	0	1	0	0	1	1	0	0	0	0	0	0	1	0
Arnot Creek	0	1	0	0	0	1	1	1	1	1	0	1	1	0	1	0	0	1	0	0	0	0	1	1	1	1	0	0	0	0	0	1	0	1	1	1	1	1	0	0
Wild River	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Vine Creek	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Herbert River	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0
Palm Creek	1	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Blencoe Creek	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Herbert River	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Break-O-Day Creek	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Tin Creek	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black Adder Creek	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Garrawalt Creek	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tributary of Kirrama Creek	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yuccabine Creek	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gowrie Creek	0	0	1	1	0	1	1	0	1	0	0	0	0	1	0	1	1	1	0	0	1	0	0	1	1	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0

Table 95 Herbert Basin fish monitoring sites and species present from the most recent survey (2021-22, reported for 2022-23). The numeral 1 indicates the species was sampled and the numeral 0 indicates the species was not sampled. Species marked with * are pest fish species.

Waterway	AmbSp.	AngRei	AngMar	AngObs	CraSte	HypSp1	MelSpp	MogAd	AcaPac	AmbMi	AmbVa	AwaAcr	BunGyr	ButBut	EleMel	GerFil	GiuApo	GloApr	GloBic	GloIll	GloLat	HepSpp	HypCo	KuhRup	LatCal	LeiEqu	LeiUni
Trebonne Creek	1	11	0	0	0	1	44	6	0	0	0	0	0	0	0	0	14	0	0	0	0	0	148	0	0	0	1
Tributary of Herbert R.	0	0	0	0	0	0	15	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Breakaway Creek	0	0	0	0	0	0	89	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Ashton Creek	3	0	0	0	0	0	103	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0
Hawkins Creek	0	4	1	0	0	0	33	23	0	0	0	0	0	0	0	0	0	0	0	1	0	8	11	1	0	0	0
Stone River	3	6	1	0	29	0	72	0	0	0	0	1	0	0	0	0	0	1	0	4	0	9	1	0	0	0	0
Herbert River	56	3	0	0	34	2	148	9	0	0	0	2	0	0	0	0	0	0	0	0	0	17	3	1	5	0	1
Herbert River	0	7	1	2	0	0	18	0	4	62	0	0	0	9	1	26	0	0	8	24	2	2	34	0	7	3	0
Herbert River	1	6	1	0	18	0	65	0	1	0	26	0	1	0	4	86	0	1	0	42	2	5	112	0	11	1	0
Herbert River	104	1	0	0	21	3	103	7	0	0	0	0	2	0	0	3	0	2	0	0	0	8	13	0	7	0	0
Blunder Creek	0	0	0	0	1	5	31	4	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	5
White Adder Creek	0	5	0	0	0	0	0	57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blunder Creek	0	3	0	0	0	2	26	2	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	14
Rudd Creek	1	0	0	0	4	0	120	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
Herbert River	0	0	0	0	0	7	18	1	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0	0	24
Herbert River	0	2	0	0	0	8	17	5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	25

Waterway	LutArg	MegCyp	MesArg	MonArg	MooSeh	NemEre	NeoAte	NeoHyr	NotRob	OphSp1	OxySel	PlaSub	PseSig	RedBik	RedChr	ScaArg	SelMul	StrKre	TanTro	ToxCha	ToxJac	AmnPer	OxyLin	OreMos*	GamHol*	PoeRet*
Trebonne Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tributary of Herbert R.	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
Breakaway Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ashton Creek	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Hawkins Creek	0	0	0	0	0	0	0	0	0	2	0	0	3	0	0	0	0	0	4	0	0	0	0	0	0	0
Stone River	0	0	0	0	0	0	0	0	0	1	0	0	33	8	0	0	0	0	0	0	0	0	0	0	0	0
Herbert River	0	1	0	0	0	6	9	0	0	0	1	0	4	0	0	0	0	3	0	0	0	33	0	0	0	0
Herbert River	27	3	6	0	2	0	0	0	3	0	0	4	24	32	29	1	1	0	0	1	1	0	0	0	0	0
Herbert River	1	0	0	1	0	0	0	0	1	0	0	0	26	169	0	1	0	1	0	0	0	12	0	0	0	0
Herbert River	0	0	0	0	0	2	7	0	1	0	0	0	19	7	0	0	0	4	0	0	0	17	1	2	0	0
Blunder Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
White Adder Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blunder Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0
Rudd Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	10	5	0
Herbert River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0
Herbert River	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0

Table 96 Translocated and alien fish species caught during the 2019-20 and 2022-23 fish assessments for each Basin

	2019-20 Assessment								2022-23 Assessment
Origin and Common name	Moss-man	Barron	Russell	Mulgrave	John-stone	Tully	Murray	Herbert	Herbert
Translocated									
Barred grunter	-	✓	-	-	-	-	-	-	-
Fly-specked hardyhead	-	✓	-	-	-	-	-	-	-
Mouth almighty	-	✓	-	-	✓	-	-	-	-
Golden Flathead Goby	-	✓	-	-	-	-	-	-	-
Sooty grunter	-	-	-	-	-	-	-	✓*	✓*
Tully grunter	-	✓	-	-	✓	-	✓	-	-
Spangled perch	-	✓	-	-	-	-	-	✓*	✓*
Bony bream	-	✓	-	-	-	-	-	-	-
Butter jew	-	✓	-	-	-	-	-	-	-
Hyrtl's tandan	-	✓	-	-	-	-	-	✓*	✓*
Sleepy cod	-	✓	-	-	-	-	-	-	✓
Northern sleepy cod	-	✓	-	-	-	-	-	-	✓
Rendahl's tandan	-	✓	-	-	-	-	-	-	-
Wet Tropics tandan	-	✓	-	-	✓	-	-	✓*	✓*
Alien									
Gambusia	-	-	-	-	-	-	-	✓	✓
Mozambique tilapia	-	-	-	-	-	-	-	✓	✓
Spotted tilapia	-	✓	✓	✓	✓	✓	✓	-	-
Guppy	✓	✓	✓	✓	✓	✓	✓	✓	✓
Swordtail	✓	-	-	-	✓	-	-	✓	-
Platy	-	-	✓	✓	✓	✓	✓	✓	-

'Translocated' refers to Australian native species that were found in waterways within which they do not naturally occur, and 'Alien' refers to fish species from outside of Australia. Note that some species are indigenous to the lowland sections of some basins but have been translocated to upper sections above waterfalls. *denotes species that were translocated to the upper Herbert catchments, whilst for Herbert lowland and coastal sites, only sleepy cod and northern sleepy cod are defined as translocated from the list of potential translocated species.

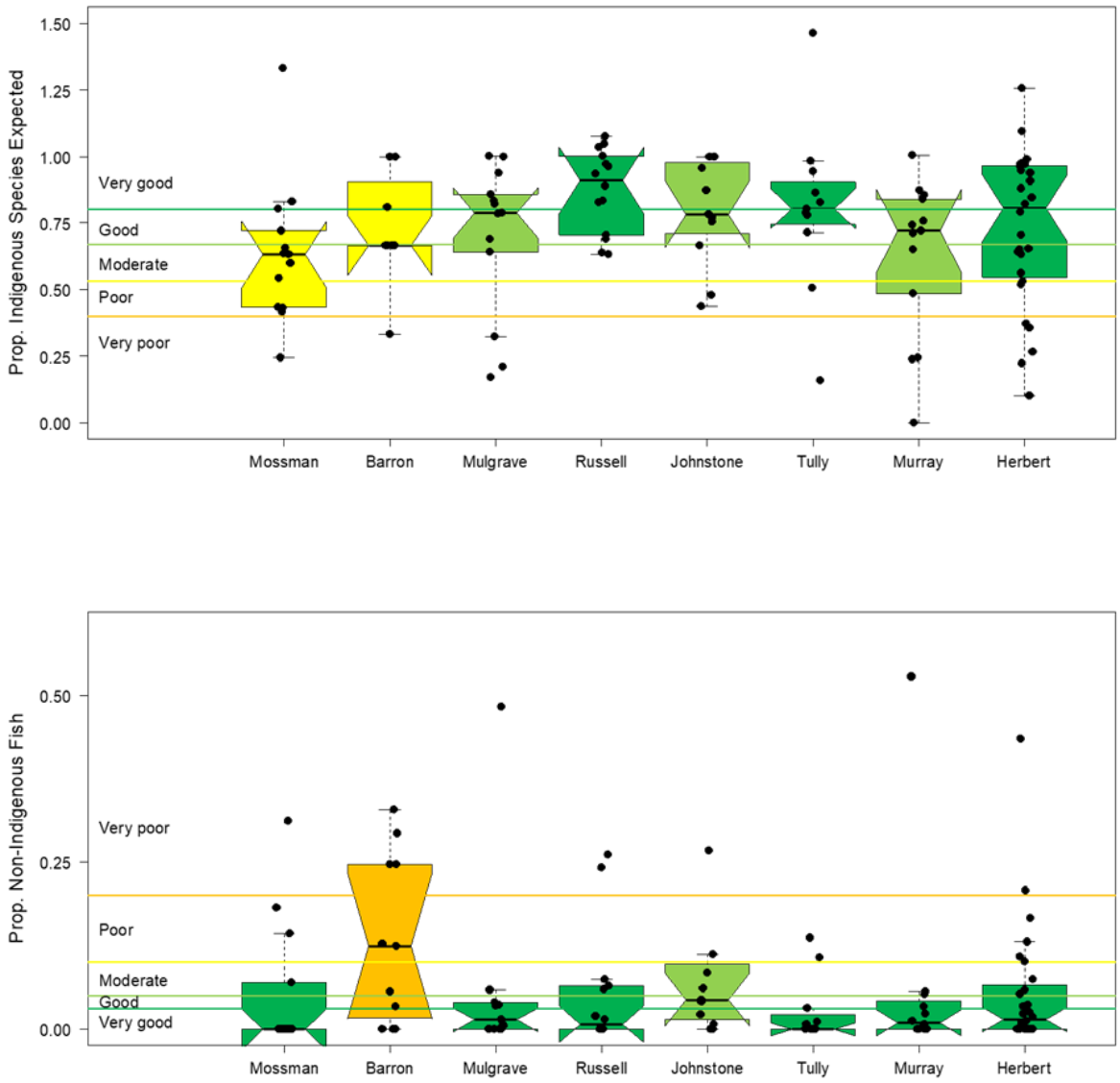


Figure 29 Box plots for sites within each basins in relation to the proportion of indigenous species expected indicator (top) and the proportion of non-indigenous fish indicator (bottom).

Interpretation of notched boxplots: the lowest line of the box is the first quartile (Q1), the upper line is third quartile (Q3) and the midline is the median; the lower whisker is Q1 - (1.5 * IQR) or lowest value within that range and the upper whisker is Q3 + (1.5 * IQR) highest value within that range, where IQR is the interquartile range (Q3-Q1); notch ≈ 95% confidence limit of median (median±(1.58*IQR)/sqrt(n)) and non-overlapping notches suggest significant differences.

Appendix E. Interpreting the pesticide risk values and risk categories

The pesticide risk metric is reported as the '% of species' protected from mixtures of pesticides detected in an ecosystem over the wet season (the period when pesticides most commonly occur in catchments and are present at their highest concentrations). How that percentage of species protected in the ecosystem is estimated is described in the methods technical report (WTW 2024) and elsewhere (Warne *et al*. 2020 and Warne *et al*. 2023). But in summary, ecotoxicity experiments provide an indication of how organisms in the ecosystem might respond when they are exposed to different concentrations of pesticides. By collating these (published) experimental data for multiple species, it is possible to derive (i.e. using species sensitivity distributions) the relationship between the concentration of a pesticide and the percentage of species it is likely to affect. Pesticide concentrations detected in an ecosystem can then be compared against the species sensitivity distribution to estimate the percentage of species being affected in the ecosystem. By expanding this process to account for the cumulative impact of multiple pesticides over the wet season, the risk of pesticides can be estimated (i.e. the Pesticide Risk Metric). The Pesticide Risk Metric can estimate the effect of mixtures of up to 22 pesticides frequently detected in waters discharging to the Great Barrier Reef, and from this, the percentage of species that should be protected from the concentrations of the 22 pesticides is estimated.

For example, a pesticide risk value of 95% species protection, means that 95% of aquatic species in an ecosystem should not experience harmful non-lethal or lethal effects (such as reduced growth or reproduction) resulting from exposure to pesticides present in that waterbody. It also means that the most sensitive 5% of aquatic species would be expected to experience some harmful non-lethal effects. The types of organisms that are most sensitive depends on the type of pesticides that they are exposed to, as pesticides are designed to affect specific types of organisms. For example, herbicides are designed to kill plants and therefore algae and aquatic plants (including seagrass and coral) are generally the most sensitive aquatic species to herbicides. Insecticides are designed to kill insects, and therefore, aquatic insects and crustaceans (e.g. crabs, lobsters, prawns and copepods), which are closely related to insects, are the most sensitive aquatic species. As pesticide concentrations increase:

- more species will experience harmful effects;
- the harmful effects will change from non-lethal to lethal; and
- what is affected will increase from individuals, to populations, to whole communities or ecosystems

Fish are relatively insensitive to herbicides and insecticides as they do not have the biochemical pathways that these pesticides affect. Therefore, based on the types and concentrations of pesticides currently being detected in the lower reaches of Great Barrier Reef catchments and the inshore marine ecosystems, it is unlikely that fish mortality or population decline would occur as a direct result of exposure to those pesticides. Rather sublethal and/or indirect effects could occur. For example, Kroon et al. (2013) found that barramundi and coral trout collected along the east coast of Queensland exhibited signs of endocrine disruption (a non-lethal effect) and the extent of this was related to the concentrations of a number of pesticides in the water where the fish were collected. In contrast, the effects on aquatic plants (such as algae and sea grasses) in lower reaches

of Great Barrier Reef catchments and the inshore marine ecosystems are expected to be greater, because they are more sensitive to herbicides, and herbicides are the main kinds of pesticides found in these waterways. This has been shown by Wood et al. (2018) who found that as herbicide concentrations increased, the number of sensitive algal species present in waterways decreased for at least the duration of the wet season. While concentrations of pesticides may not be sufficiently high to kill fish, they could be indirectly affected by pesticides through declines in their food (e.g. fish that eat plants or insects), and/or habitats (e.g. aquatic plants and sea grasses). Such indirect effects could decrease the amount of food and shelter available for organisms, including fish, further up food webs. Instability in a food web can lead to increased vulnerability of an ecosystem to other stressors (e.g. disease) and decrease ecosystem resilience.

The estimates of species protected were divided into five categories ranging from very low to very high risk (Table 97) that were aligned to the ecosystem protection levels used in the Australian and New Zealand Water Quality Guidelines (ANZG, 2018). The alignment of the percentage of species protected, pesticide risk categories and the ecosystem protection levels is shown in Table 97.

Table 97 The alignment of the percentage of protected species, risk category and ecosystem protection levels.

Pesticide risk value (% species protection)	Risk category	Ecosystem condition (ANZG, 2018)
≥ **99%**	Very Low	high conservation or ecological value systems
<99 to **95%**	Low	slightly to moderately disturbed systems
<95 to **90%**	Moderate	
<90 to **80%**	High	highly disturbed systems
<80%	Very High	

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Appendix F. Coral reef site indicator and index scores

Table 98 Inshore coral indicator and index scores (2022-23) for each site.

Zone	Reef	Depth	Com-position	Cover	Change	Juvenile	Macro-algae	Coral condition
North	Snapper North	2	0.00	0.42	0.70	0.08	0.00	0.24
	Snapper North	5	0.50	0.63	0.84	0.31	0.62	0.58
	Snapper South	2	0.50	0.76	0.81	1.00	0.84	0.78
	Snapper South	5	1.00	0.90	0.53	0.05	0.00	0.50
	Low Isles	5	0.50	0.66	0.57	0.40	0.91	0.61
	Green	5	nd	nd	nd	nd	nd	nd
Central	Fitzroy East	2	0.50	0.60	0.49	0.38	1.00	0.59
	Fitzroy East	5	0.00	0.76	0.61	0.62	0.87	0.57
	Fitzroy West	2	1.00	1.00	1.00	0.85	0.00	0.77
	Fitzroy West	5	0.50	0.92	0.89	0.74	0.66	0.74
	Fitzroy West LTMP	5	1.00	0.63	1.00	0.51	1.00	0.83
	Franklands East	2	1.00	0.95	0.46	0.25	0.62	0.65
	Franklands East	5	1.00	0.52	0.50	0.43	0.00	0.49
	Franklands West	2	1.00	0.93	0.60	0.20	0.00	0.55
	Franklands West	5	0.50	0.79	0.53	0.11	0.00	0.39
	High East	2	0.50	0.67	0.12	0.16	0.00	0.29
	High East	5	0.50	0.62	0.36	0.18	0.00	0.33
	High West	2	0.00	0.74	0.47	0.34	0.57	0.42
	High West	5	0.00	0.29	0.74	0.36	1.00	0.48
South	Barnards	2	1.00	0.82	0.63	0.29	1.00	0.75
	Barnards	5	1.00	0.76	0.35	0.76	1.00	0.77
	Bedarra	2	1.00	0.22	0.31	0.48	0.00	0.40
	Bedarra	5	0.50	0.36	0.48	1.00	0.61	0.59
	Dunk North	2	0.50	0.70	0.57	0.55	0.00	0.47
	Dunk North	5	0.50	0.59	0.71	1.00	0.51	0.66
	Dunk South	2	1.00	0.49	0.44	0.25	0.14	0.46
	Dunk South	5	0.50	0.51	0.40	0.56	0.01	0.40
Palm Island	Havannah	2	1.00	0.45	0.49	0.26	0.00	0.44
	Havannah	5	1.00	0.60	0.39	0.34	0.00	0.47
	Havannah North	5	1.00	0.29	0.50	0.62	0.00	0.48
	Lady Elliot	2	1.00	0.41	0.28	0.28	0.00	0.39
	Lady Elliot	5	0.00	0.65	0.69	0.81	0.35	0.50
	Palms East	2	1.00	0.63	0.25	0.20	1.00	0.62
	Palms East	5	1.00	0.71	0.34	0.33	1.00	0.68
	Palms West	2	0.00	0.58	0.72	0.42	1.00	0.54
	Palms West	5	0.00	0.44	0.25	0.62	1.00	0.46
	Pandora	2	0.50	0.19	0.27	0.16	0.00	0.22
	Pandora	5	1.00	0.32	0.42	0.46	0.39	0.52
	Pandora North	5	0.00	0.85	0.44	0.40	0.11	0.36

Note that scores are multiplied by 100 to fit the standardised report card scoring range. nd indicates no data available.

Table 99 Offshore coral indicator and index scores (2022-23) for each site.

Reef	Coral change	Coral cover	Juveniles	Coral condition
Agincourt Reef No.1	0.47	0.62	1.00	0.70
Farquharson Reef	0.21	0.13	0.44	0.26
Feather Reef	0.68	0.62	1.00	0.77
Hastings Reef	0.58	0.35	0.52	0.49
Mackay Reef	0.55	0.31	0.86	0.57
Peart Reef	0.62	0.46	1.00	0.69
St. Crispin Reef	0.61	0.70	1.00	0.77
Taylor Reef	0.68	0.22	0.80	0.57
Thetford Reef	0.41	0.51	1.00	0.64

Note that the Long Term Monitoring Program underwent a sampling redesign for 2021-22 onwards. This reduced the number of sites from 15 to 8 whilst surveys will occur every year at all sites. Details of the redesign are provided in the methods technical report (WTW 2024).

Appendix G. Index, indicator category and indicator scores and grade tables for 2015-16 to 2021-22

Basins

Water quality

Table 100 Basin water quality index, indicator category and indicator scores and grades for the 2021-22 reporting period.

Basin	Sediment	Nutrients			Pesticides	Water quality
	TSS	DIN	FRP	**Nutrients**		
Daintree	**90**	84	76	**80**	**93**	**87**
Mossman~	**71**	49	64	**57**	**64**	**64**
Barron	**80**	72	68	**70**	nd	**75**
Mulgrave	**80**	33	70	**51**	**77**	**69**
Russell	**90**	58	71	**65**	**69**	**74**
Johnstone	**81**	68	50	**59**	**69**	**70**
Tully	**79**	40	66	**53**	**62**	**65**
Murray	**90**	24	62	**43**	**40**	**57**
Herbert	**83**	43	76	**60**	**69**	**70**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data or insufficient data available. *Pesticide score was calculated from monitoring at the Coquette Point GBR CLMP site on the Johnstone River downstream of the confluence with the South Johnstone River. ~Mossman River was assessed for base-flow only. For each basin DIN and FRP indicator values are averaged to provide the nutrient indicator category score (presented in bold) and that the three indicator categories (sediment, nutrients and pesticides) are averaged to provide the WQ score (all presented in bold).

Table 101 Basin water quality index, indicator category and indicator scores and grades for the 2020-21 reporting period.

Basin	Sediment	Nutrients			Pesticides	Water quality
	TSS	DIN	FRP	**Nutrients**		**20-21**
Daintree	**90**	90	73	**81**	**93**	**88**
Mossman~	**90**	34	51	**43**	**nd**	**66**
Barron	**63**	81	72	**76**	**nd**	**70**
Mulgrave	**90**	39	69	**54**	**75**	**73**
Russell	**80**	61	76	**68**	**75**	**75**
Johnstone	**90**	69	53	**61**	**75**	**75**
Tully	**90**	48	77	**62**	**61**	**71**
Murray	**71**	49	60	**55**	**23**	**49**
Herbert	**78**	43	73	**58**	**61**	**66**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data or insufficient data available. *Pesticide score was calculated from monitoring at the Coquette Point GBR CLMP site on the Johnstone River downstream of the confluence with the South Johnstone River. ~Mossman River was assessed for base-flow only. For each basin DIN and FRP indicator values are averaged to provide the nutrient indicator category score (presented in bold) and that the three indicator categories (sediment, nutrients and pesticides) are averaged to provide the WQ score (all presented in bold).

Table 102 Basin water quality index, indicator category and indicator scores and grades for the 2019-20 reporting period.

Basin	Sediment	Nutrients			Pesticides	Water quality
	TSS	DIN	FRP	**Nutrients**		**19-20**
Daintree	**90**	90	82	**86**	**98**	**91**
Mossman~	**90**	56	76	**66**	**nd**	**78**
Barron	**67**	67	75	**71**	**nd**	**69**
Mulgrave	**72**	39	75	**57**	**78**	**69**
Russell	**68**	46	77	**62**	**71**	**67**
Johnstone	**90**	74	66	**70**	**76**	**78**
Tully	**84**	42	77	**60**	**70**	**71**
Murray	**71**	31	69	**50**	**27**	**49**
Herbert	**90**	46	76	**61**	**68**	**73**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data or insufficient data available. *Pesticide score was calculated from monitoring at the Coquette Point GBR CLMP site on the Johnstone River downstream of the confluence with the South Johnstone River. ~Mossman River was assessed for base-flow only. For each basin DIN and FRP indicator values are averaged to provide the nutrient indicator category score (presented in bold) and that the three indicator categories (sediment, nutrients and pesticides) are averaged to provide the WQ score (all presented in bold).

Table 103 Basin water quality index, indicator category and indicator scores and grades for the 2018-19 reporting period.

Basin	Sediment	Nutrients			Pesticides	Water quality
	TSS	DIN	FRP	**Nutrients**		**18-19**
Daintree#	**68**	90	90	**90**	**85**	**84**
Mossman~	**90**	42	89	**66**	**60**	**69**
Barron	**55**	70	81	**76**	**89**	**74**
Mulgrave	**78**	49	72	**61**	**69**	**66**
Russell	**76**	58	90	**74**	**75**	**75**
Johnstone	**90**	72	69	**70**	**74***	**75**
Tully	**78**	42	90	**66**	**63**	**68**
Murray	**74**	53	77	**65**	**25**	**59**
Herbert	**81**	37	67	**52**	**68**	**61**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data or insufficient data available. *Pesticide score was calculated from monitoring at the Coquette Point GBR CLMP site on the Johnstone River downstream of the confluence with the South Johnstone River. #Daintree River was assessed for high flows only. ~Mossman River was assessed for base-flow only. For each basin DIN and FRP indicator values are averaged to provide the nutrient indicator category score (presented in bold) and that the three indicator categories (sediment, nutrients and pesticides) are averaged to provide the WQ score (all presented in bold).

Table 104 Basin water quality index, indicator category and indicator scores and grades for the 2017-18 reporting period.

Basin	Sediment	Nutrients			Pesticides	Water quality
	TSS	DIN	FRP	**Nutrients**		**17-18**
Daintree#	**90**	70	61	**65**	**90**	**82**
Mossman~	**76**	44	89	**67**	**70**	**71**
Barron	**68**	78	80	**79**	**87**	**78**
Mulgrave	**90**	32	71	**52**	**57**	**66**
Russell	**90**	45	76	**60**	**54**	**68**
Johnstone	**73**	75	70	**72**	**61***	**69**
Tully	**80**	39	73	**56**	**54**	**63**
Murray	**nd**	nd	nd	**nd**	**nd**	**nd**
Herbert	**90**	32	83	**58**	**66**	**71**

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. nd indicates no data or insufficient data available. *Pesticide score was calculated from monitoring at the Coquette Point GBR CLMP site on the Johnstone River downstream of the confluence with the South Johnstone River. #Daintree River was assessed for high flows only. ~Mossman River was assessed for base-flow only. For each basin DIN and FRP indicator values are averaged to provide the nutrient indicator category score (presented in bold) and that the three indicator categories (sediment, nutrients and pesticides) are averaged to provide the WQ score (all presented in bold).

Table 105 Basin water quality index, indicator category and indicator scores and grades for the 2016-17 reporting period using the previous pesticide assessment method.

Basin	Sediment	Nutrients			Pesticides	Water quality
	TSS	DIN	FRP	**Nutrients**		**Score**
Daintree	**nd**	nd	nd	**nd**	**nd**	**nd**
Mossman	**nd**	nd	nd	**nd**	**nd**	**nd**
Barron	**76**	90	84	**87**	**nd**	**81**
Mulgrave	**68**	37	72	**55**	**65**	**63**
Russell	**77**	44	90	**67**	**66**	**70**
Johnstone	**81**	70	57	**64**	**71***	**72**
Tully	**78**	41	79	**60**	**61**	**66**
Murray	**nd**	nd	nd	**nd**	**nd**	**nd**
Herbert	**90**	44	90	**67**	**71**	**76**

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. nd indicates no data or insufficient data available. *Pesticide score was calculated from monitoring at the Coquette Point GBR CLMP site on the Johnstone River downstream of the confluence with the South Johnstone River. For each basin DIN and FRP indicator values are averaged to provide the nutrient indicator category score (presented in bold) and that the three indicator categories (sediment, nutrients and pesticides) are averaged to provide the WQ score (all presented in bold).

Table 106 Basin water quality index, indicator category and indicator scores and grades for the 2015-16 reporting period using the previous pesticide assessment method.

Basin	Sediment	Nutrients			Pesticides	Water quality
	TSS	DIN	FRP	**Nutrients**		**Score**
Daintree	**nd**	nd	nd	**nd**	**nd**	**nd**
Mossman	**nd**	nd	nd	**nd**	**nd**	**nd**
Barron	**89**	63	90	**76**	**nd**	**82**
Mulgrave	**71**	29	62	**45**	**71**	**62**
Russell	**90**	45	80	**63**	**66**	**73**
Johnstone	**90**	74	69	**72**	**76***	**79**
Tully	**80**	33	81	**57**	**57**	**65**
Murray	**nd**	nd	nd	**nd**	**nd**	**nd**
Herbert	**90**	59	90	**74**	**76**	**80**

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. nd indicates no data or insufficient data available. *Pesticide score was calculated from monitoring at the Coquette Point GBR CLMP site on the Johnstone River downstream of the confluence with the South Johnstone River. For each basin DIN and FRP indicator values are averaged to provide the nutrient indicator category score (presented in bold) and that the three indicator categories (sediment, nutrients and pesticides) are averaged to provide the WQ score (all presented in bold).

Habitat and hydrology

Table 107 Results of habitat and hydrology index (H&H) and indicator categories for basins 2021-22

Basin	Flow	Invasive weeds	Habitat modification	Riparian extent	Wetland extent	H&H
Daintree	nd	54	100	99	60	**78**
Mossman	75	81	100	68	16	**68**
Barron	77	34	36	68	11	**45**
Mulgrave	78	43	100	78	33	**66**
Russell	91	41	100	79	33	**69**
Johnstone	77	24	98	74	25	**60**
Tully	95	71	57	72	17	**62**
Murray	61	19	100	75	19	**55**
Herbert	80	19	92	85	20	**59**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available.

Table 108 Results of habitat and hydrology index (H&H) and indicator categories for basins 2020-21

Basin	Flow	Invasive weeds	Habitat modification	Riparian extent	Wetland extent	H&H
Daintree	nd	54	100	99	60	**78**
Mossman	95	81	100	68	16	**72**
Barron	69	34	36	68	11	**44**
Mulgrave	80	43	100	78	33	**67**
Russell	91	41	100	79	33	**69**
Johnstone	96	24	98	74	25	**64**
Tully	100	71	57	72	17	**63**
Murray	78	19	100	75	19	**58**
Herbert	86	19	92	85	20	**60**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available.

Table 109 Results of habitat and hydrology index (H&H) and indicator categories for basins 2019-20

Basin	Flow	Invasive weeds	Habitat modification	Riparian extent	Wetland extent	H&H
Daintree	nd	54	100	99	60	78
Mossman	75	81	100	68	16	68
Barron	80	34	36	68	11	46
Mulgrave	75	43	100	78	33	66
Russell	76	41	100	79	33	66
Johnstone	92	24	98	74	25	63
Tully	61	71	57	72	17	56
Murray	61	19	100	75	19	55
Herbert	66	19	92	85	20	56

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available.

Table 110 Results of habitat and hydrology index (H&H) and indicator categories for basins 2018-19

Basin	Flow	Invasive weeds	Habitat modification	Riparian extent	Wetland extent	H&H
Daintree	nd	62	100	99	60	80
Mossman	61	36	100	68	16	56
Barron	65	56	36	68	11	47
Mulgrave	55	52	100	78	33	63
Russell	61	41	100	79	33	63
Johnstone	66	29	98	74	25	59
Tully	43	81	57	72	17	54
Murray	68	19	100	75	19	56
Herbert	69	19	92	85	20	57

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available.

Table 111 Results of habitat and hydrology index (H&H) and indicator categories for basins 2017-18

Basin	Flow	Invasive weeds	Habitat modification	Riparian extent	Wetland extent	H&H
Daintree	nd	62	100	99	60	80
Mossman	95	36	100	68	16	63
Barron	51	56	36	68	11	45
Mulgrave	93	52	100	78	33	71
Russell	95	41	100	79	33	69
Johnstone	97	29	98	74	25	65
Tully	99	81	57	72	17	65
Murray	78	19	100	75	19	58
Herbert	92	19	92	85	20	61

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available.

Table 112 Results of habitat and hydrology index (H&H) and indicator categories for basins 2016-17.

Basin	Flow	Invasive weeds	Habitat modification	Riparian extent	Wetland extent	H&H
Daintree	nd	62	100	99	61	81
Mossman	95	36	100	68	17	63
Barron	62	56	36	68	11	47
Mulgrave	61	52	100	78	34	65
Russell	95	41	100	79	35	70
Johnstone	96	29	98	74	26	65
Tully	80	81	57	72	17	61
Murray	61	19	100	75	21	55
Herbert	62	19	92	85	20	56

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. nd indicates no data available.

Table 113 Results of habitat and hydrology index (H&H) and indicator categories for basins 2015-16.

Basin	Flow	Invasive weeds	Habitat modification	Riparian extent	Wetland extent	H&H
Daintree	nd	62	100	99	61	81
Mossman	nd	36	100	68	17	55
Barron	nd	56	36	68	11	43
Mulgrave	nd	52	100	78	34	66
Russell	nd	41	100	79	35	63
Johnstone	nd	29	98	74	26	57
Tully	nd	81	57	72	17	57
Murray	nd	19	100	75	21	54
Herbert	nd	19	92	85	20	54

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

Fish

Table 114 Results for freshwater fish indicator and index for 2017-18.

	Fish indicator scores		Standardised scores		
Basin	Native species richness (PONSE)	Pest fish (Proportion of sample)	Native species richness (PONSE)	Pest fish (Proportion of sample)	Fish Index
Mulgrave	0.769	0.031	76	76	76
Russell	0.813	0.011	82	91	86

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

Estuaries

Water quality

Table 115 Estuary water quality indicator, indicator category and index scores and grades for 2021-2022.

Estuary	Chl *a*	Nutrients			Phys/Chem				Pest-icides	Water quality
	Chl *a*	DIN	FRP	**Nut-rients**	Turb-idity	DO Low	DO High	**Phys/ Chem**	Pest-icides	
Daintree	**55**	71	90	**80**	90	90	90	**90**	**93**	**79**
Dickson Inlet	**66**	65	80	**72**	90	59	90	**74**	**nd**	**71**
Barron	**30**	37	48	**43**	75	59	90	**67**	**nd**	**46**
Trinity Inlet	**64**	90	90	**90**	90	42	90	**66**	**nd**	**73**
Russell-Mulgrave	**90**	31	56	**44**	90	71	90	**80**	**73**	**72**
Johnstone	**90**	22	48	**35**	90	73	90	**73**	**69**	**67**
Moresby	**51**	66	90	**78**	90	56	90	**73**	**nd**	**67**
Hinchinbrook Channel	**47**	90	90	**90**	90	76	90	**83**	**nd**	**73**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. Risk metric scores for pesticide are from GBR CLMP sites as per freshwater basins. nd indicates no data available. For each estuary DIN and FRP indicator values are averaged to provide the Nutrient indicator category score (presented in bold) and that the turbidity and DO indicator scores (using the lowest of the two DO values) are averaged to provide the Phys/Chem indicator score (presented in bold). The indicator categories (Chl *a*, Nutrients, Phys/Chem and Pesticides) are averaged to provide the WQ score (all presented in bold). **Note:** Pesticides are from GBR CLMP high flow data as per freshwater basins.

Table 116 Estuary water quality indicator, indicator category and index scores and grades for 2020-2021.

Estuary	Chl *a*	Nutrients			Phys/Chem				Pest-icides	Water quality
	Chl *a*	DIN	FRP	**Nut-rients**	Turb-idity	DO Low	DO High	**Phys/ Chem**	Pest-icides	
Daintree	**86**	81	90	**85**	90	81	90	**85**	**94**	**88**
Dickson Inlet	**84**	71	nd	**71**	90	90	90	**90**	**nd**	**82**
Barron	**74**	46	73	**59**	90	65	90	**77**	**nd**	**70**
Trinity Inlet	**70**	90	90	**90**	90	31	90	**60**	**nd**	**73**
Russell-Mulgrave	**90**	52	90	**71**	90	69	90	**79**	**75**	**79**
Johnstone	**90**	37	70	**54**	nd	90	90	**90**	**75**	**77**
Moresby	**69**	70	90	**80**	90	68	90	**79**	**nd**	**76**
Hinchinbrook Channel	**64**	90	90	**90**	90	78	90	**84**	**nd**	**79**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. Risk metric scores for pesticide are from GBR CLMP sites as per freshwater basins. nd indicates no data available. For each estuary DIN and FRP indicator values are averaged to provide the Nutrient indicator category score (presented in bold) and that the turbidity and DO indicator scores (using the lowest of the two DO values) are averaged to provide the Phys/Chem indicator score (presented in bold). The indicator categories (Chl *a*, Nutrients, Phys/Chem and Pesticides) are averaged to provide the WQ score (all presented in bold). **Note:** Pesticides are from GBR CLMP high flow data as per freshwater basins.

Table 117 Estuary water quality indicator, indicator category and index scores and grades for 2019-2020.

	Chl *a*	Nutrients			Phys/Chem				Pest-icides	Water quality
Estuary	Chl *a*	DIN	FRP	**Nut-rients**	Turb-idity	DO Low	DO High	**Phys/ Chem**	Pest-icides	
Daintree	**90**	90	90	**90**	90	90	90	**90**	**98**	**92**
Dickson Inlet	**81**	76	90	**77**	90	69	90	**79**	**nd**	**81**
Barron	**46**	39	80	**60**	85	64	90	**74**	**nd**	**60**
Trinity Inlet	**66**	90	90	**90**	90	20	90	**55**	**nd**	**70**
Russell-Mulgrave	**90**	67	90	**78**	90	68	90	**79**	**74**	**80**
Johnstone	**90**	34	90	**62**	nd	nd	nd	**nd**	**76**	**76**
Moresby	**90**	69	90	**79**	90	69	90	**79**	**nd**	**83**
Hinchinbrook Channel	**77**	90	90	**90**	90	90	90	**90**	**nd**	**85**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. Risk metric scores for pesticide are from GBR CLMP sites as per freshwater basins. nd indicates no data available. For each estuary DIN and FRP indicator values are averaged to provide the Nutrient indicator category score (presented in bold) and that the turbidity and DO indicator scores (using the lowest of the two DO values) are averaged to provide the Phys/Chem indicator score (presented in bold). The indicator categories (Chl *a*, Nutrients, Phys/Chem and Pesticides) are averaged to provide the WQ score (all presented in bold). **Note:** Pesticides are from GBR CLMP high flow data as per freshwater basins.

Table 118 Estuary water quality indicator, indicator category and index scores and grades for 2018-19.

	Chl *a*	Nutrients			Phys/Chem				Pest-icides	Water quality
	Chl *a*	DIN	FRP	**Nut-rients**	Turb-idity	DO Low	DO High	**Phys/ Chem**	Pest-icides	
Daintree	**80**	72	90	**81**	67	90	90	**78**	**85**	**81**
Dickson Inlet	**90**	78	72	**75**	90	81	90	**85**	nd	**83**
Barron	**37**	41	57	**49**	73	64	90	**69**	**90**	**61**
Trinity Inlet	**45**	68	74	**71**	77	35	90	**56**	nd	**58**
Russell-Mulgrave	**90**	27	90	**59**	90	51	90	**70**	**70**	**72**
Johnstone	**90**	51	79	**65**	90	65	90	**77**	**74**	**76**
Moresby	**90**	65	90	**77**	79	66	90	**73**	nd	**80**
Hinchinbrook Channel	**65**	90	90	**90**	75	77	90	**76**	nd	**77**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. Risk metric scores for pesticide are from GBR CLMP sites as per freshwater basins. nd indicates no data available. For each estuary DIN and FRP indicator values are averaged to provide the Nutrient indicator category score (presented in bold) and that the turbidity and DO indicator scores (using the lowest of the two DO values) are averaged to provide the Phys/Chem indicator score (presented in bold). The indicator categories (Chl *a*, Nutrients, Phys/Chem and Pesticides) are averaged to provide the WQ score (all presented in bold). **Note:** Pesticides are from GBR CLMP high flow data as per freshwater basins.

Table 119 Estuary water quality indicator, indicator category and index scores and grades for 2017-18.

	Chl *a*	Nutrients			Phys/Chem				Pest-icides	Water quality
	Chl *a*	DIN	FRP	**Nut-rients**	Turb-idity	DO Low	DO High	**Phys/ Chem**	Pest-icides	
Daintree	**87**	76	90	**83**	71	90	90	**80**	**90**	**85**
Dickson Inlet	**90**	80	68	**74**	90	63	90	**76**	nd	**80**
Barron	**38**	48	57	**52**	85	90	90	**87**	**87**	**66**
Trinity Inlet	**57**	67	79	**73**	90	37	90	**63**	nd	**65**
Russell-Mulgrave	**90**	29	59	**44**	90	61	90	**75**	**55**	**66**
Johnstone	**90**	28	48	**38**	nd	78	90	**78**	**61**	**67**
Moresby	**90**	65	90	**77**	69	69	90	**69**	nd	**79**
Hinchinbrook Channel	**90**	90	90	**90**	61	73	90	**67**	nd	**82**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. Pesticide risk metric scores are from GBR CLMP sites as per freshwater basins. nd indicates no data available. For each estuary DIN and FRP indicator values are averaged to provide the Nutrient indicator category score (presented in bold) and that the turbidity and DO indicator scores (using the lowest of the two DO values) are averaged to provide the Phys/Chem indicator score (presented in bold). The indicator categories (Chl *a*, Nutrients, Phys/Chem and Pesticides) are averaged to provide the WQ score (all presented in bold). **Note:** Pesticides are from GBR CLMP high flow data as per freshwater basins.

Table 120 Estuary water quality indicator, indicator category and index scores and grades for 2016-17 using the previous method for pesticide assessment.

	Chl *a*	Nutrients			Phys/Chem				Pest-icides	Water quality
	Chl *a*	DIN	FRP	**Nut-rients**	Turb-idity	DO Low	DO High	**Phys/ Chem**	Pest-icides	
Daintree	**90**	65	55	**60**	90	90	90	**90**	nd	**80**
Dickson Inlet	**77**	77	nd	**77**	nd	39	90	**39**	nd	**64**
Barron	**60**	48	57	**52**	86	76	90	**81**	nd	**64**
Trinity Inlet	**90**	69	90	**79**	90	41	90	**65**	nd	**78**
Russell-Mulgrave	**90**	51	76	**64**	81	83	90	**82**	**66**	**75**
Johnstone	**90**	48	65	**56**	nd	nd	nd	nd	**71**	**72**
Moresby	**90**	61	90	**75**	90	66	90	**78**	nd	**81**
Hinchinbrook Channel	**90**	90	90	**90**	90	90	90	**90**	nd	**90**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. Pesticide risk metric scores are from GBR CLMP sites as per freshwater basins. nd indicates no data available. For each estuary DIN and FRP indicator values are averaged to provide the Nutrient indicator category score (presented in bold) and that the turbidity and DO indicator scores (using the lowest of the two DO values) are averaged to provide the Phys/Chem indicator score (presented in bold). The indicator categories (Chl *a*, Nutrients, Phys/Chem and Pesticides) are averaged to provide the WQ score (all presented in bold). **Note:** Pesticides are from GBR CLMP high flow data as per freshwater basins.

Table 121 Estuary Water quality indicator, indicator category and index scores and grades for 2015-16 using the previous method for pesticide assessment.

	Chl *a*	Nutrients			Phys/Chem				Pest-icides	Water quality
	Chl *a*	DIN	FRP	**Nut-rients**	Turb-idity	DO Low	DO High	**Phys/ Chem**	**Pest-icides**	
Daintree	**90**	63	72	**67**	90	74	90	**82**	nd	**79**
Dickson Inlet	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Barron	**8**	53	54	**54**	90	90	90	**90**	nd	**50**
Trinity Inlet	**90**	90	90	**90**	90	52	90	**71**	nd	**83**
Russell-Mulgrave	**90**	53	69	**61**	90	90	90	**90**	**71**	**78**
Johnstone	**90**	50	68	**59**	nd	29	90	**29**	**76**	**63**
Moresby	**90**	61	90	**75**	90	48	90	**69**	nd	**78**
Hinchinbrook Channel	**90**	90	90	**90**	74	76	90	**75**	nd	**85**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available. For each estuary DIN and FRP indicator values are averaged to provide the Nutrient indicator category score (presented in bold) and that the turbidity and DO indicator scores (using the lowest of the two DO values) are averaged to provide the Phys/Chem indicator score (presented in bold). The indicator categories (Chl *a*, Nutrients, Phys/Chem and Pesticides) are averaged to provide the WQ score (all presented in bold). **Note:** Pesticides are from GBR CLMP high flow data as per freshwater basins.

Habitat and hydrology

Table 122 Results for habitat and hydrology index (H&H) and indicator categories for the 2021-22 reporting period.

Estuary	Mangrove & saltmarsh	Riparian extent	Flow	Fish barriers	Seagrass	H&H
Daintree	87^	28	nd	61	-~	59
Dickson Inlet	67^	49	nd	80	nd	65
Barron	57^	22	79	60	-	55
Trinity Inlet	60^	58	nd	61	38	54
Russell-Mulgrave	84^	24	81	81	-	67
Johnstone	63	9	71	81	-	56
Moresby	83^	66	nd	61	0	52
Hinchinbrook Channel	83^	53	nd	**60**	nd	65

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. *nd indicates no data available. - indicates that it does not occur at the location. nd indicates no data available. ^ indicates the estuaries that include the new shoreline mangrove habitat indicator introduced in 2020-21

Table 123 Results for habitat and hydrology index (H&H) and indicator categories for the 2020-21 reporting period.

Estuary	Mangrove extent	Riparian extent	Flow	Fish barriers	Sea-grass	H&H
Daintree	88^	28	nd	61	-	59
Dickson Inlet	69^	47	nd	100	nd	72
Barron	57^	23	75	61	-	54
Trinity Inlet	57^	59	nd	61	42	54
Russell-Mulgrave	81^	24	84	81	-	67
Johnstone	63	9	98	81	-	63
Moresby	79	68	nd	61	18	56
Hinchinbrook Channel	84	51	nd	**60**	nd	65

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. *nd indicates no data available. - indicates that it does not occur at the location. nd indicates no data available. ^ indicates the estuaries that include the new shoreline mangrove habitat indicator introduced in 2020-21.

Table 124 Results for habitat and hydrology index (H&H) and indicator categories for the 2019-20 reporting period.

Estuary	Mangrove extent	Riparian extent	Flow	Fish barriers	Sea-grass	H&H
Daintree	93	28	nd	61	-	60
Dickson Inlet	75	47	nd	100	nd	74
Barron	39	23	93	61	-	54
Trinity Inlet	53	59	nd	61	54	57
Russell-Mulgrave	98	24	75	81	-	69
Johnstone	63	9	95	81	-	62
Moresby	79	68	nd	61	25	58
Hinchinbrook Channel	84	51	nd	80	nd	71

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. *nd indicates no data available. - indicates that it does not occur at the location.

Table 125 Results for habitat and hydrology index (H&H) and indicator categories for the 2018-19 reporting period.

Estuary	Mangrove extent	Riparian extent	Flow	Fish barriers	Seagrass	H&H
Daintree	93	28	nd*	61	-	60
Dickson Inlet	75	47	nd	100	nd	74
Barron	39	23	57	61	-	45
Trinity Inlet	53	59	nd	61	46	55
Russell-Mulgrave	98	24	57	81	-	65
Johnstone	63	9	65	81	-	54
Moresby	79	68	nd	61	8	54
Hinchinbrook Channel	84	51	nd	80	nd	71

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. *nd indicates no data available. - indicates that it does not occur at the location.

Table 126 Results for habitat and hydrology index (H&H) and indicator categories for the 2017-18 reporting period.

Estuary	Mangrove extent	Riparian extent	Flow	Fish barriers	Seagrass	H&H
Daintree	93	25	nd*	61	-	60
Dickson Inlet	75	47	nd	100	nd	74
Barron	39	22	49	61	-	43
Trinity Inlet	53	57	nd	61	31	50
Russell-Mulgrave	98	24	98	81	-	75
Johnstone	63	9	98	81	-	63
Moresby	79	64	nd	61	0	51
Hinchinbrook Channel	84	51	nd	80	nd	72

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. *nd indicates no data available. - indicates that it does not occur at the location.

Table 127 Results for habitat and hydrology index (H&H) and indicator categories for the 2016-17 reporting period.

Estuary	Mangrove extent	Riparian extent	Flow	Fish barriers	Seagrass	H&H
Daintree	93	25	nd*	61	-	60
Dickson Inlet	75	47	nd	100	nd	74
Barron	39	22	59	61	-	45
Trinity Inlet	53	57	nd	61	30	50
Russell-Mulgrave	98	24	74	81	-	69
Johnstone	63	9	81	81	-	58
Moresby	79	64	nd	61	7	53
Hinchinbrook Channel	84	51	nd	80	nd	72

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. nd indicates no data available. - indicates that it does not occur at this location.

Table 128 Results for habitat and hydrology index (H&H) and indicator categories for the 2015-16 reporting period using the updated scoring methods.

Estuary	Mangrove extent	Riparian extent	Flow	Fish barriers	Seagrass	H&H
Daintree	93	25	nd	61	-	60
Dickson Inlet	75	47	nd	100	nd	74
Barron	39	22	nd	61	-	41
Trinity Inlet	53	57	nd	61	21	48
Russell-Mulgrave	98	24	nd	81	-	67
Johnstone	63	9	nd	81	-	51
Moresby	79	64	nd	61	13	54
Hinchinbrook Channel	84	51	nd	80	nd	72

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available. ^Decisions rules require ≥ 60% indictor categories (I.C.) for aggregation to index. - indicates that it does not occur at this location.

Inshore marine

Water quality

Table 129 Results for water quality indicators, indicator categories and index for inshore marine zones 2021-22

Zone	Water clarity			Chl *a*	Nutrients				Pest-icides	Water quality
	TSS	Tur-bidity	**Water clarity**	Chl *a*	NOx	PN	PP	**Nutrients**	Risk metric	
North	84		**84**	**83**	87	71	68	**75**	nd	**81**
Central	80	69	**76**	**65**	29	36	67	**45**	nd	**62**
South	61	65	**65**	**75**	41	18	63	**39**	nd	**60**
Palm Island	74	80	**77**	**65**	62	38	79	**61**	nd	**68**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available. The indicator values are averaged to provide the water clarity and nutrient indicator category scores (presented in bold) and that the four indicator categories are averaged to provide the water quality index score (also presented in bold).

Table 130 Results for water quality indicators, indicator categories and index for inshore marine zones 2020-21

Zone	Water clarity			Chl *a*	Nutrients				Pest-icides	Water quality
	TSS	Tur-bidity	**Water clarity**	Chl *a*	NOx	PN	PP	**Nut-rients**	Risk metric	**20- 21**
North	69	nd	69	86	57	65	57	60	nd	72
Central	81	59	75	69	22	26	62	37	nd	60
South	58	60	62	75	5	18	48	21	nd	52
Palm Island	76	67	71	64	44	44	61	50	nd	62

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available. The indicator values are averaged to provide the water clarity and nutrient indicator category scores (presented in bold) and that the four indicator categories are averaged to provide the water quality index score (also presented in bold).

Table 131 Results for water quality indicators, indicator categories and index for inshore marine zones 2019-20.

Zone	Water clarity			Chl *a*	Nutrients				Pest-icides	Water quality
	TSS	Tur-bidity	**Water clarity**	Chl *a*	NOx	PN	PP	**Nutrients**	Risk metric	
North	96	nd	**96**	**91**	100	79	80	**86**	nd	**91**
Central	92	72	**89**	**75**	11	55	62	**43**	**89**	**74**
South	83	67	**82**	**71**	21	26	57	**42**	**91**	**72**
Palm Island	94	88	**91**	**68**	39	0	66	**37**	nd	**65**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available. The indicator values are averaged to provide the water clarity and nutrient indicator category scores (presented in bold) and that the four indicator categories are averaged to provide the water quality index score (also presented in bold).

Table 132 Results for water quality indicators, indicator categories and index for inshore marine zones 2018-19.

Zone	Water clarity			Chl *a*	Nutrients				Pest-icides	Water quality
	TSS	Tur-bidity	**Water clarity**	Chl *a*	NOx	PN	PP	**Nutrients**	Pest-icides	
North	88		**88**	**75**	92	76	69	**80**	**96**	**85**
Central	71	64	**70**	**52**	12	19	33	**21**	**89**	**58**
South	47	60	**54**	**24**	3	6	8	**7**	**91**	**44**
Palm Island	86	73	**80**	**66**	0	0	8	**2**	**91**	**60**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available. The indicator values are averaged to provide the water clarity and nutrient indicator category scores (presented in bold) and that the four indicator categories are averaged to provide the water quality index score (also presented in bold).

Table 133 Results for water quality indicators, indicator categories and index for inshore marine zones 2017-18.

Zone	Water clarity			Chl *a*	Nutrients				Pest-icides	Water quality
	TSS	Tur-bidity	**Water clarity**	Chl *a*	NOx	PN	PP	**Nutrients**	Pest-icides	
North	52	nd	**52**	**49**	95	69	36	**70**	**92**	**66**
Central	41	60	**41**	**36**	21	64	68	**53**	**84**	**53**
South	20	60	**31**	**36**	1	50	68	**34**	**88**	**47**
Palm Island	39	68	**57**	**46**	21	27	73	**42**	**86**	**53**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available. The indicator values are averaged to provide the water clarity and nutrient indicator category scores (presented in bold) and that the four indicator categories are averaged to provide the water quality index score (also presented in bold).

Table 134 Results for water quality indicators, indicator categories and index for inshore marine zones 2016-17.

Zone	Water clarity			Chl *a*	Nutrients				Pest-icides	Water quality
	TSS	Tur-bidity	**Water clarity**	Chl *a*	NOx	PN	PP	**Nutrients**	Pest-icides	
North	69	nd	**69**	**47**	95	50	51	**68**	**93**	**69**
Central	48	63	**51**	**52**	4	57	78	**50**	**80**	**58**
South	10	62	**23**	**54**	0	23	70	**26**	**86**	**47**
Palm Island	5	87	**54**	**67**	12	59	67	**47**	**87**	**64**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. nd indicates no data available. The indicator values are averaged to provide the water clarity and nutrient indicator category scores (presented in bold) and that the four indicator categories are averaged to provide the water quality index score (also presented in bold).

Table 135 Results for water quality indicators, indicator categories and index for inshore marine zones 2015-16.

Zone	Water clarity			Chl *a*	Nutrients				Pest-icides	Water quality
	TSS	Tur-bidity	**Water clarity**	Chl *a*	NOx	PN	PP	**Nutrients**	Pest-icides	
North	75	nd	75	**71**	100	72	52	**76**	**96**	**79**
Central	41	63	40	**64**	18	72	79	**61**	**93**	**64**
South	23	68	33	**64**	11	61	75	**47**	**96**	**60**
Palm Island	64	77	70	**62**	18	32	83	**49**	**93**	**69**

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100. The indicator values are averaged to provide the water clarity and nutrient indicator category scores (presented in bold) and that the four indicator categories are averaged to provide the water quality index score (also presented in bold).

Coral

Table 136 Results for coral indicators and coral index for the inshore marine zones 2021-22.

Inshore Zone	Juvenile	Macroalgae	Cover	Change	Composition	Coral 20-21
North	38	55	65	70	30	51
Central	38	59	73	64	58	58
South	67	40	54	64	75	60
Palm Island	37	38	47	47	58	45

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

Table 137 Results for coral indicators and coral index for the inshore marine zones 2020-21.

Inshore Zone	Juvenile	Macroalgae	Cover	Change	Composition	Coral 20-21
North	41	45	49	58	25	44
Central	36	74	70	68	65	63
South	72	34	49	68	81	61
Palm Island	44	45	45	48	63	49

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

Table 138 Results for coral indicators and coral index for the inshore marine zones 2019-20.

Inshore Zone	Juvenile	Macroalgae	Cover	Change	Composition	Coral 19-20
North	33	42	44	70	33	44
Central	40	65	74	64	61	61
South	78	44	46	74	75	62
Palm Island	51	55	43	50	66	53

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

Table 139 Results for coral indicators and coral index for the inshore marine zones 2018-19.

Inshore Zone	Juvenile	Macroalgae	Cover	Change	Composition	Coral condition
North	32	44	41	69	33	44
Central	41	64	66	73	58	60
South	87	41	43	72	75	62
Palm Island	45	45	44	61	67	52

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

Table 140 Results for coral indicators and coral index for the inshore marine zones 2017-18.

Inshore Zone	Juvenile	Macroalgae	Cover	Change	Composition	Coral condition
North	40	49	45	70	50	51
Central	38	73	62	74	58	61
South	81	40	34	66	58	55
Palm Island	51	32	37	60	63	49

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

Table 141 Results for coral indicators and coral index for the inshore marine zones 2016-17.

Inshore Zone	Juvenile	Macroalgae	Cover	Change	Composition	Coral condition
North	40	40	42	67	42	46
Central	30	76	58	80	42	57
South	89	46	32	74	58	60
Palm Island	55	32	33	59	67	49

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

Table 142 Results for coral indicators and coral index for the inshore marine zones 2015-16.

Inshore Zone	Juvenile	Macroalgae	Cover	Change	Composition	Coral condition
North	37	56	42	62	33	46
Central	40	67	72	70	53	60
South	95	35	31	66	50	55
Palm Island	59	31	36	50	70	49

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

Seagrass

The tables below present the average score for each indicator from all sites within a zone. However, for purposes of scoring condition, the QPSMP seagrass site score is the minimum of the indicator values (biomass, area and species composition) unless species composition is zero, in which case it is the average of species composition (0) and the next lowest scoring indicator (not shown in the tables), meaning it is not always calculated as an average of these indicator scores shown in the tables. For the MMP the seagrass site score is the average of the indicator values (percent cover and resilience). The condition score for an inshore zone is the average of the site scores.

Table 143 Inshore marine seagrass results for 2021-22.

Inshore zone	Biomass	Area	Species compo -sition	Percent cover	Resilience	Seagrass condition
North	74	85	95	64	41	60
Central	nd	nd	nd	nd	nd	nd
South	nd	nd	nd	28	48	40
Palm Island	nd	nd	nd	nd	nd	nd

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100.

Table 144 Inshore marine seagrass results for 2020-21.

Inshore zone	Biomass	Area	Species compo -sition	Percent cover	Resilience	Seagrass condition
North	77	85	93	43	47	57
Central	nd	nd	nd	nd	nd	nd
South	nd	nd	nd	31	32	40
Palm Island	nd	nd	nd	nd	nd	nd

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100.

Table 145 Inshore marine seagrass results for 2019-20

Inshore zone	Bio-mass	Area	Species compo-sition	Percent cover	Tissue nut-rients	Repro-ductive effort	Seagrass condition
North	70	84	85	36	38	20	46
Central	nd	nd	nd	nd	nd	nd	nd
South	nd	nd	nd	19	36	38	35
Palm Island	nd	nd	nd	nd	nd	nd	nd

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100.

Table 146 Inshore marine seagrass results for 2018-19.

Inshore zone	Biomass	Area	Species compo-sition	Percent cover	Tissue nutrients	Repro-ductive effort	Seagrass condition
North	62	92	71	43	37	63	53
Central	nd	nd	nd	nd	nd	nd	nd
South	nd	nd	nd	28	27	17	35
Palm Island	nd	nd	nd	nd	nd	nd	nd

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100.

Table 147 Inshore marine seagrass results for 2017-18.

Inshore zone	Biomass	Area	Species composition	Percent cover	Tissue nutrients	Repro-ductive effort	Seagrass condition
North	54	75	76	48	35	38	46
Central	nd	nd	nd	nd	nd	nd	nd
South	nd	nd	nd	19	39	0	23
Palm Island	nd	nd	nd	nd	nd	nd	nd

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100.

Table 148 Seagrass results for 2016-17.

Inshore zone	Biomass	Area	Species composit ion	Percent cover	Tissue nutrients	Repro-ductive effort	Seagrass condition
North	52	70	48	52	35	0	30
Central	nd	nd	nd	nd	nd	nd	nd
South	nd	nd	nd	0	43	8	6
Palm Island	nd	nd	nd	nd	nd	nd	nd

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100.

Table 149 Seagrass results for the 2015-16.

Inshore zone	Biomass	Are a	Species Composition	Abundan ce	Tissue nutrients	Repro-ductive effort	Seagrass condition
North	40	48	71	40	31	25	30
Central	nd	nd	nd	nd	nd	nd	nd
South	nd	nd	nd	14	41	0	18
Palm Island	nd	nd	nd	nd	nd	nd	nd

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 – 100.

Offshore marine

Water quality

Table 150 Results for water quality indicators and water quality index for the offshore marine environment 2018-19.

Chlorophyll-*a*	Water clarity (TSS)	Water quality
100	98.2	99.1

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

Table 151 Results for water quality indicators and water quality index for the offshore marine environment 2017-18.

Chlorophyll-*a*	Water clarity (TSS)	Water quality
99.9	98.1	99.0

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

Table 152 Results for water quality indicators and water quality index for the offshore marine environment 2016-17.

Chlorophyll-*a*	Water clarity (TSS)	Water quality
99.6	99.3	99.5

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

Table 153 Results for water quality indicators and water quality index for the offshore marine environment 2015-16.

Chlorophyll-*a*	Water clarity (TSS)	Water quality
99.7	99.1	99.4

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

Coral

Offshore coral sampling design update 2021-22

Report card update
The LTMP updated the sampling design for 2021-22 onwards. For the Wet Tropics region, the LTMP previously included 15 reefs with a subset monitored in alternating years. The updated sampling design has reduced the number of surveyed reefs to nine and conducts surveys at all reefs every year. Details of the changes to the reefs that are surveyed are presented in the methods technical report (WTW 2024).

Whilst this change reduces the number of reefs monitored it has the distinct advantage of increasing the frequency of sampling from a two-year to one-year cycle. The previous design involved rolling scores forward for reefs not sampled in a given year, and meant that there was a lag in the condition assessment for reefs not surveyed for the reporting year.

The updated LTMP sampling design has meant that offshore coral scores produced for 2021-22 onwards are not directly comparable to the scores using the previous design as presented in the report cards up to 2020-21. The indicators and index scores and grades for offshore coral are presented in Table 154 for the previous sampling design, and for the updated sampling design, for which the scores and grades have been back-calculated for the previous reporting years. This allows the condition of reefs to be assessed over time for the updated sampling design.

Differences between the indicator and index scores and grades are evident for the two sampling designs. The updated sampling design has typically produced higher indicator scores, and consistently higher index scores, since 2017-18 compared to the previous sampling design.

Table 154 Offshore coral scores and grades from the previous and the updated LTMP sampling design.

	Previous sampling design				Updated sampling design			
Year	Juveniles	Coral Cover	Coral Change	**Coral**	Juveniles	Coral Cover	Coral Change	**Coral**
2022-23	nd	nd	nd	nd	84	43	53	**61**
2021-22	nd	nd	nd	nd	92	39	52	**61**
2020-21	65	32	52*	**50**	74	34	43	**54**
2019-20	62	29	37	**42**	73	29	51	**51**
2018-19	68	26	51	**48**	80	27	70	**59**
2017-18	71	28	53	**51**	77	25	67	**56**
2016-17	95	51	56	**67**	99	52	67	**73**
2015-16	96	60	54	**70**	97	61	66	**75**

Standardised scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 – 100. The coral index is shown in bold and is the average of the three contributing indicators.
* indicated scores are not directly comparable to previous years. The Coral Change indicator is only estimated during years free from acute disturbances, such as cyclones, marine heat waves and outbreaks of crown-of-thorns starfish. Internal revision of disturbance categorisation at AIMS has led to more disturbances being categorised and this resulted in increased scores for the coral change indicator. nd indicates no data available.

Appendix H. Estuary fish barrier remediation

The sites of the remediation works on waterways in the Hinchinbrook Channel zone assessed for the fish barrier indicator are presented in Figure 30. The photos show sites before and after remediation works which constructed fish passage structures to facilitate longitudinal connectivity for fish and other aquatic fauna. The sites were prioritised for remediation as part of the Fish Homes and Highways project (Terrain NRM 2024). Mapping of fish barrier and remediation site locations for the project is available here.

Figure 30. Photos of before and after remediation works of fish barriers on waterways assessed for the Hinchinbrook estuary zone.

Waterway: Five Mile Ck	Site code	Barrier Type: Rock weir with pipes
Basin: Murray		Remediation: Rock fishway
Before 		After 
Waterway: Herbert River	Site code	Barrier Type: Rock weir
Basin: Herbert		Remediation: Rock fishway
Before 		After 

Waterway: Lagoon Ck	Site code	Barrier Type: Rock weir with pipes
Basin: Herbert		Remediation: Rock ramp fishway
Before 		After 

Waterway: Lannercost Ck	Site code	Barrier Type: Causeway/weir (drop barrier)
Basin: Herbert		Remediation: Rock ramp fishway
Before 		After 

Waterway: Lannercost Ck	Site code	Barrier Type: Causeway
Basin: Herbert		Remediation: Bed level crossing
Before 		After 

References

(Terrain NRM 2024). Fish barrier remediation works in the Herbert and Murray Catchments Reef. Trust VII 2021-2023 Summary Report. Terrain NRM, Innisfail, Queensland.

Appendix I. Log of updates 2022-23

The table below lists section, page and caption number, and summary of updates for the 2022-23 results technical report to assist reviewers.

Section number and title	Page/caption number	Summary of update
1. EXECUTIVE SUMMARY	p. iii-ix	2022-23 score summary and selected key messages.
3. Climatic influences in the region	p. 9-14	Text, figures, tables and key messages.
	Appendix A Figure 20 p.83	Long term rainfall figure.
4. Freshwater basins		
4.1.Water Quality	p. 16-23	Text, tables, figures and key messages.
	Appendix B p. 87-100	Detailed results: text, tables and figures (box plots) for reference
	Appendix B p. 101-106	Basin pesticide sites contributing chemicals: text and figures.
4.2.Habitat and Hydrology		
Habitat modification	p. 24-25, Table 8	Updated of Impoundment length for 2022-23.
Wetland Extent	p. 25-28, Table 12, Table 13	2019 results and comparison between versions: text and tables.
Flow	p. 29-31	Results text, tables, figure and key messages.
	Appendix C p. 118-123	Detailed results: table for reference.
Habitat and hydrology index	p. 31	Text, scoring and grading tables.
4.3 Fish	p. 32-35, Table 18, Table 19	Text, site and scoring tables.
	Appendix D Table 86, Table 95, Table 96	Species list and species codes, Survey results by site, translocated and alien species list by zone.
4.4.Overall basin scores and grades	p. 37	Text and table update.
5. ESTUARIES		
5.1.Water Quality	p. 39-44	Text, tables, figures and key messaging.
	Appendix B p. 106-113	Detailed results: tables for reference.
5.2.Habitat and Hydrology		
Fish barriers	p. 51-55	Hinchinbrook Channel estuary update, text and table.
	Appendix H p. 167	Before and after images of fish barrier remediation works
Flow	p. 55 - 56	Results text, table and key messaging.
	Appendix C p. 118-123	Detailed results: tables for reference.

Section number and title	Page/caption number	Summary of update
Seagrass	p. 56-59	Results text, table, key messaging and recommendations (messaging provided by Alex Carter).
Habitat and hydrology index	p. 59	Results text, and tables
5.3. Overall estuary scores and grades	p. 61	Text and table update.
6. INSHORE MARINE		
6.1. Water Quality	p. 63-66	Results text, table, and key messaging
	Appendix B p. 114	Detailed results: tables for reference.
6.2. Coral	p. 66-69	Results text, table and key messaging (messaging provided based on MMP report).
	Appendix F p. 142	Inshore coral site list with indicator and condition index scores
6.3. Seagrass	p. 69-72	Results text, table, key messaging and recommendations (messaging provided by Alex Carter).
6.4 Inshore fish	p. 72-73	Update on the Integrated Fish Monitoring project. Based on information provided by Alex Carter.
6.5. Overall inshore marine scores and grades	p. 73	Results text and table.
7 OFFSHORE MARINE		
7.1. Water Quality	p. 74	No water quality reporting for 2022-23
7.2. Coral	p. 74-77, 166	Results text, tables and key messaging (messaging from LTMP monitoring results published online).
	Appendix F p. 143	Offshore coral site list with indicator and condition index scores
	Appendix G p. 166	Report card update of sampling design changes from 2021-22 moved to appendix.
7.3. Overall offshore marine score and grade	p.77	Results text and table.
Appendix G. Index, indicator category and indicator scores and grade tables for 2015-16 to 2021-22.	p.144-166	Results tables from all previous years.