Mackay-Whitsunday-Isaac Report Card Results 2024

(Reporting on data July 2022 to June 2023)

Technical Report
Mackay-Whitsunday-Isaac Healthy Rivers to Reef Partnership
July 2024

Executive Summary

The Mackay-Whitsunday-Isaac (MWI) Healthy Rivers to Reef Partnership (the Partnership) was established in October 2014 with the primary focus of producing an annual report card on the health of our region's waterways. The 2024 Report Card (reporting on the 2022–2023 financial year) is the Partnership's tenth Report Card, demonstrating the MWI community's commitment to understanding and caring for the local environment. This commitment is matched outside of regional reporting boundaries as this is one of five regional report cards released annually in the Great Barrier Reef (GBR) World Heritage Area.

This document provides detailed results of waterway health and discusses these findings in relation to guideline values, regional climate, natural processes, and human activities. It contains data from a variety of waterway condition assessments including freshwater, estuarine, inshore, and offshore marine environments. For each waterway type, a series of environmental *indicators* are aggregated into *indicator categories* and then into *indices*. Although most indicators are assessed annually, others are updated every three or four years due to differences in the time scales at which notable changes typically occur and/or logistical constraints (Table I). As the Report Card integrates data from many sources with evolving maturity and comprehensiveness, confidence levels are published following results, as are historic scores for comparison where appropriate.

Table I. Frequency of reporting and latest updates for waterway condition indicators in the 2024 MWI Report Card.

Water type	Index	Indicator Categories	Frequency of Reporting	Last Updated
Freshwater	Water Quality	Sediment	Annually	**2023**
		Nutrients	Annually	**2023**
		Pesticides	Annually	**2023**
	Habitat and Hydrology	In-stream habitat modification	4 Yearly	**2023**—Impoundment Length
				2023—Fish Barriers
		Flow	Annually	**2023**
		Riparian ground cover*	Unknown	**2014** (scores revised in 2016)
		Freshwater wetlands	4 Yearly	**2019** (2017 data)
	Fish	Fish	3 Yearly	**2021**
Estuary	Water Quality	Phys-chem	Annually	**2023**
		Nutrients	Annually	**2023**
		Chlorophyll-*a*	Annually	**2023**
		Pesticides	Annually	**2023**
	Habitat and Hydrology	Riparian Vegetation	4-Yearly	**2022** (2019 data)
		Mangrove and Saltmarsh	4-Yearly	**2022** (2019 data)
		Fish Barriers	4-Yearly	**2023**
Marine	Water Quality	Nutrients	Annually	**2023**
		Water Clarity	Annually	**2023**
		Chlorophyll-*a*	Annually	**2023**
		Pesticides	Annually	**2023**
	Coral	Coral	Annually	**2023**
	Seagrass	Seagrass	Annually	**2023**

*Due to methodology changes to riparian ground cover mapping (provided by the Department of Environment and Science), this indicator category has not been updated since 2014.

I. Regional Climate

Annual average temperatures were above average compared to the long-term mean in all MWI basins (Section 1.4.3), and sea surface temperature has been above the long-term mean for the past ten years (Appendix 8.1.6). Rainfall was average in comparison to the long-term mean in O'Connell, Pioneer, and Plane Basins, while in the Don and Proserpine Basins rainfall was above average (Section 1.4.4). During the 2022-23 reporting season, rainfall was higher in all MWI basins in comparison to the previous three years (Appendix 8.1). Rainfall was varied and patchy across time, with above average rainfall across the region in July and October 2022 and January 2023, while February, May, and June 2023 recorded below average rainfall in all basins (Section 1.4.4). Regional rainfall is often a key driver of the Report Card scores as reductions or increases in runoff throughout the region lead to reductions or increases of inputs into aquatic systems, in particular as it relates to the agricultural context (Section 1.4.4.1).

Although there were no extreme events recorded in the MWI region during the 2022-23 reporting season, historic extreme events can have long-lasting impacts on aquatic ecosystems (Section 1.4.2). Furthermore, under current climate change projections marine heatwaves as recorded in 2022 and 2020 are going to become more widespread, frequent, and intense. Climate scientists also predict more extremely hot days and a higher intensity of short-duration heavy rainfall events. Storm events are expected to decline in frequency but increase in intensity. For these reasons, climate change remains the most significant threat affecting the health of the GBR (GBRMPA, 2019).

II. Freshwater Basins

Water quality index, fish barriers indicator, impoundment length indicator, and flow scores were updated for freshwater basin condition assessments during this reporting period (Table II). The fish index, riparian extent indicator, and wetlands extent indicator were based on repeated data (following multi-year reporting cycles) (Section 2).

MWI **basin overall** grades were the same as the previous monitoring period (Figure I). Improved scores in the Don Basin were driven by improved **water quality** (Section 2.1.4), likely influenced by increased sampling across the reporting period.

Table II. Condition grades of freshwater indicator categories and overall basins for the 2024 Report Card.

Freshwater Basin	2024 Report Card				
	Water Quality	Habitat and Hydrology	Fish	Basin Score and Grade	
Don	**59**	**72**	88	**73**	**B**
Proserpine		**54**	80	**67**	**B**
O'Connell	**52**	**41**	83	**58**	**C**
Pioneer	**52**	**39**	75	**55**	**C**
Plane	**37**	**45**	73	**51**	**C**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

Sediment scores exceeded guideline values with ‘moderate’ to ‘very poor’ grades observed across the Don, O’Connell, and Plane basins for six or more consecutive years (Section 2.1.1).

Nutrients indicator category grades improved in the Plane, Pioneer, and Don Basins, which shifted the Don Basin grade to ‘moderate’, while the Plane and Pioneer remained ‘poor’ and ‘moderate’ respectively. Grade change in the Don Basin was influenced by reduced concentrations of both DIN and FRP, likely related to increased sampling availability, while in the Plane Basin score change was influenced by reduced concentration of FRP (Section 2.1.2).

Pesticide risk remained the poorest scoring indicator for basin water quality in the MWI region, with most of the region’s basins recording either ‘poor’ or ‘very poor’ grades (Section 2.1.3). As with previous years, applications of imidacloprid and diuron due to agricultural land use were the key contributors to pesticide risk across most of the MWI region. In the Don Basin and Plane Creek Sucrogen Weir sites, metsulfuron-methyl was the key contributor to pesticide risk.

In the **habitat and hydrology** index (Section 2.2), the **fish barriers** indicator (Section 2.2.1.1) score decline in the Don Basin was largely due to the construction of new waterway barriers which may be tied to land clearing and development in the form of intensive horticulture. **Habitat modification** indicator category (Section 2.2.1.3) scores in the Proserpine Basin improved due to the removal of a sand dam near the freshwater / estuarine interface.

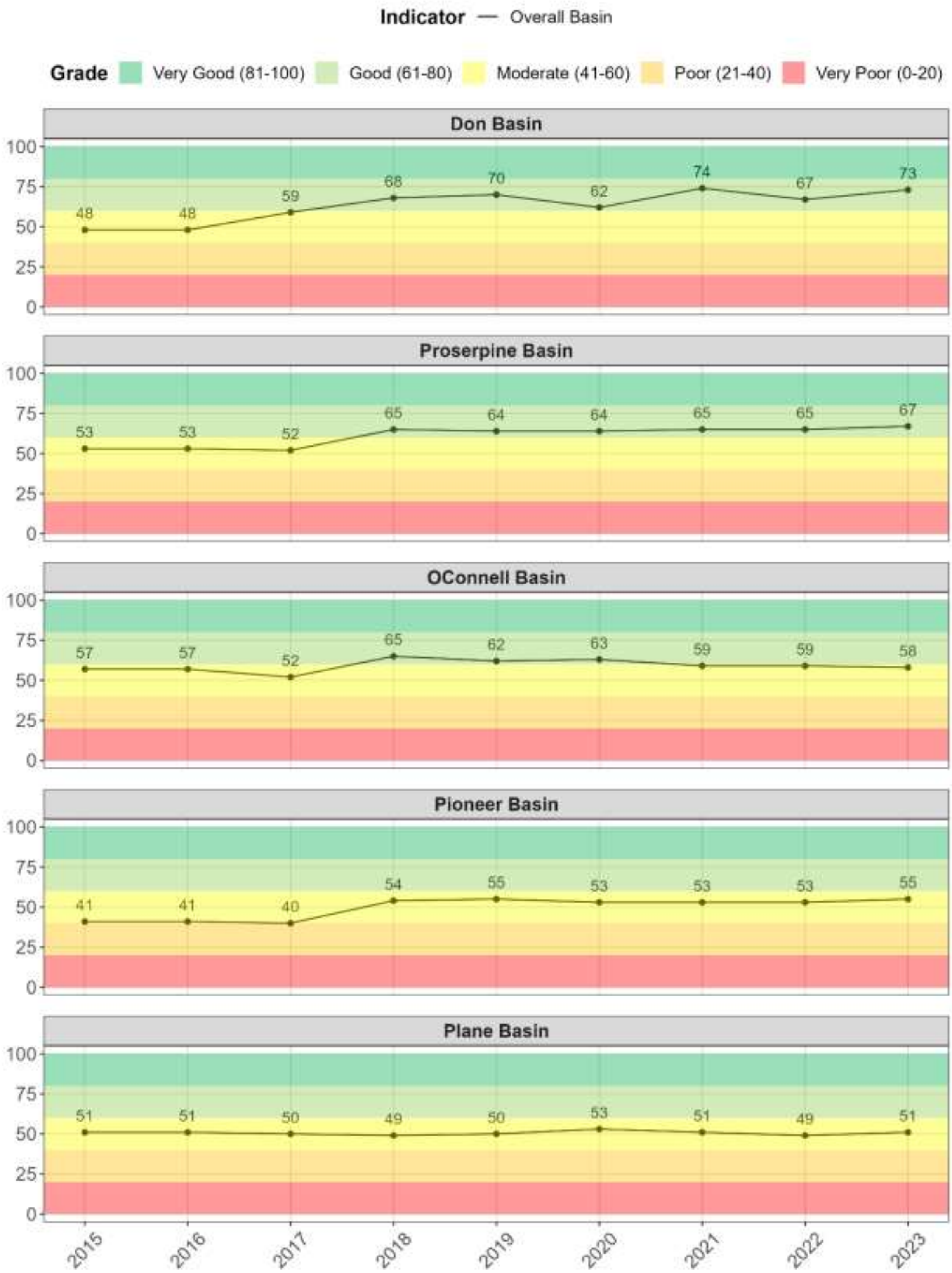

Figure I. Overall basin grades for the 2024 Report Card compared to the historic record.

III. Estuaries

Estuarine assessments during this reporting period included water quality scores and fish barriers indicator within habitat and hydrology index (Table III). Other contributors to habitat and hydrology are based on repeat data. Scores remained similar to the previous year, with grade improvements in both Vines Creek and Carmila Creek estuaries (Figure II).

Table III. Estuary overall condition alongside indicator category scores and grades for the 2024 Report Card (2022-23 reporting period).

Estuary	2024 Report Card				
	Water Quality	Habitat and Hydrology	Fish	Estuary Score and Grade	
Gregory River	73	84		79	B
O'Connell River^	53	53		53	C
St Helens/Murray Creek	58	67		62	B
Vines Creek	63	60		61	B
Sandy Creek	63	52		57	C
Plane Creek	78	57		68	B
Rocky Dam Creek	56	75		66	B
Carmila Creek	68	95		81	A

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

^ Data used to evaluate the O'Connell River estuary are taken from an end-of-catchment monitoring site within the O'Connell River which is also used to monitor nutrients within freshwater basins.

Water quality index (Section 3.1) grades improved in both Vines and Sandy Creek estuaries to 'good'. Improvement in Sandy Creek was driven by reduced pesticide risk and decreased concentrations of chl-*a*, while Vines Creek recorded improvements in all water quality indicators.

DIN indicator scores (Section 3.1.1) declined in the Gregory for the second consecutive year (although remained 'good'), while both Vines and Sandy Creek recorded improved scores for the second consecutive year ('poor' and 'moderate' respectively).

Chl-*a* indicator scores (Section 3.1.2) improved in both Rocky Dam and Carmila estuaries, reversing a declining trend over the previous years, although both remained 'poor'. The Gregory and Murray/St Helens estuaries recorded their lowest chl-*a* scores since the Report Card's inception ('moderate' and 'poor' respectively).

Pesticides indicator scores (Section 3.1.4) recorded 'high' risk to estuarine species in Sandy Creek, O'Connell River, and Rocky Dam estuaries. Diuron and imidacloprid remained key contributors to pesticide risk throughout the region, and metsulfuron-methyl was a key contributor in Plane Creek Estuary. Other chemicals contributing to increased risk for aquatic species included metolachlor, imazapic, atrazine, and fipronil.

Fish barriers indicator score (Section 3.2.1) decline in the O'Connell Estuary was due to identification of a low passability barrier on Gibson Creek associated with the expansion of a cropping development. Score decline in both Vines Creek and Murray / St Helens estuaries was due to increased barrier density and may be influenced by improved aerial imagery which allowed identification of barriers that potentially existed in previous reporting yet were unable to be distinguished. Remediation of the first barrier upstream from the Sandy Creek Estuary mouth resulted in an improved score.

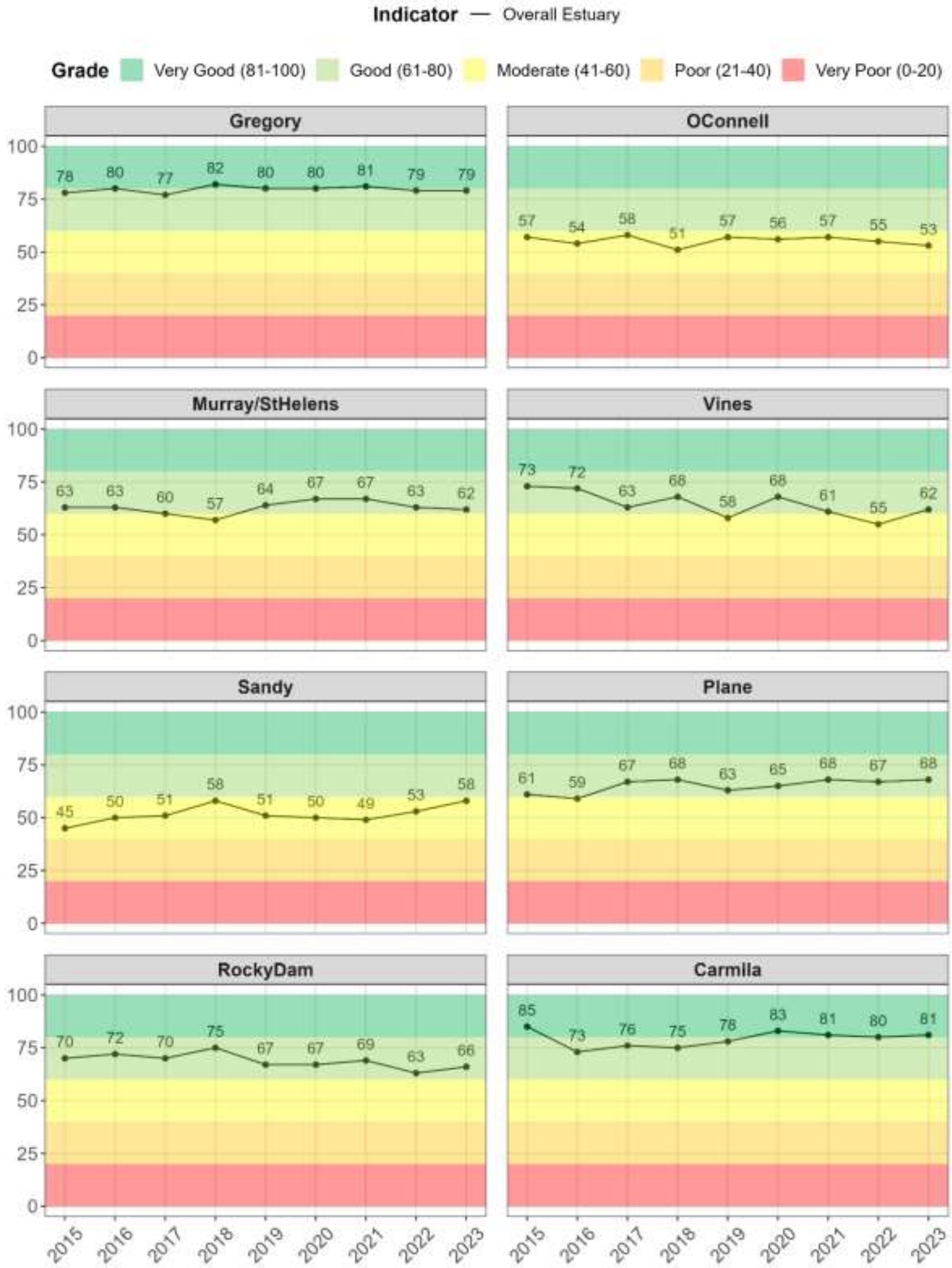

Figure II. Overall condition scores and grades of estuaries for the 2024 Report Card (2022-23 reporting cycle) in comparison to historic scores.

IV. Inshore and Offshore Marine

All inshore marine zone indicators have been updated in the current reporting cycle, as has the offshore marine coral index (Table IV). Offshore water quality is not currently reported as new data sources are being investigated. Overall inshore zone grades remained the same as the previous year, bar Whitsunday Zone, which improved from 'poor' to 'moderate' (Figure III).

Table IV. Overall inshore and offshore marine scores and grades for the 2024 Report Card (2022-23 data). Overall grade for Offshore Zone cannot be calculated due to minimum index requirements.

2024 Report Card						
Marine Zones	**Water Quality**	**Coral**	**Seagrass**	**Fish**	**Total Score and Grade**	
Northern	55	35	73		**54**	**C**
Whitsunday	58	35	30		**41**	**C**
Central	55	48	67		**56**	**C**
Southern	40	21	70		**43**	**C**
Offshore*		66				

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap
* The Offshore Zone cannot be given an overall grade as only the coral index was measured during the 2022–23 reporting cycle; however, coral scores remain for reference.

Water quality index grade (Section 4.1) decline in the Northern and Southern Zones was influenced by increased concentration of chl-*a*. The improved grade in the Whitsunday Zone was influenced by decreased concentrations of nutrients and chl-*a*, and largely due to the incorporation of pesticide monitoring for the first time. Although the time averaged passive polar pesticide results were 'very good' in all inshore marine zones, grab sample results (used only for reference) highlight that spikes in pesticide concentrations have occurred at levels that pose high risks to aquatic species (Appendix 8.4.1.6).

Coral index grades (Section 4.2) remained the same as the previous year. Coral cover in the Whitsunday and Northern Zones have remained 'poor' since TC Debbie, demonstrating limited recovery of these coral communities. Macroalgae cover was the limiting factor in further growth of coral communities in the Southern Zone.

Seagrass index grades (Section 4.3) remained the same in all inshore marine zones. Recovery after impacts from TC Debbie in 2017 appear stable in the Northern Zone, with all condition indicators remaining 'good' or above. Although improvement was recorded at Pioneer Bay coastal meadow, Whitsunday Zone scores continue to be 'poor' overall, and decline was influenced by the reintroduction of subtidal monitoring sites at Cid Harbour and Whitehaven Beach which were graded 'poor' or lower. Meadows in the Southern Zone continued to have a high utilisation by dugongs and turtles, with numerous feeding trails and animal presence detected during surveys.

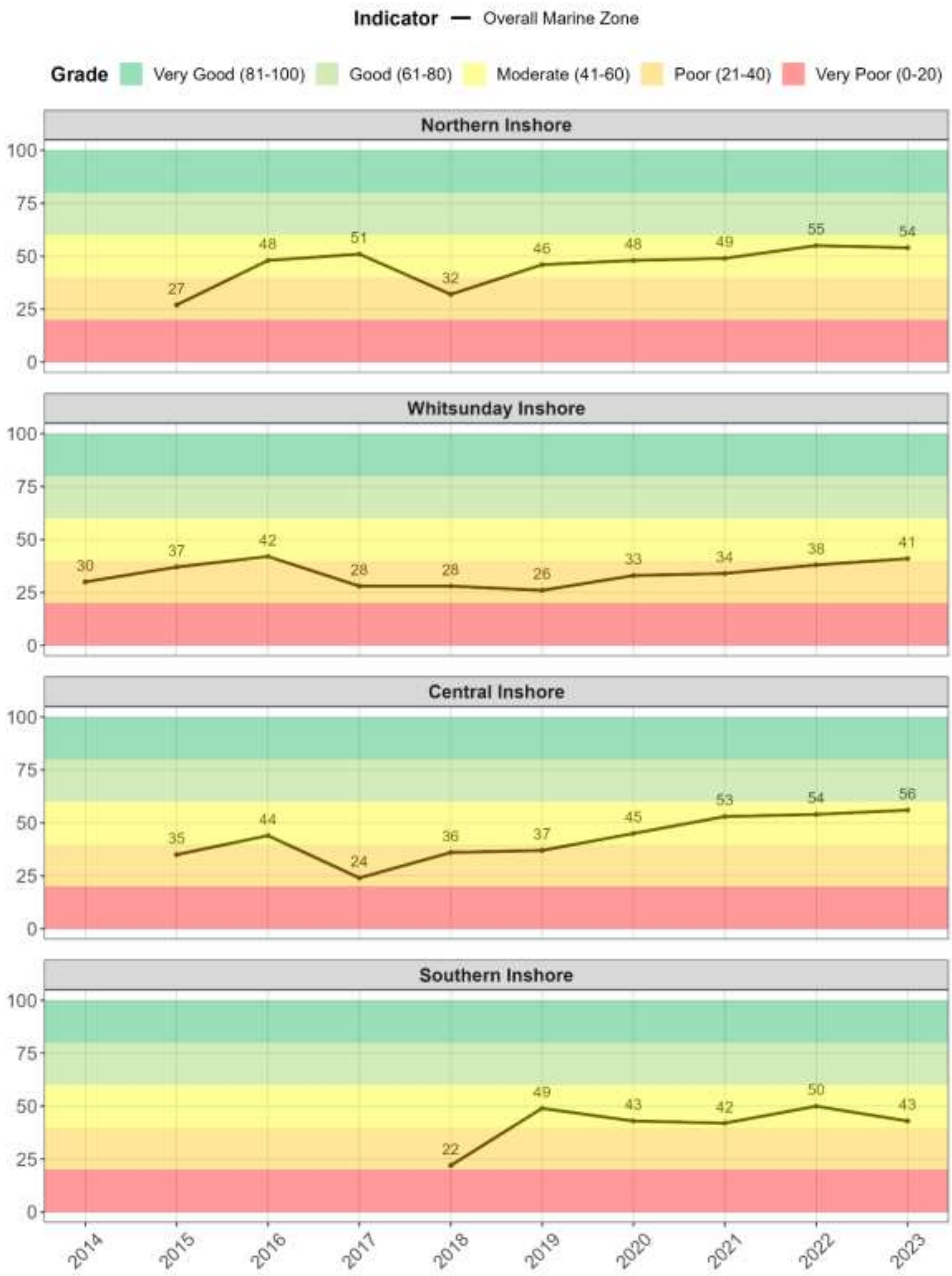

Figure III. Overall inshore marine scores for the 2024 Report Card (2022-23 data) compared to the historic record. Historic scores may differ slightly from past reporting as they have been back-calculated to reflect changes in sites and/or methods for marine indices.

Authorship Statement

The Mackay-Whitsunday-Isaac (MWI) Healthy Rivers to Reef Partnership (the Partnership) 'Mackay-Whitsunday-Isaac 2024 Report Card Results' technical report was compiled by the Partnership's Senior Technical Officer Brie Sherow.

Substantial input was received from the Regional Report Card's Technical Working Group (TWG) members. Some content was also drawn from technical reports from previous MWI Report Cards.

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The Partnership acknowledges the Traditional Owners from the Land and Sea Country of (or within) the region, including the Yuwibara, Koinmerburra, Barada, Widi, Ngaro, Gia and Juru Peoples, and pays respect to the ancestors, the Elders both past and present, and to the people.

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Terms and Acronyms

AIMS	Australian Institute of Marine Science
AMDI	Australian Marine Debris Initiative
Average	A calculated central value of a set of numbers measured by adding up all values and dividing by the number of values included.
Basin	An area of land where surface water runs into smaller channels, creeks, or rivers and discharges into a common point and may include many sub-basins or sub-catchments. Also known as river basin or catchment.
Best management practice	Best management practices articulate a reasonable best practice level that can be expected to result in a moderate–low risk to water quality.
Biodiversity	The variability among living organisms from all sources. It includes diversity within species and between species and the diversity of ecosystems.
Biomass	The total quantity or weight of organisms over a given area or volume.
BoM	Bureau of Meteorology
Chl-*a*	Chlorophyll-*a*: A measure of overall phytoplankton biomass. It is widely considered a useful proxy for measuring nutrient availability and the productivity of a system.
CTF	Cease-to-flow
CV	Coefficient of variation
DDL	Declared Downstream Limit
DEHP	Department of Environment and Heritage Protection, Queensland. Now part of DESI.
DESI	Department of Environment, Science, and Innovation Queensland
DHW	Degree Heating Weeks (DHW) are an accumulated measurement of sea surface temperature (SST) that assesses the instantaneous bleaching heat stress during the prior 12-week period. Significant coral bleaching usually occurs when the DHW value reaches 4 °C-weeks. By the time the DHW value reaches 8 °C-weeks, severe, widespread bleaching and significant mortality are likely. Source: Coral Reef Watch, National Oceanic and Atmospheric Administration (CRW, NOAA)[1]
DIN	Dissolved inorganic nitrogen
DO	Dissolved oxygen
Driver	An overarching cause of change in the environment.
Ecosystem	A dynamic complex of plant, animal, and microorganism communities and their non-living environment interacting as a functional unit.
Ecosystem health	"An ecological system is healthy and free from 'distress syndrome' if it is stable and sustainable—that is, if it is active and maintains its organization and autonomy over time and is resilient to stress.

[1] https://coralreefwatch.noaa.gov/product/50km/index.php

	Ecosystem health is thus closely linked to the idea of sustainability, which is seen to be a comprehensive, multiscale, dynamic measure of system resilience, organization, and vigour." (Costanza, 1992)
EC	An enclosed coastal (EC) water body includes shallow, enclosed waters near an estuary mouth and extends seaward towards deeper, more oceanic waters further out. The seaward cut-off off an EC water body is defined by the Great Barrier Reef Marine Park Authority (GBRMPA, 2010).
Estuary	The aquatic environment at the interface between freshwater and marine ecosystems.
Fish (as an index)	The fish community index, measured by two indicators (the number of indigenous and non-indigenous fish, respectively), is evaluated and included in the ecosystem health assessment (coasters) for basins. Inclusion in the Report Card will contribute to an understanding of the local fish communities.
Fish Barriers (as an indicator)	Fish barriers relate to any man-made barriers that prevent or delay connectivity between key habitats that have 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.
FRP	Filterable reactive phosphorus
GBR	Great Barrier Reef
GBRCLMP	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—Limits that are defined by experts in their respective fields used to gauge the condition of an indicator/site. If grades/scores exceed guideline values, this signifies that changes impacting ecosystem health have occurred at a level beyond naturally occurring processes.
Impoundment (also impoundment length)	An indicator used in the 'in-stream habitat modification' indicator for freshwater basins in the region. This index reports on the proportion (%) of the linear length of the main river channel inundated at the Full Supply Level of artificial in-stream structures, such as dams and weirs.
Index	Is generated by indicator categories (e.g., water quality is an index 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., nutrients made up of particulate nitrogen and particulate phosphorus).
Inshore (as a reporting zone)	Inshore is a reporting zone in the Mackay-Whitsunday-Isaac Report Card that includes enclosed coastal, open coastal, and mid-shelf waters.
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.
ISP	Independent Science Panel established under the Reef Water Quality Protection Plan (now Reef 2050 Water Quality Improvement Plan), who have independently reviewed the methodologies involved in the report card assessments.
LOR	Limit of reporting
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. Increased macroalgae on a coral reef is often undesirable, indicating reef degradation (Diaz-Pulido & McCook, 2008).
Mean	The average or 'central' value of a set of numbers.
Measure	A measured value that contributes to an indicator score for indicators that consist of multiple measures (e.g., flow, estuary fish barriers).
Median	The middle value out of a defined list of values.
MMP	Great Barrier Reef Marine Monitoring Program. This provides water quality, coral, and seagrass data for the Central and Whitsunday inshore zones in the Report Card.
MoA	The mode of action is used to classify pesticides according to how they exert their effect on the target organism. The mode of action will be defined by its biochemical effects.
MWI	Mackay-Whitsunday-Isaac
MWQ	Marine water quality (MWQ) dashboard and data—Bureau of Meteorology.
NOx	Oxidised nitrogen (nitrate and nitrite)
NQBP	North Queensland Bulk Ports Corporation Ltd
Offshore Zone	Offshore is a reporting zone in the Mackay-Whitsunday-Isaac Report Card that includes mid-shelf and offshore water bodies.
Offshore (water body)	Offshore water bodies begin 60 km from the enclosed coastal boundary and extend to 280 km in the Mackay-Whitsunday-Isaac Region (GBRMPA, 2010).

OGBR&WH	Office of the Great Barrier Reef & World Heritage
Overall Score	The overall scores for each reporting zone used in the Report Card are generated by an index or an aggregation of indices.
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 (PRM)	Refers to the methodology for estimation of ecological risk associated with pesticide pollution.
Phys–chem	The physical–chemical indicator category that includes the indicators dissolved oxygen (DO) and turbidity.
PN	Particulate nitrogen
PONSE	Proportion of native (fish) species expected
Ports	NQBP Port Authority
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 (Nelder 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[2].
PSII herbicides	Herbicides that inhibit Photosystem II, an essential component of a plant’s ability to absorb and transfer light energy. These include ametryn, atrazine, diuron, hexazinone, tebuthiuron, bromacil, fluometuron, metribuzin, prometryn, propazine, simazine, terbuthylazine, and 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.
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 GBRCLMP); the Department of Regional Development, Manufacturing and Water (includes management of water monitoring); and the Department of Resources (includes management of Queensland Spatial).
QPSMP	Queensland Ports Seagrass Monitoring Program

[2] Queensland Government 2016. Water Plan (Wet Tropics) 2013. Water Act 2000. https://www.legislation.qld.gov.au/view/pdf/2016-12-06/sl-2013-0282

RCA	Reef Check Australia
RE	Regional ecosystem
REMP	Receiving Environment Monitoring Program
Resilience (as an indicator)	A multivariate metric developed by the MMP to measure the capacity of seagrass to cope with disturbances (Collier et al., 2021). The resilience metric better accommodates differences in recovery strategies between species in comparison to previous indicators.
Riparian extent (as an indicator)	An indicator used in the assessments of both basin and estuarine zones in the Mackay-Whitsunday-Isaac Report Cards. This indicator uses mapping resources to determine the extent of the vegetated interface between land and waterways in the region.
Secchi	Secchi depth (m)—a measure of water clarity determined as the depth at which an opaque disc lowered into a water column is no longer visible.
SF	Scaling factor—A value used to set scoring range limits for indicators.
SST	Sea surface temperature
Standardised condition score	The transformation of indicator scores into the MWI Report Card scoring range of 0 to 100.
TC	Tropical Cyclone
TSS	Total suspended solids
TWG	Technical Working Group
Waterway	All freshwater, estuarine, and marine bodies of water, including reefs, and storm drains, channels, and other human-made structures in the MWI Region.
Water quality guideline	For the purposes of waterway assessment, the term water quality guideline refers to values for the condition assessment of water quality drawn from a range of sources, including water quality objectives scheduled under the Environmental Protection (Water) Policy 2009 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 the condition assessment of water quality scheduled under the Environmental Protection (Water) Policy 2009.

1 Introduction

1.1 Purpose of this document

This document provides technical results to support the 2024 Mackay-Whitsunday-Isaac (MWI) Report Card on waterway health. The results provided in this document relate to the condition of environmental indicators across freshwater, estuarine, and marine environments (Figure 1).

Figure 1. The MWI Healthy Rivers to Reef Partnership reporting region, showing marine zones, freshwater basins, and monitored rivers.

This document presents scores and grades based on data collected between 1st July 2022 and 30th June 2023 combined with repeat data for indicators that are updated less frequently. The condition assessments for environmental indicators are presented as numerical scores and compared to historic results. Confidence levels are presented alongside results. Refer to the Mackay-Whitsunday-Isaac 2024 Report Card Methods (MWI HR2RP, 2024) for sampling and scoring methodology. When appropriate, previous results back-calculated using updated methods are presented for reference. Additional information associated with 2024 Report Card results are contained in appendices.

1.2 Background

The MWI Healthy Rivers to Reef Partnership (the Partnership) was established in October 2014, with the primary focus of producing an annual report card on the health of the region's waterways. The 2024 Report Card aggregates condition assessments from sampling sites within the freshwater, estuarine, and marine ecosystems in the reporting region (Figure 2). Human Dimensions such as Urban Water Stewardship and Cultural Heritage assessments have also been included. For each index, a series of indicators grouped into indicator categories are used to provide a holistic assessment of these environmental, social, cultural, and economic factors.

The 2017–2022 Program Design[3] outlines the guiding framework for the development and scope of the 2024 Report Card. Since the publication of the Program Design in 2018, changes to the monitoring sites and methods have occurred and are highlighted where relevant. For more detail, refer to the Methods Report (MWI HR2RP, 2024) and the MWI Report Card Program Design 2017 to 2022. The Program Design is currently being updated by Technical Officers in the Regional Report Card network and members of the TWG. Anticipated outputs of the program design review, occurring through 2025, include:

1. consolidated methods documentation (where possible), to deliver consistency of methods between the Northern 3 Regional Report Cards (RRCs);
2. stream-lined technical reports providing overviews of climate, score and grade tables, trends, and key messages;
3. an outline of the framework that was established in previous Report Cards alongside a plan to improve the Report Cards over the upcoming timeframe;
4. and consolidated priority for ongoing research and development of the RRCs.

[3] https://healthyriverstoreef.org.au/wp-content/uploads/2018/12/mackay-whitsunday-report-card-program-design-2017-2022.pdf

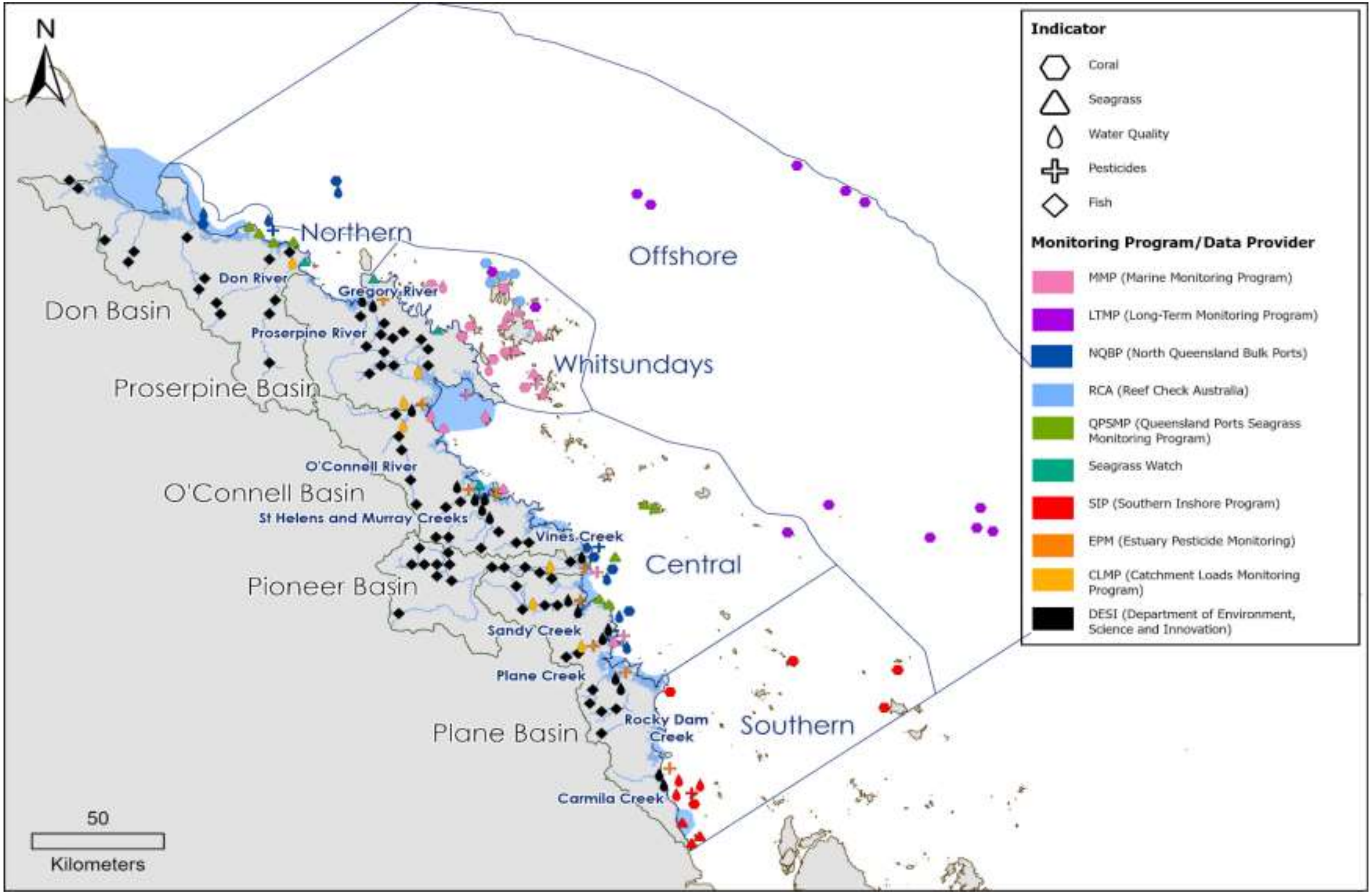


Figure 2. Mackay-Whitsunday-Isaac sampling sites showing sampling sites within freshwater basins, estuarine, inshore (designated by the local or state jurisdictional boundary), and offshore marine zones (designated by the eastern boundary of the Great Barrier Reef Marine Park).

1.3 Terminology

The Report Card assesses environmental indicators to report on the overall condition of MWI waterways. Scores for indicators are aggregated into indicator categories and typically follow three key themes: water quality, habitat, and taxa.

In the Report Card, overall scores and grades for indices are represented in the format of a coaster (Figure 3). An **indicator** is a measured value (e.g., particulate nitrogen concentration). **Indicator categories** (e.g., nutrients) are generated by one or more indicators. **Index/indices** (e.g., water quality) are generated by the aggregation of indicator categories. **Grades** are generated by the aggregation of indices or by a single index score.

Figure 3. Terminology used for defining the level of aggregation of indicators and how they are displayed in coasters in the Report Card.

Ordinal categories are used to describe the scores for condition of indicators, indicator categories and the overall score. This follows a five-point grading system from 'very good' (A) to 'very poor' (E) (Table 1). Indicators have specific scoring ranges and bandwidths, which are listed below the relevant results tables. Results for indicators that have divergent scoring ranges and bandwidths are required to be translated into a common scoring range before aggregation (based on that used by the Great Barrier Reef Water Quality Report Card (Table 1).

Table 1. Overall range of scores and grades within the Report Card

Scoring Range	Condition Grade and Colour Code
81 to 100	A = Very Good
61 to <81	B = Good
41 to <61	C = Moderate
21 to <41	D = Poor
0 to <21	E = Very Poor

1.4 Regional Setting

1.4.1 Drivers of Condition Assessments

Climate, population, and the economy are the key external forces that influence the condition of waterways in the Mackay-Whitsunday-Isaac (MWI) Region, either directly or by driving activities that put pressure on local waterways (Figure 4).[4] Terrestrial activities can put pressure on aquatic environments due to the transportation of sediments, nutrients, pesticides and other contaminants via surface water runoff. Increased loads of these pollutants are then received by coastal waters through river discharge offshore waters. Additional pressures that can impact the region's marine ecosystems include ports and marinas, shipping, fishing, tourism, and recreational activities.

Figure 4. Conceptual diagram of the key drivers, pressures, and ecosystems in the MWI Region.

The MWI reporting region includes the Don, Proserpine, O'Connell, Pioneer, and Plane basins, and is made up of 33 sub-catchments that flow into eight receiving waters, from Upstart Bay in the north to Flaggy Rock Creek in the south. Land use in the region is dominated by agricultural activities (including sugarcane, grazing and horticulture), and activities such as mining and urban development (Figure 5).

[4] https://healthyriverstoreef.org.au/our-region/pressures/

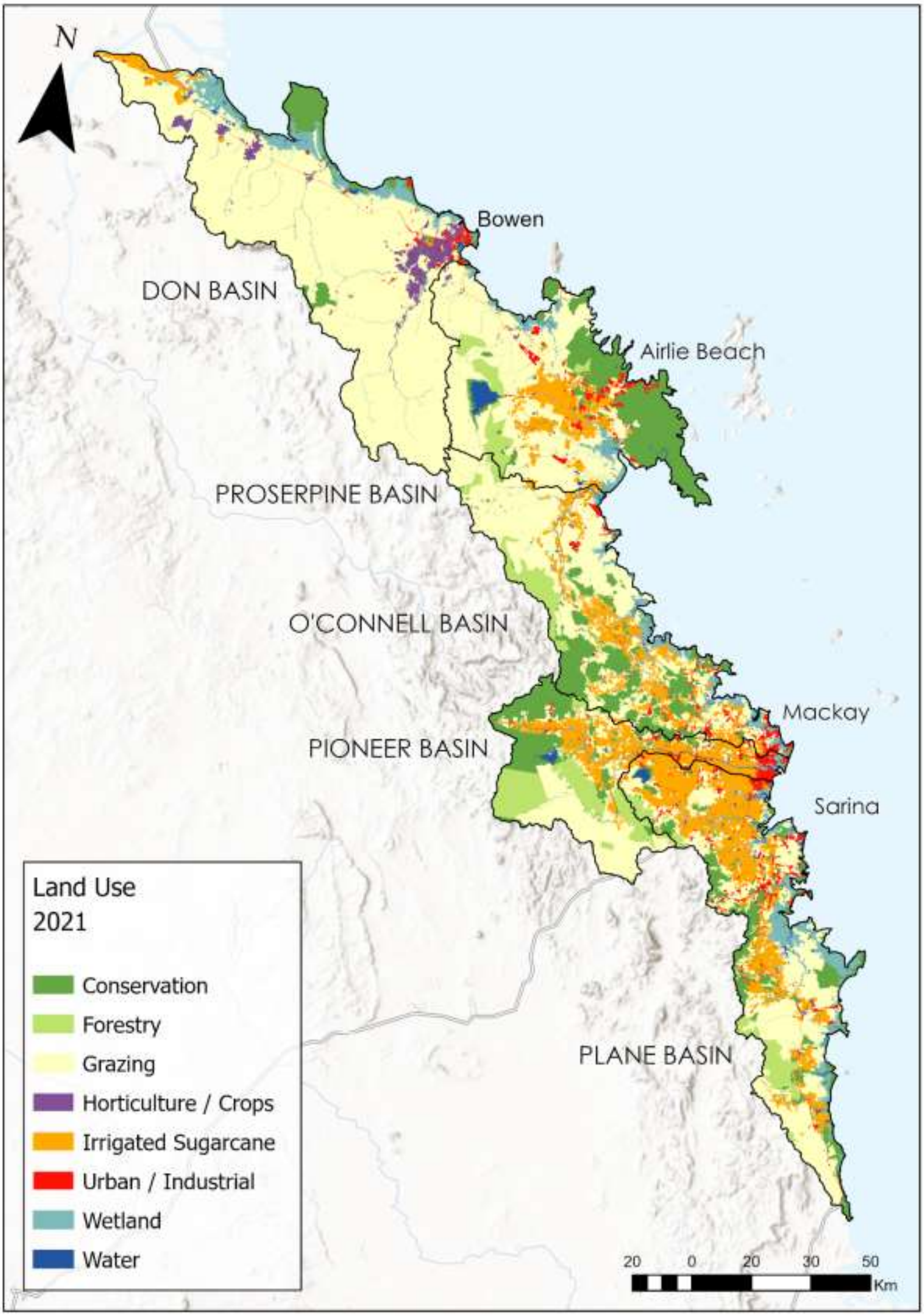


Figure 5. Land use in the MWI reporting region. Source: Australian Land Use and Management Classification V8 (2016), spatial data last updated 2021.

1.4.2 Regional Climate

Geographically, the MWI region is situated in North Queensland, north of the Tropic of Capricorn and typified by a tropical to subtropical climate. Regional climate is characterised by two distinct seasons: wet (November to April) and dry (May to October). During the wet season, the region may experience elevated rainfall, tropical lows, and Tropical Cyclones (TCs). TCs may generate considerable rainfall and flooding in addition to increased sediment resuspension in the marine environment. Predominant trade winds create a similar but smaller-scale effect (particularly in the Don Basin), and dry season south easterly trade winds result in increased wave action on nearshore benthos leading to larger volumes of sediment resuspension.

Annual shifts in weather patterns influence the frequency and severity of environmental events (e.g. drought, bushfires, and floods) within natural ecosystems and modified environments. Climate variability can dictate how land management activities evolve within and between seasons, and weather events often influence scores of environmental indicators. Recent events within the MWI region include below average rainfall between 2019–2022, marine heat waves in 2020 and 2022, and the residual impacts of TC Debbie in March 2017.

1.4.3 Temperature

Since records began in 1910, Australia's climate has warmed by 1.44°C (±0.24°C) with every decade since 1950 warmer than the one before. 'Very high' monthly maximum temperatures now occur six times as often as they did in 1960.[5] This is reflected locally, with the Mackay weather station recording annual maximum temperature (°C) anomalies that have been above zero (unusually warm) almost every year since the 1980s—a stark change to the 70 years prior (Figure 6).

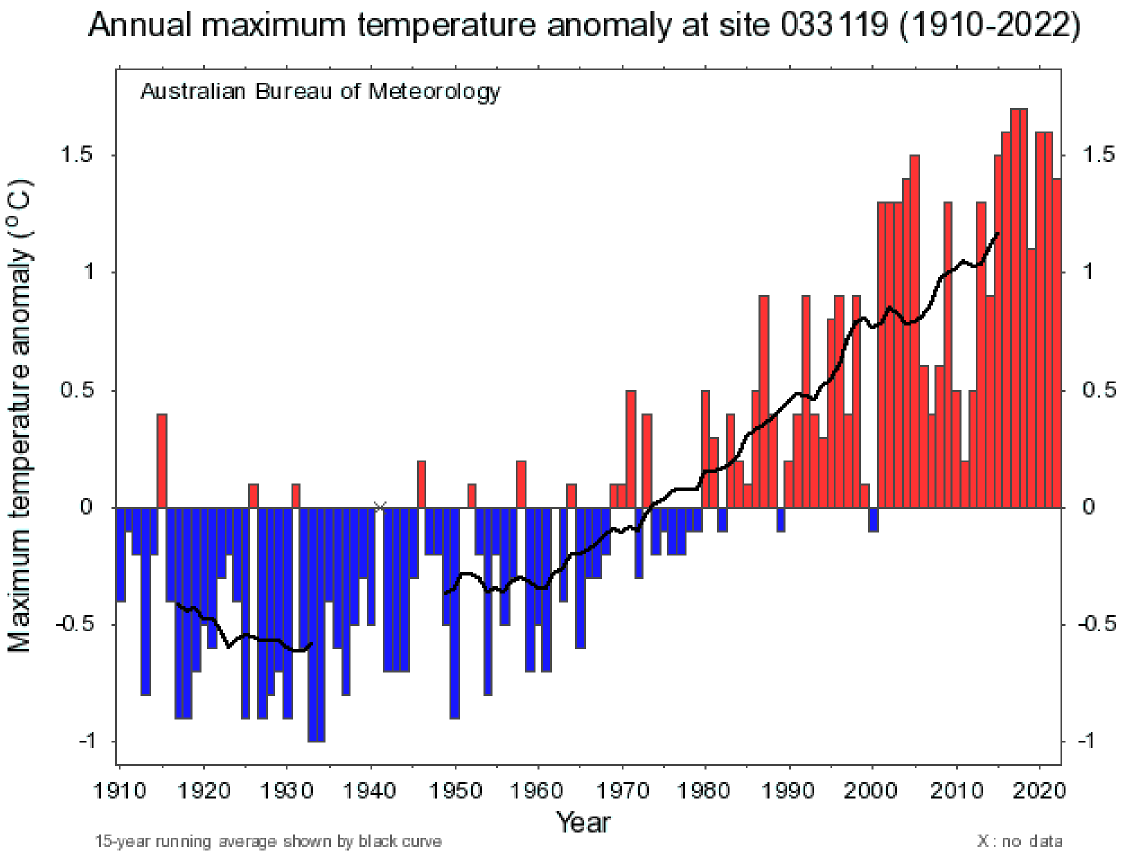


Figure 6. Annual maximum temperature (˚C) anomaly at Mackay (site 033119) from 1910 to 2022. A rolling fifteen-year average is shown by the black line. Source: Bureau of Meteorology, Australia climate change site data (http://www.bom.gov.au/climate/change/hqsites/).

All basins in the Mackay-Whitsunday-Isaac region experienced annual air temperatures that were 'above average', and the Don Basin recorded annual air temperatures that were in the 90th percentile of long-term annual average temperatures since 1910 (Table 2). These temperature anomalies were up to 0.8 °C above the long-term mean (Figure 7).

[5] http://www.bom.gov.au/state-of-the-climate/australias-changing-climate.shtml

Table 2. Monthly temperature percentiles and annual average percentiles for basin areas of the Mackay-Whitsunday-Isaac Region for 2022–23 compared to a long-term mean based on historical temperature records from 1910 to 2023. Data source: Bureau of Meteorology.

Basin	2022						2023						Annual average
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Don	Very much below average	Average	Very much above average	Very much above average	Above average	Below average	Average	Average	Very much above average	Highest 1%	Below average	Highest 1%	Very much above average
Proserpine	Very much below average	Average	Very much above average	Very much above average	Above average	Below average	Below average	Above average	Very much above average	Very much above average	Very much below average	Highest 1%	Above average
O'Connell	Very much below average	Average	Above average	Very much above average	Above average	Below average	Below average	Above average	Very much above average	Very much above average	Very much below average	Highest 1%	Above average
Pioneer	Very much below average	Average	Above average	Above average	Average	Below average	Below average	Above average	Very much above average	Very much above average	Very much below average	Highest 1%	Above average
Plane	Very much below average	Average	Above average	Above average	Average	Below average	Very much below average	Above average	Very much above average	Very much above average	Very much below average	Highest 1%	Above average

Air temperature percentile categories

≤ 1	> 1 – < 10	10 – < 30	30 – < 70	70 – < 90	90 – < 99	≥ 99
Lowest 1%	Very much below average	Below average	Average	Above average	Very much above average	Highest 1%

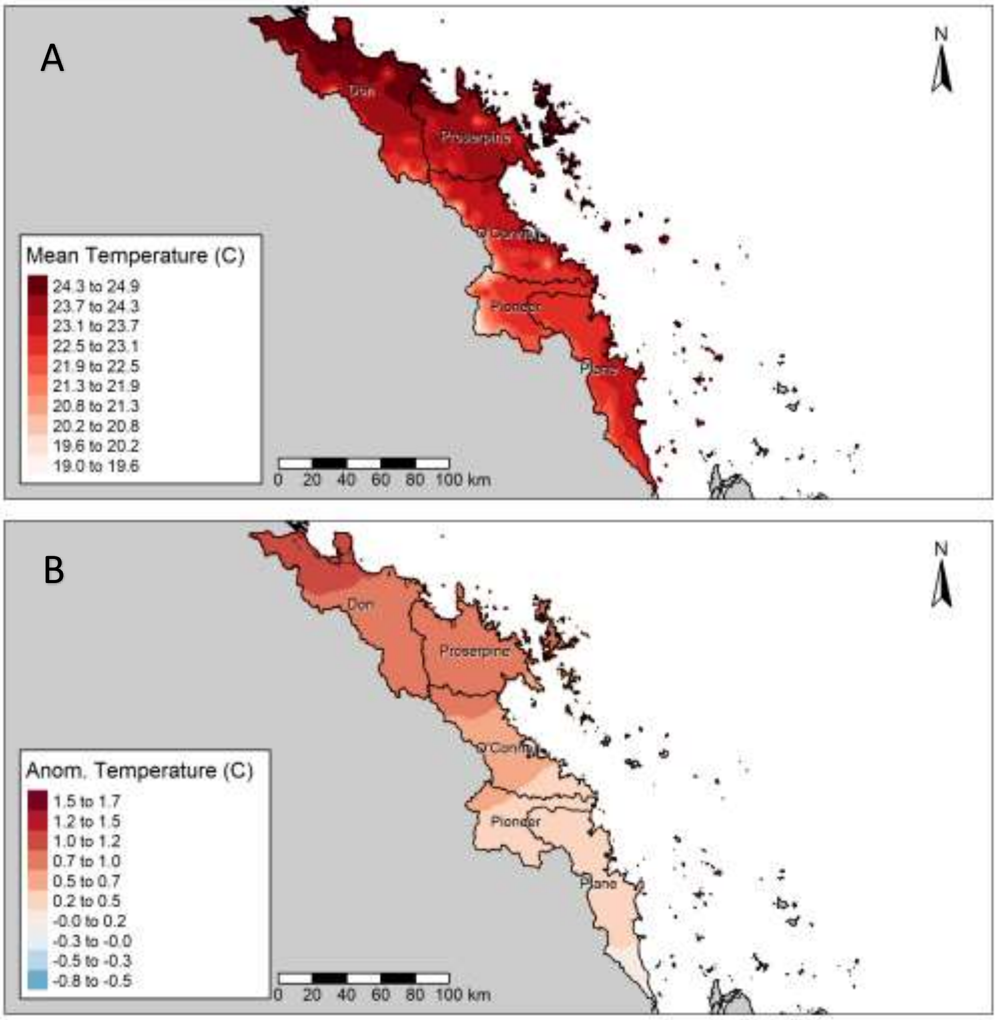


Figure 7. Air temperature in Mackay-Whitsunday-Isaac. A) Mean annual temperature in the MWI region in 2022-23. Annual temperature was derived by taking the mean of monthly averages calculated across spatial grid subsets of each basin. The long-term mean was calculated from the oldest 30-year record (1911-1940). The scale is derived from actual air temperatures recorded across the region. B) Difference in degrees Celsius of 2022-23 temperatures from a long-term mean based on historical temperature records from 1911 to 1940. The scale is derived from the absolute min and max anomaly values recorded within the 30-year reference period. Data source: Bureau of Meteorology (BOM).

1.4.4 Rainfall

Australian rainfall for the 2022–23 period was 32% above the 1961–90 climatological averaging period, wetter than the previous two years (~10% above), and a departure from the preceding drier than average periods between 2017-2021). La Niña was established in September for the third year in a row, peaking in November and easing in early 2023.[6] Annual rainfall in the Mackay-Whitsunday-Isaac (MWI) Region ranged from 900 to 2,500 mm, with rainfall anomalies ranging from 200 mm below the long-term average in parts of the Plane and Pioneer Basin to 600 mm above in parts of the O'Connell and Proserpine Basins (Figure 8). The intensity of rainfall events has increased, causing a higher risk of flash flooding that can impact agricultural and urban communities and natural ecosystems.[6]

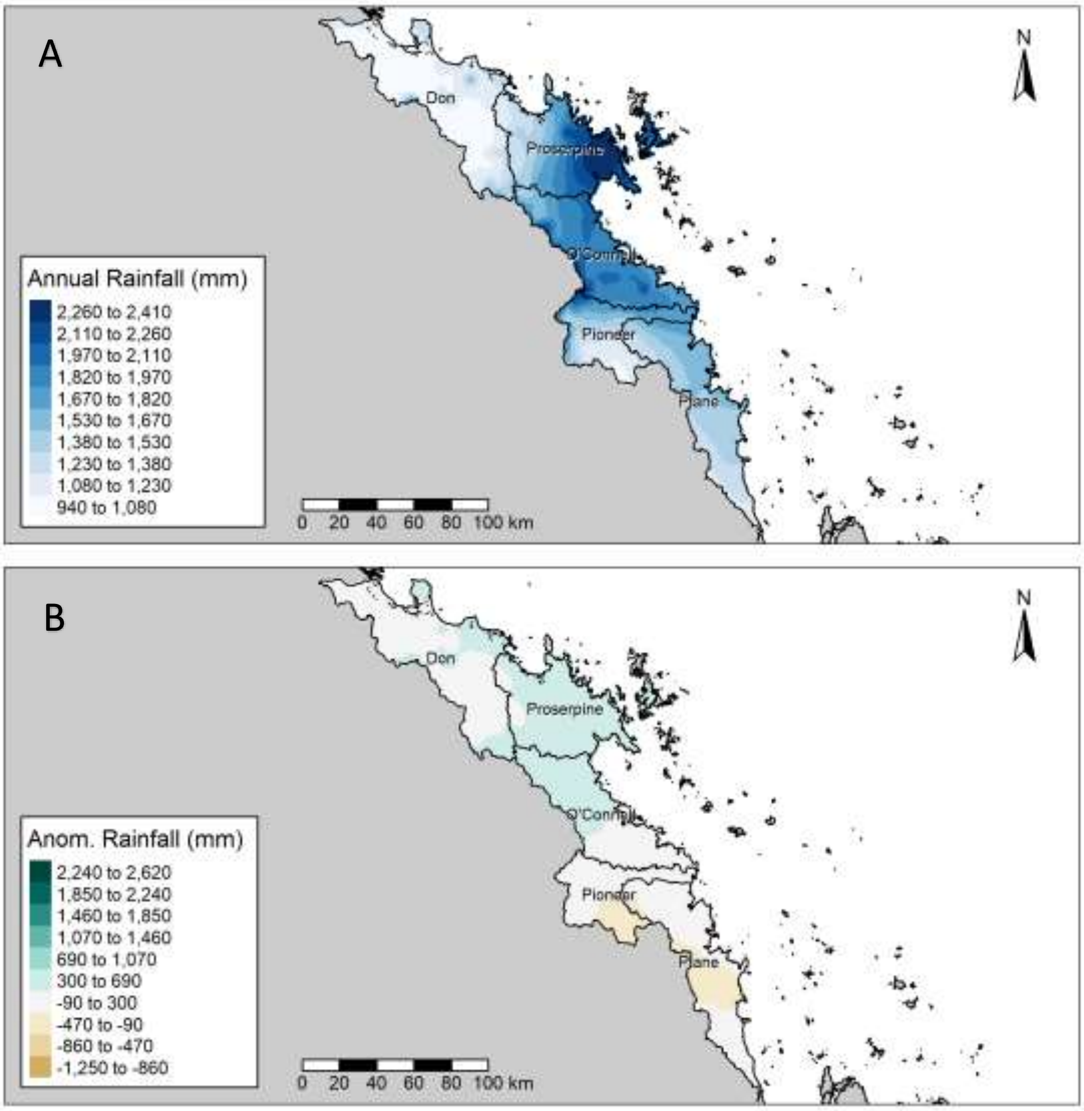


Figure 8. Rainfall in Mackay-Whitsunday-Isaac. A) Annual rainfall in the MWI region in 2022-23. Annual rainfall was derived by summing monthly averages calculated across spatial grid sub-sets of each basin. The scale is based on rainfall recorded across the MWI region during the current reporting period. B) Anomaly of annual rainfall (mm) in 2022-23 from the long-term mean (calculated from historical rainfall records from 1991 to 2020). Data source: Australian Water Outlook (https://awo.bom.gov.au/).

[6] http://www.bom.gov.au/climate/current/financial-year/aus/summary.shtml

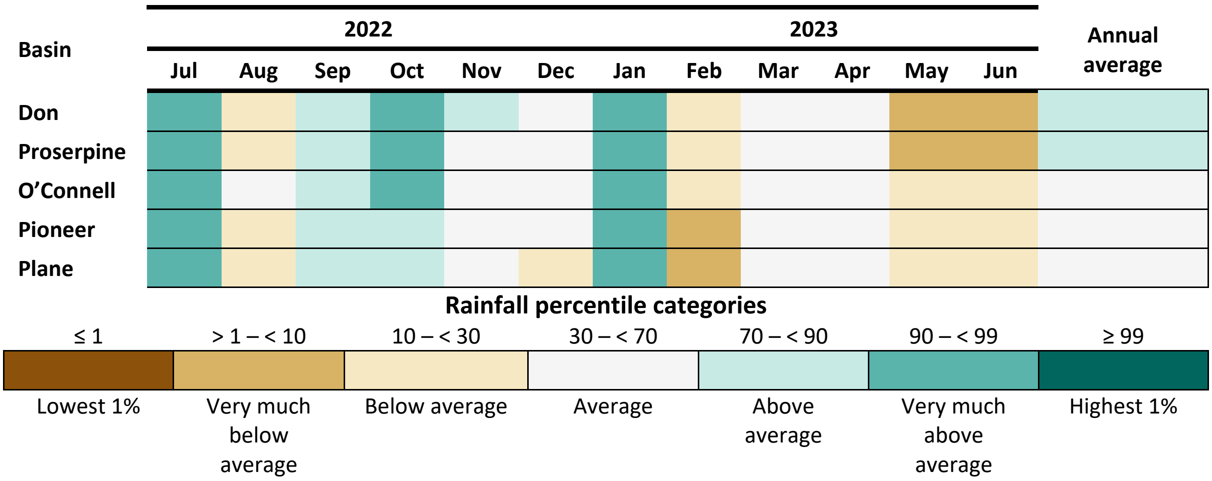
The Don Basin has consistently been the driest of the MWI basins since 1911, with a long-term mean of 910 mm compared to ~1500 mm for the other basins (Table 3). In the last ten years, the Plane Basin recorded nine years of annual rainfall below this mean, with the other four basins recording seven out of the past ten years below the long-term mean (Appendix 8.1). All basins bar Plane had higher annual rainfall in 2022–23 than the long-term mean (Table 3), with higher annual rainfall during the 2022–23 reporting year compared to the previous year (Appendix 8.1).

Table 3. Annual rainfall statistics for basins in the Mackay-Whitsunday-Isaac region during 2022-23.

Basin	Annual mean rainfall (mm)	Long-term mean (mm)	Anomaly (mm) (+/- long-term mean	Percentage (%) of long-term mean
Don	1101	910	191	121%
Proserpine	1811	1428	383	127%
O'Connell	1887	1571	316	120%
Pioneer	1467	1458	8.78	100%
Plane	1441	1488	-48	97%

Annual rainfall patterns obscure the variation in rainfall observed throughout the year, with monthly rainfall ranging from ‘very much above average’ to ‘very much below average’ (Table 4). Rainfall was high across the region in July 2022 and January 2023, as was the case for most of the state, resulting in the wettest monthly rainfall on record since 2016[7] and 2010[8] respectively. These wetter than average months were both followed by drier than average conditions in August 2022 and February 2023 respectively (Table 4). Both May and June of 2023 recorded below average rainfall in all basins (Table 4), a pattern that was seen across the state.[9]

Table 4. Monthly rainfall percentiles and annual average percentiles for basin areas for the Mackay-Whitsunday-Isaac Region for 2022–23. Data source: Australian Water Outlook (https://awo.bom.gov.au/).



[7] https://www.bom.gov.au/climate/current/month/qld/archive/202207.summary.shtml
[8] https://www.bom.gov.au/climate/current/month/qld/archive/202301.summary.shtml
[9] https://www.bom.gov.au/climate/current/month/qld/archive/202306.summary.shtml

Due to the high rainfall across the MWI region for 2022–23, discharges measured at gauging stations across the region were generally higher than the long-term mean annual discharge, the exception being Dumbleton Weir in the Pioneer Basin (Figure 9). In contrast, the rainfall for the previous reporting year was lower across the MWI region, and discharges were lower than the long-term mean annual discharge. Freshwater flow can impact ecosystem condition scores across freshwater, estuarine, and marine zones. Overall trends show declines in annual streamflow across the country, with over half of Australia's reference stations showing declining trends due to the impacts of climate change.[10] In Queensland, climate change is predicted to influence increases in temperatures and intensity and frequency of rainfall events and other extreme weather conditions.[11]

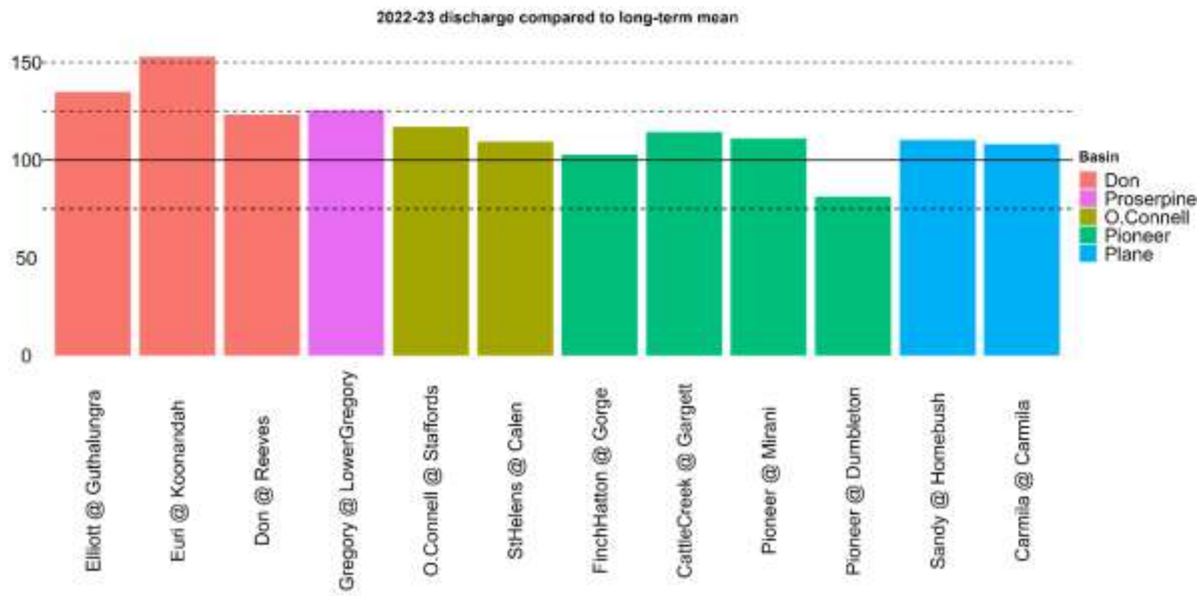


Figure 9. Proportion of 2022–23 discharge recorded from gauging stations at major river channels in Mackay-Whitsunday-Isaac Region compared to the long-term mean. The x axis represents sites where discharge is measured, the y-axis represents the percentage of the long-term mean discharge. The long-term mean is represented by a solid black horizontal line, while dashed lines represent 75%, 125%, and 150% of long-term mean. Long-term mean annual discharge is based on historical gauging station records until present; the number of years included varies according to station. Source: Queensland Government (water-monitoring.information.qld.gov.au).

1.4.5 Agricultural Context

Over 90% of cane plantings were delayed until late August to early October due to wet conditions in March – May 2022. Consequently, a high proportion of plant cane fertiliser was applied after November, and a high proportion of spray applications were applied after December and into early 2023. Use of imidacloprid, an insecticide used for grub control and commonly applied at the same time as granular fertiliser, increased from October as soil conditions improved. Rain increased throughout November, triggering first flush events throughout most of the region, bar Pioneer which occurred early December. Weed growth caused increased spraying of PSII herbicides (e.g. Diuron), and increased rain pushed harvest behind schedule, which caused a higher percentage of blocks to be sprayed and fertilised after November. This coincided with pesticide detections above ecosystem

[10] https://www.bom.gov.au/state-of-the-climate/australias-changing-climate.shtml
[11] https://www.qld.gov.au/__data/assets/pdf_file/0023/68126/queensland-climate-change-impact-summary.pdf

guidelines in Proserpine, O'Connell, and Sandy Creek sites in early to mid-November. (P. Trendell, pers. comm. 13/03/24).

Early December 2022 had high rainfall occurring during a late crush as growers worked to finish fertiliser and insecticide applications. Ideally cane crush would finish in November, however during the 2022-23 season it did not finish until mid-January (7^{th} – 13^{th}) 2023 across the three milling areas, and extreme weather directly following the crush caused run-off events and restricted access to blocks during the week following crush. The herbicide Metolachlor was detected in December and January, reflecting the late season and spray applications closer to wet season than usual. Furthermore, ratoons had grub control (imidacloprid) and fertiliser (including mill mud) applied in December and January and increases in products such as Diuron were detected despite the no-spray window during this period (P. Trendell, pers. comm. 13/03/24).

Diuron and imidacloprid were detected above ecosystem guidelines in March and April, suggesting applications in February and March. These detections reflect the delays in application due to the late finish for harvest, and increased pressure from weed growth (P. Trendell, pers. comm. 13/03/24).

1.4.6 Marine Climate

In Australian waters, the average sea surface temperature (SST) has risen by more than 1° C since 1900[12] and eight of the ten warmest years on record have occurred since 2010 (Appendix 8.1.6). Consequently, marine heatwaves (defined by temperatures in the upper range of historical baseline conditions for 5+ days) have increased in frequency and duration. Marine heatwaves can cause permanent damage to marine ecosystems; including the depletion of seagrass meadows, higher occurrences of disease and wide-spread coral bleaching, and a reduction in coral resilience.[15]

Climate change is the most significant threat affecting the health of the Great Barrier Reef (GBR), impacting this ecosystem through several cumulative impacts (GBRMPA, 2019). Perhaps the greatest threat among these is the increase in atmospheric temperature, with more extremely hot days and fewer extremely cold days. There will likely be an increased frequency of high intensity, short-duration rainfall events, impacting stream flow and erosion.[13] Storm events are predicted to decline in frequency but increase in intensity, which is likely to have major consequences for coastal communities and ecosystems when combined with sea level rise. Marine heatwaves will become more frequent and intense, becoming larger in their spatial and temporal scales. Ocean acidification is also predicted to worsen with rising CO_2 levels, putting increased pressure on coral populations that are already under significant stress.[14]

1.4.6.1 Coral Bleaching

Heat stress in coral is a measure of the duration of time in which the temperature exceeds the long-term mean maximum, with four Degree Heating Weeks (DHW) likely to cause significant coral bleaching.[15] The marine heatwave of 2022, which peaked in March, resulted in the first mass bleaching event to occur during a La Niña year.[16] Despite this fourth bleaching event since 2016, the combination of lower accumulated heat stress and few acute stresses (e.g., TCs) resulted in low coral mortality and continued recovery.[17] In the MWI marine zones, 2023 was primarily low risk for marine heat waves throughout the region (Figure 10). Full recovery and future health of coral depends on continued lack of disturbances, and it is important to continue monitoring these habitats. While heat stress is particularly damaging for corals, it can also have major impacts on seagrass meadows and other organisms on the GBR.

[12] https://www.bom.gov.au/state-of-the-climate/oceans.shtml
[13] https://www.bom.gov.au/state-of-the-climate/future-climate.shtml
[14] https://www.bom.gov.au/state-of-the-climate/australias-changing-climate.shtml
[15] https://coralreefwatch.noaa.gov/satellite/education/tutorial/crw24_dhw_product.php
[16] https://www.bom.gov.au/state-of-the-climate/oceans.shtml
[17] https://www.aims.gov.au/monitoring-great-barrier-reef/gbr-condition-summary-2021-22

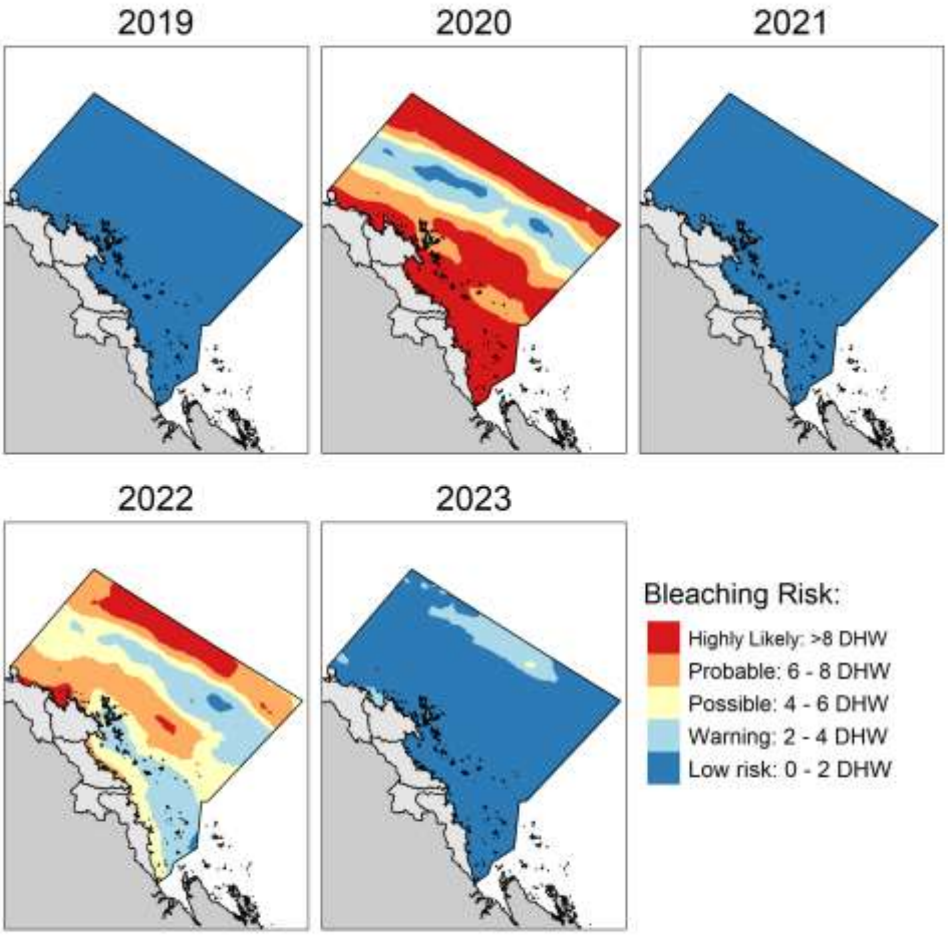


Figure 10. Degree heating weeks (DHW) for the MWI Region from 2019 to 2023. This is a measure of heat stress accumulation over the past 12 weeks by summing SSTs exceeding 1°C above the long-term mean maximum temperature. Source: NOAA coral reef watch.

1.4.6.2 Tropical Cyclones

Tropical cyclone (TC) systems in the region develop from tropical lows, typically between November and April. There were no significant storm events recorded in the Mackay-Whitsunday-Isaac region during 2022–2023.[18] Current climate trends show a decline in the number of TCs across Australia since 1982, however, it has been predicted that the intensity of storms will increase.[19]

TC Debbie made landfall near Airlie Beach on Queensland's Whitsunday Coast on Tuesday, 28th March 2017 after crossing the Whitsunday Islands as a large and powerful category 4 storm system.[20] Flow-on effects arising from TC Debbie in 2017 continue to impact some ecosystems, particularly evident in coral and seagrass condition scores in the inshore marine environment.

[18] https://www.bom.gov.au/cyclone/tropical-cyclone-knowledge-centre/history/past-tropical-cyclones/
[19] https://www.bom.gov.au/state-of-the-climate/australias-changing-climate.shtml
[20] https://www.bom.gov.au/cyclone/history/debbie17.shtml

2 Freshwater Basin Results

The overall freshwater basin grades were derived from three indices: water quality, habitat and hydrology, and fish; each made up of a series of indicator categories and indicators (Figure 11). Some are assessed annually, while others are updated every three or four years (Table 5). The designated reporting frequency reflects a combination of the gradual nature of change associated with these indicators and the logistical feasibility of assessing them. For more information on reporting frequencies and metrics for each indicator, refer to the Methods Report (MWI HR2RP, 2024).

Figure 11. Freshwater basin indicators (outer ring), indicator categories (middle ring) and indices (inner ring) that contribute to overall scores.

Table 5. Freshwater frequency of reporting for specific indicator categories and their update status for the 2024 Report Card.

Index	Indicator Categories	Frequency of Reporting	Last Updated (data year)
Water Quality	Sediment	Annually	**2023**
	Nutrients	Annually	**2023**
	Pesticides	Annually	**2023**
Habitat and Hydrology	In-stream habitat modification	4 Yearly	**2023**—Impoundment Length
			2023—Fish Barriers
	Flow	Annually	**2023**
	Riparian ground cover	4 Yearly*	**2014** (scores revised in 2016)
	Freshwater wetlands	4 Yearly	**2019**
Fish	Fish	3 Yearly	**2021**

*Due to methodology changes to riparian ground cover mapping (provided by the Department of Environment and Science), this indicator category has not been updated since 2014.

2.1 Water Quality in Freshwater Basins

Water quality condition scores for the 2024 Report Card were derived using data obtained from the Great Barrier Reef Catchment Loads Monitoring Program (CLMP). Scores were based on samples collected from end-of-catchment monitoring sites in the Don Basin (Don River mouth), Proserpine Basin (Glen Isla), and Pioneer Basin (Dumbleton Weir), with two in the O'Connell Basin (Stafford's Crossing and O'Connell Caravan Park) and Plane Basin (Sandy Creek at Homebush and Plane Creek at Sucrogen Weir) (Figure 12).

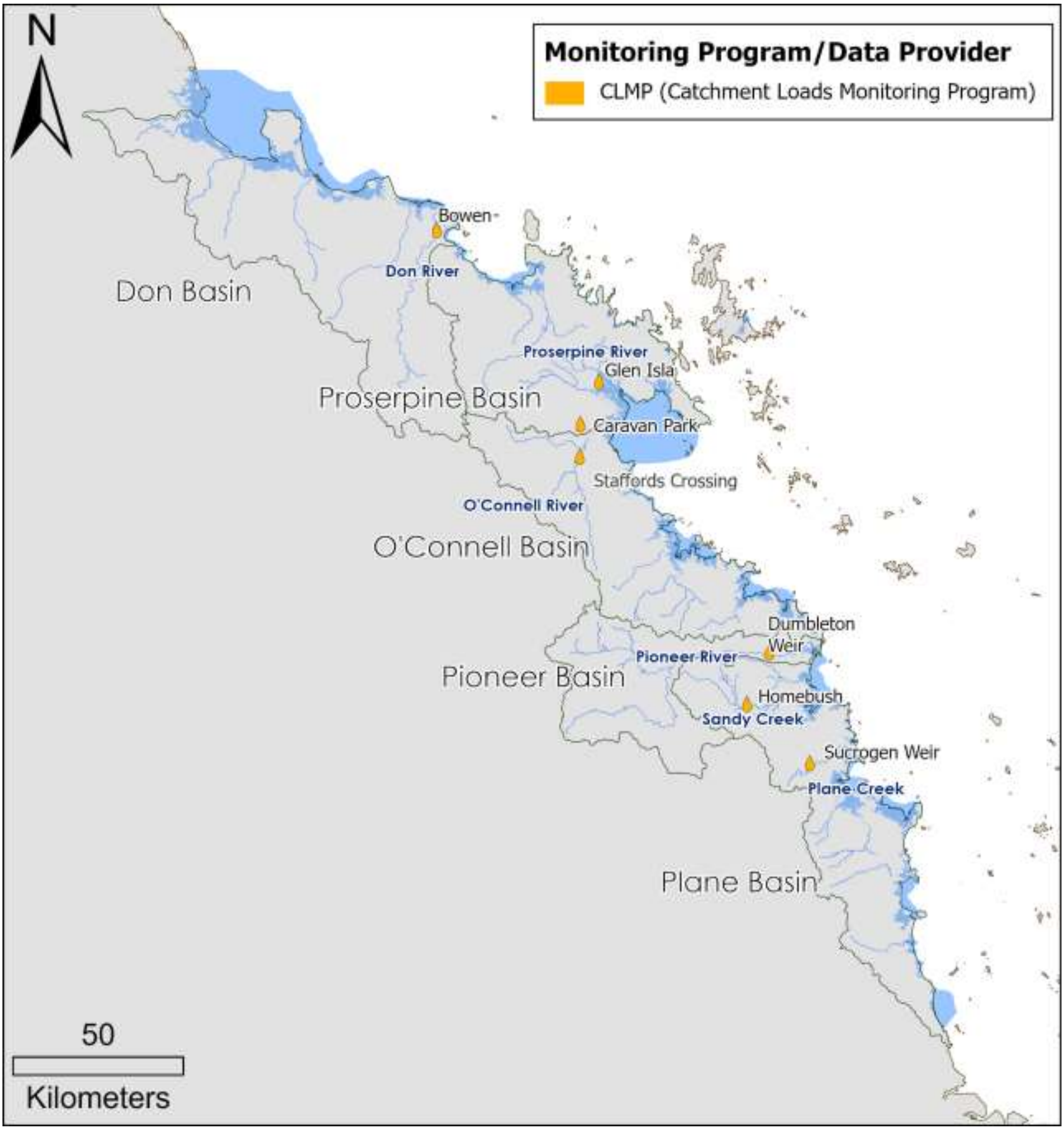


Figure 12. Sampling locations for freshwater water quality monitoring (including pesticides) in the Mackay-Whitsunday-Isaac (MWI) region for the 2024 Report Card (2022-23 data). Data provided by the Catchment Loads Monitoring Program (CLMP) as part of the Queensland Government.

Where multiple monitoring sites exist within a reporting zone, a weighted average of site-level scores was used to determine the relevant indicator score (Appendix 8.2.3). In each case, weightings are based upon the catchment area draining into the waterway upstream of the gauging station. Further information on site and sampling methodology is provided in the Methods Report (MWI HR2RP, 2024).

Water quality samples in Mackay-Whitsunday-Isaac (MWI) basins are collected using two methods: manual grab sampling and automated grab sampling using refrigerated pump samplers. Intensive automated sampling (daily or every few hours) occurred during high flow events, and monthly sampling during low or base-flow (ambient) conditions. Where sites are tidally influenced, samples were collected on the outgoing low tide.[21]

Water quality criteria for assessment was derived from the Queensland Water Quality Guidelines (DESI, 2009) for all MWI basins except for the Don. Criteria assessments for the Don Basin were based on the 'Draft environmental values and water quality guidelines: Don and Haughton River basins, Mackay-Whitsunday-Isaac estuaries, and coastal/marine waters' (Newham et al., 2017). Condition scores were calculated by comparing the annual sample median to the guideline value for each indicator at each site within a reporting area (basin). For further details on the adopted guidelines refer to the Methods Report (MWI HR2RP, 2024).

Notes on data interpretation for Report Card results:

Tidal Influence in Proserpine River: Concentrations of nutrients and sediments at this site are influenced by tidal movements and are not suitable for reporting the ambient state in the freshwater ecosystem. Since 2018, nutrient and sediment indicator category results for the Proserpine Basin have not been reported in the MWI Report Card. The dilutive potential of the tidal inflow of seawater is not anticipated to decrease the relevance of the Pesticide Risk Metric (PRM) score, and pesticides are still reported for the Proserpine Basin. Work is currently being undertaken to find a suitable freshwater sampling site in the Proserpine River.

Low flow in Don River: Due to a lack of surface flow in the Don River for much of the monitoring period, water quality monitoring in this basin is often restricted to periods of substantial rainfall in the area (MWI HR2RP, 2024). Despite the condensed sampling period, scores for total suspended solids (TSS) and nutrients in the Don Basin were allocated as if water quality monitoring data encompassed both ambient (low flow) conditions and event (high flow) conditions, in line with other MWI basins. Therefore, grades for the Don Basin should be considered in the context of wet season representation.

[21] Catchment pollutant loads monitoring methods, Great Barrier Reef Report Card 2016, Reef Water Quality Protection Plan, Queensland Government.

2.1.1 Sediments

Sediment scores are based on the reported concentrations of total suspended sediment (TSS). This indicator category is particularly vulnerable to changes in rainfall, wherein periods of high flow can mobilise large amounts of sediment in a basin. The rainfall across the 2022-23 season was average in O'Connell, Pioneer, and Plane Basins, and above average in Don and Proserpine Basins.

Results (Table 6, Figure 13)**:**

Table 6. Results for the sediment indicator category (based on a measure of total suspended solids (TSS)) for water quality in freshwater basins for the 2024 Report Card (2022–23 data).

Freshwater Basin	2024 Report Card (2022-23 data) Sediment Score
Don (Don River)	59
Proserpine (Proserpine River)^	
O'Connell (O'Connell River)	59
Pioneer (Pioneer River)	71
Plane (Sandy and Plane Creeks)	59

■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

^Proserpine data were found to be tidal confounded and therefore excluded from these scores.

Key Message:

1) Sediment scores indicated 'moderate' to 'good' grades in the current reporting cycle, with trends showing generally stable scores across the region.
2) All basins recorded high monthly median sediment concentrations in January and July, additionally the Don Basin recorded its highest concentration in October, reflecting above average rainfall during those months.
3) High monthly median concentrations were recorded in May at Plane Basin Sucrogen Weir site and March at Pioneer Basin Dumbleton Weir site despite rainfall being average or below average during those months.

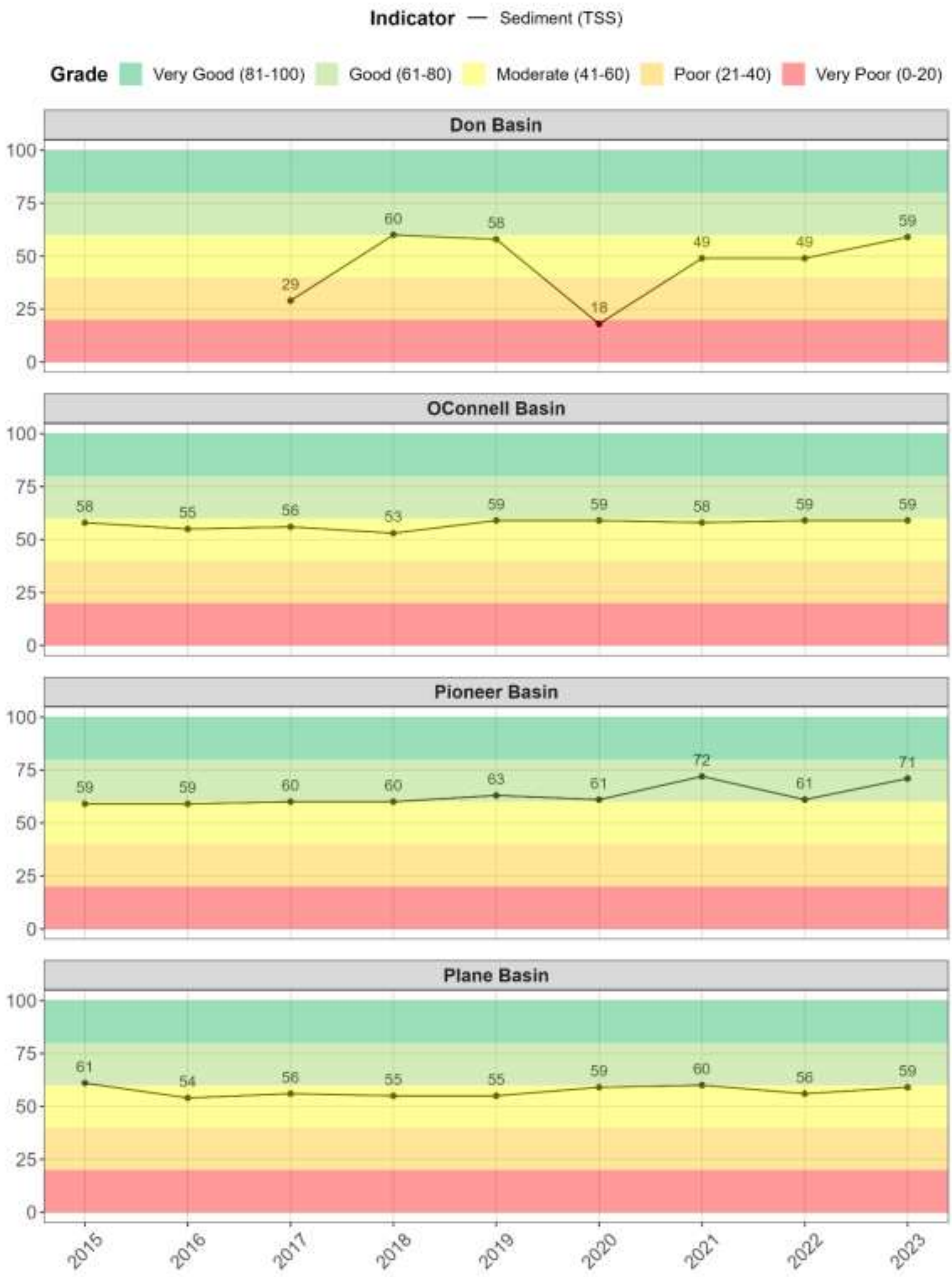


Figure 13. Results for the sediment indicator category (based on a measure of total suspended solids (TSS)) for water quality in freshwater basins for the 2024 Report Card (2022–23 data) in comparison to historic scores. Scores from 2018 onwards include multiple sites in the O'Connell and Plane Basins

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2.1.2 Nutrients

The nutrients indicator category contains dissolved inorganic nitrogen (DIN) and filterable reactive phosphorus (FRP) indicators.

<u>**Results** (Table 7, Figure 14, Figure 15, Appendix 8.2.3)</u>

Table 7. Results for dissolved inorganic nitrogen (DIN) and filterable reactive phosphorus (FRP) indicators and overall nutrients indicator category scores for water quality in freshwater basins for the 2024 Report Card (2022–23 data).

Freshwater Basin	2024 Report Card (2022-23 data)		
	DIN	FRP	Nutrients
Don	43	60	**51**
Proserpine^			
O'Connell	61	59	**60**
Pioneer	60	58	**59**
Plane	39	28	**33**

■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = assigned 90 | ■ No score/data gap

^Proserpine data were found to be tidal confounded and therefore excluded from these scores.

Key Messages:

1) Nutrient grades did not change in O'Connell, Pioneer and Plane Basins compared to the previous reporting period.
2) The Don Basin improved from 'poor' to 'moderate' due to decreased concentrations of both DIN and FRP. This was likely influenced by increased sampling availability due to increased surface flow in comparison to the previous reporting cycle.

2.1.2.1 Filterable Reactive Phosphorus (FRP)

FRP scores improved in the Don ('poor' to 'moderate'). FRP scores improved in the Plane Basin in the 2022-23 reporting period, following a noticeable decline in scores at both monitored locations during the previous reporting cycle. Still, monthly medians for FRP at the Sandy Creek site exceeded the guideline value for all months in the 2022–23 reporting period. The Sandy Creek site recorded minor runoff events distributed throughout the year (rather than major events just during the wet season), which increased dry season monthly median concentrations (K. Rohde, pers. comm. 28/04/2023). The lower FRP grade in Sandy Creek compared to the neighbouring Plane Creek is likely reflective of land use differences within these catchments. High concentrations of FRP may be related to runoff from mill mud applications on pasture or plant cane (P. Trendell, pers. comm. 28/04/23).

2.1.2.2 Dissolved Inorganic Nitrogen (DIN)

DIN remained an indicator of concern for the MWI Region. All monitored basins in the region were graded 'moderate' or 'poor' in the 2022–23 reporting period except the O'Connell Basin ('good'). A trend of decreasing DIN concentrations was evident in the Pioneer Basin (Figure 14). The current DIN score is the highest yet recorded in the Pioneer, and the first time the basin has consecutively improved in score over four reporting periods. Monthly median concentrations in the basin were within guideline values during five months of the year.

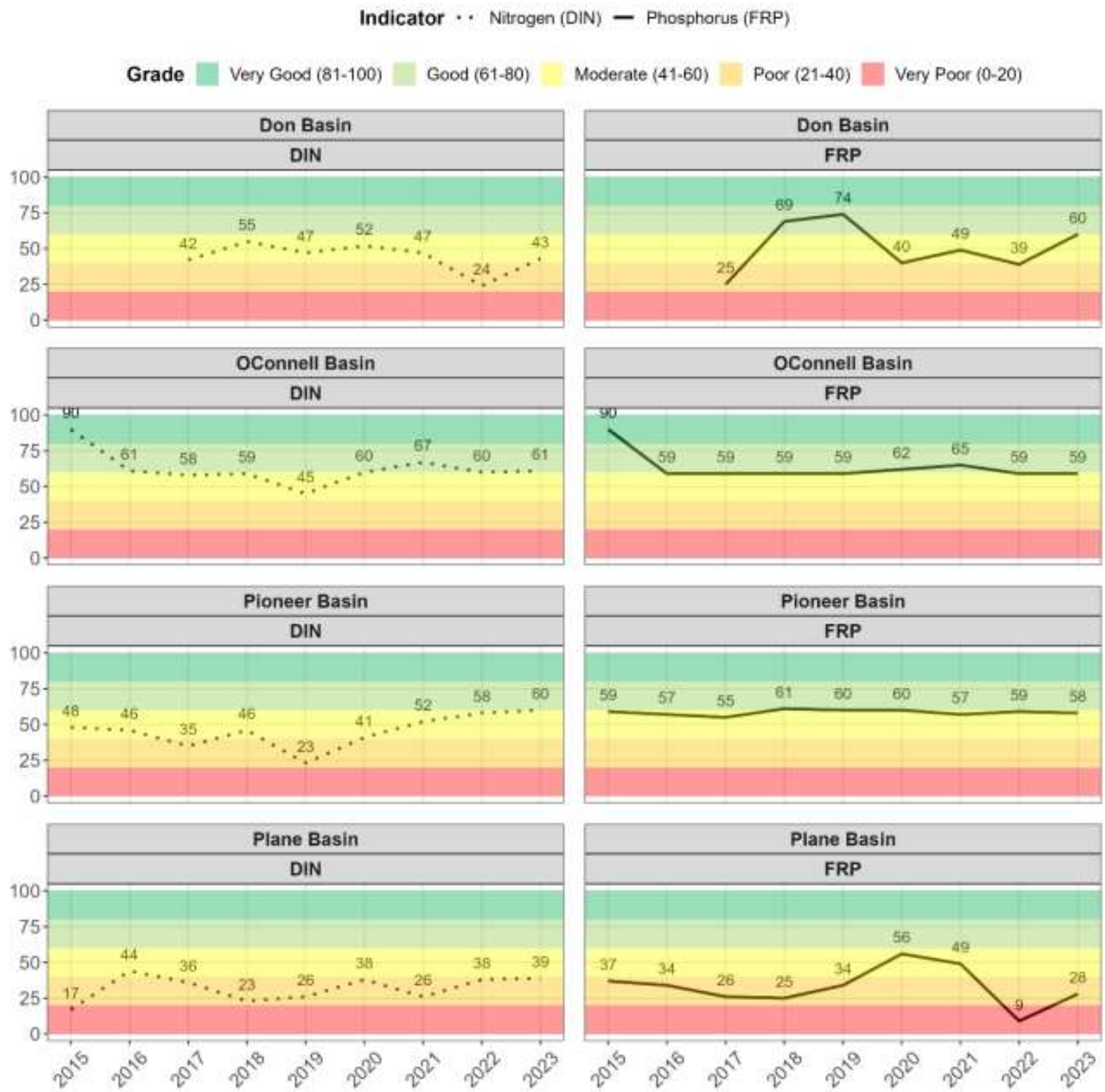

Figure 14. DIN and FRP indicator scores per basin for the 2024 Report Card (2022-23 data) and historic record. Scores from 2018 onwards are derived from results obtained at multiple sites in the O'Connell and Plane Basins. As a result, these are not directly comparable to scores reported for the preceding years.

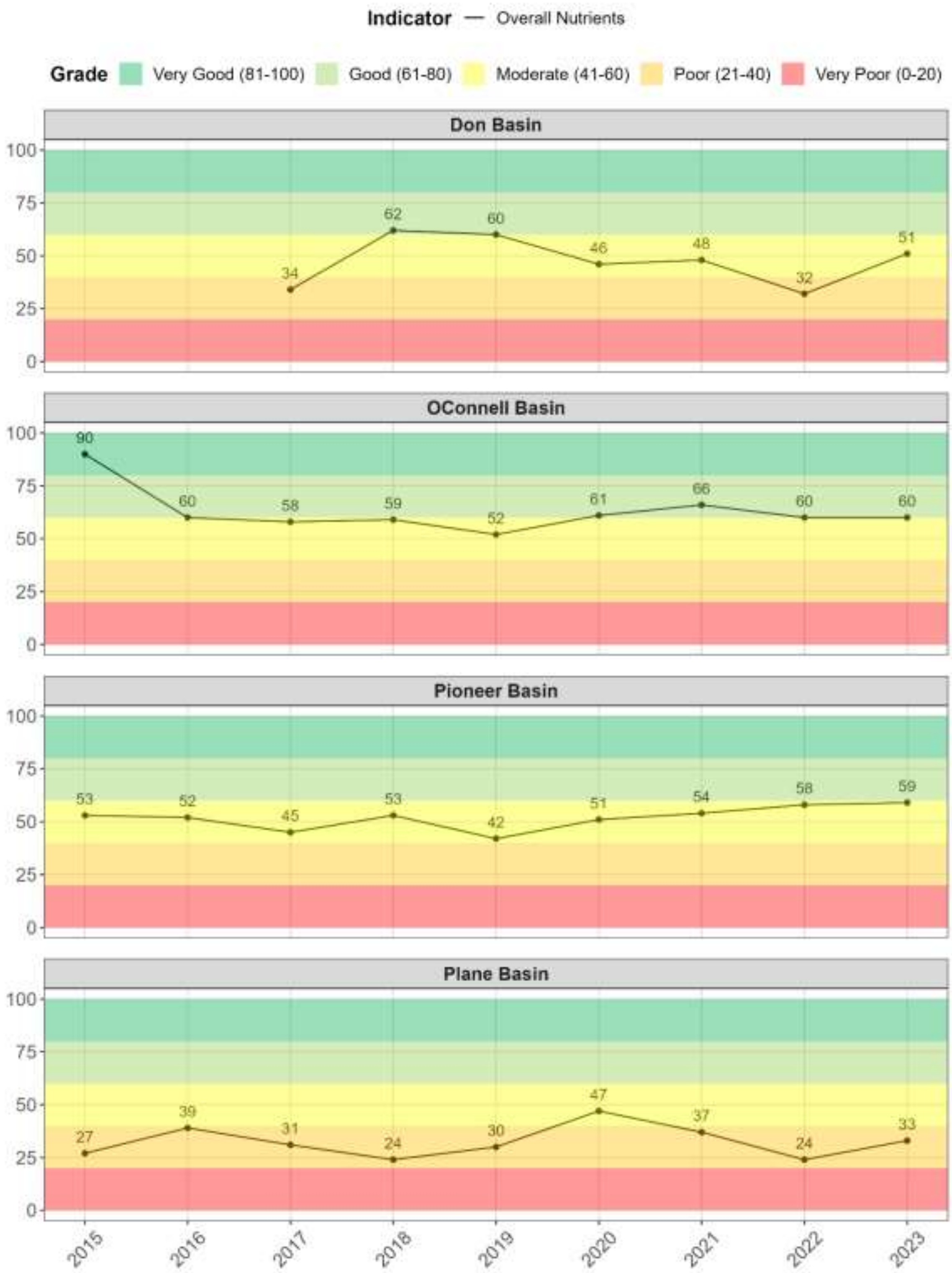

Figure 15. Results for overall nutrients indicator category scores for water quality in freshwater basins for the 2024 Report Card (2022-23 data) in comparison to historic scores. Scores from 2018 onwards are derived from results obtained at multiple sites in the O'Connell and Plane Basins. As a result, these are not directly comparable to scores reported for the preceding years.

2.1.3 Pesticides

The pesticide indicator scores were developed using the Pesticide Risk Metric (PRM) (Warne et al., 2020, 2023). The PRM quantifies the ecological risk associated with exposure to a mixture of pesticides as the percent of aquatic species that may be adversely affected. For further information on the methodology adopted for the calculation of the PRM, refer to the Methods Report (MWI HR2RP, 2024).

Results (Table 8, Figure 16, Figure 17)

Table 8. Results for the Pesticide Risk Metric (PRM) indicator accounting for 22 pesticides, reporting aquatic species protected (%) and overall standardised pesticide score for freshwater basins for the 2024 Report Card (2022-23 data).

Freshwater Basin	2024 Report Card (2022-23 data)	
	PRM (% species Protected)	Standardised Pesticide Score
Don	96	68
Proserpine	72	18
O'Connell	88	37
Pioneer	83	27
Plane	70	18

Species protected scores: ■ Very Poor = <80% | ■ Poor = <90 to 80% | ■ Moderate = <95 to 90% | ■ Good = <99 to 95% | ■ Very Good = ≥99% | ■ No score/data gap
Pesticide scores: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

Key Messages:

1) Imidacloprid and diuron were key contributors to pesticide risk throughout the region.
2) Metsulfuron-methyl was a key contributor to risk in the Don Basin and at Plane Creek Sucrogen Weir sites specifically.
3) Overall, pesticides remained the poorest scoring indicator for basin water quality in the MWI region in the 2022–23 reporting year, indicating a high risk of adverse effects to the region's aquatic species due to pesticide exposure.

The **Proserpine and Plane Basins** have both scored 'very poor' for seven consecutive years for pesticides. At sites associated with agricultural land use, particularly sugarcane, the major contributors were imidacloprid (an insecticide), and diuron (a herbicide). Other contributors to pesticide risk included metolachlor, imazapic, hexazinone, MCPA, isoxaflutole, and atrazine. Variation in the pesticide risk profile across the region reflects relevant land-use applications.

The **Pioneer and O'Connell Basins** scores both declined, causing a drop in grade to 'poor' in the O'Connell. Imidacloprid and diuron were the biggest contributors to this change. Imidacloprid was a larger contributor to pesticide risk in the O'Connell Basin, while diuron concentrations were the key contributor in the Pioneer Basin.

The **Don Basin** improved from 'poor' to 'good'. This was largely due to increased sampling availability in the waterway. Metsulfuron-methyl was the largest contributor to pesticide risk in the Don Basin. Small amounts of metsulfuron-methyl can cause large changes in PRM scores as this pesticide has a high-risk profile (R. Mann, pers. comm. 21/04/23). Metolachlor, associated with horticulture, was also detected at levels that pose risk to aquatic species.

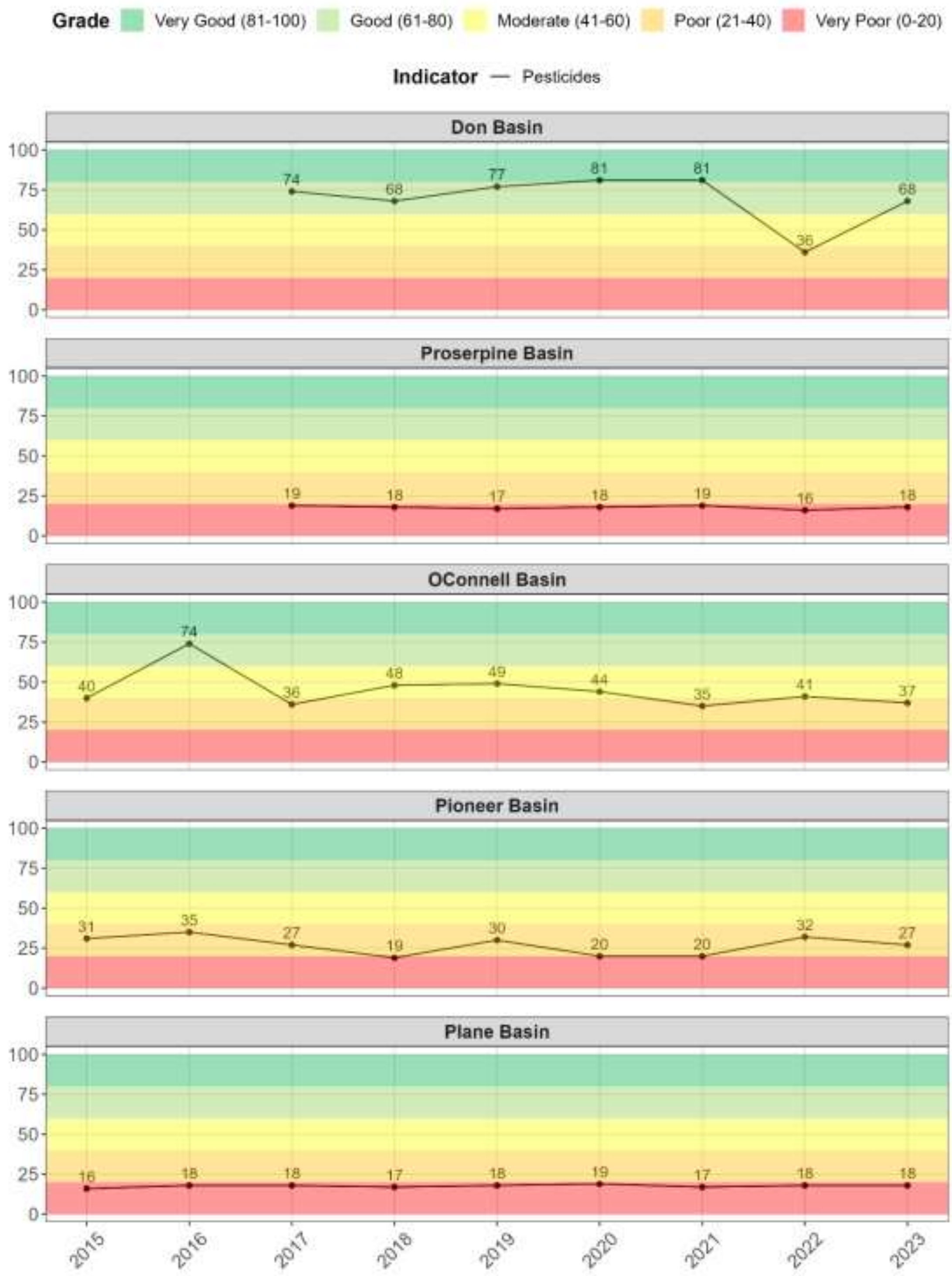

Figure 16. Results for the pesticide indicator (accounting for 22 pesticides) for freshwater basins in the 2024 Report Card (2022-23 data) compared to the historic record. Pesticides scores in 2017 have been back-calculated to incorporate changes in the methods that occurred for the first time in the 2018 Report Card. From 2017 to 2020 O'Connell Basin grades included data from a second monitoring site (Stafford's Crossing), whereas other years incorporated data from Caravan Park site only. Scores in Plane Basin prior to 2017 include only Sandy Creek Homebush site, whereas from 2017 Plane Creek Sucrogen Weir is also included.

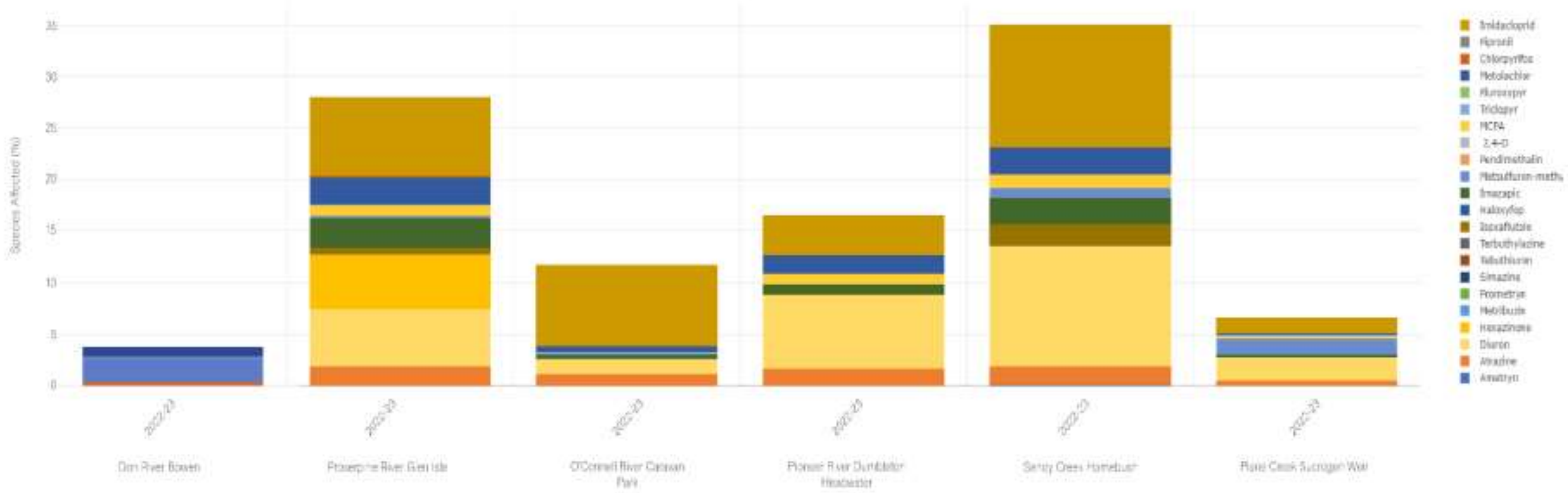

Figure 17. The proportional contribution of each chemical to the final Pesticide Risk Metric (PRM) score, for the 2022–23 reporting year. In this instance, the PRM is expressed as the % species affected fraction. Source: QLD Government, GBR CLMP..

2.1.4 Water Quality Index Scores

Water quality index scores are an average of sediments, nutrients, and pesticides indicator categories (Table 9). Based on the rules for the minimum proportion of information required to generate overall scores, a final water quality score could not be calculated for the Proserpine Basin (see Section 2.1 for details).

Results (Table 9, Figure 18)

Table 9. Results for water quality indicator categories and final water quality index scores in freshwater basins for the 2024 Report Card (2022–23 data).

Freshwater Basin	2024 Report Card (2022-23 data)			
	Sediments	Nutrients	Pesticides	Water Quality Index
Don	59	51	68	**59**
Proserpine			18	
O'Connell	59	60	37	**52**
Pioneer	71	59	27	**52**
Plane	59	33	18	**37**

■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

Key Messages:

1) The Don Basin recorded the only grade change for overall water quality in the 2024 Report Card. The return to ‘moderate’ grade from ‘poor’ was likely influenced by the sampling regime.
2) This was the seventh consecutive year that scores for water quality have remained ‘moderate’ or below in the O’Connell Basin, and the tenth year in the Pioneer and Plane basins.

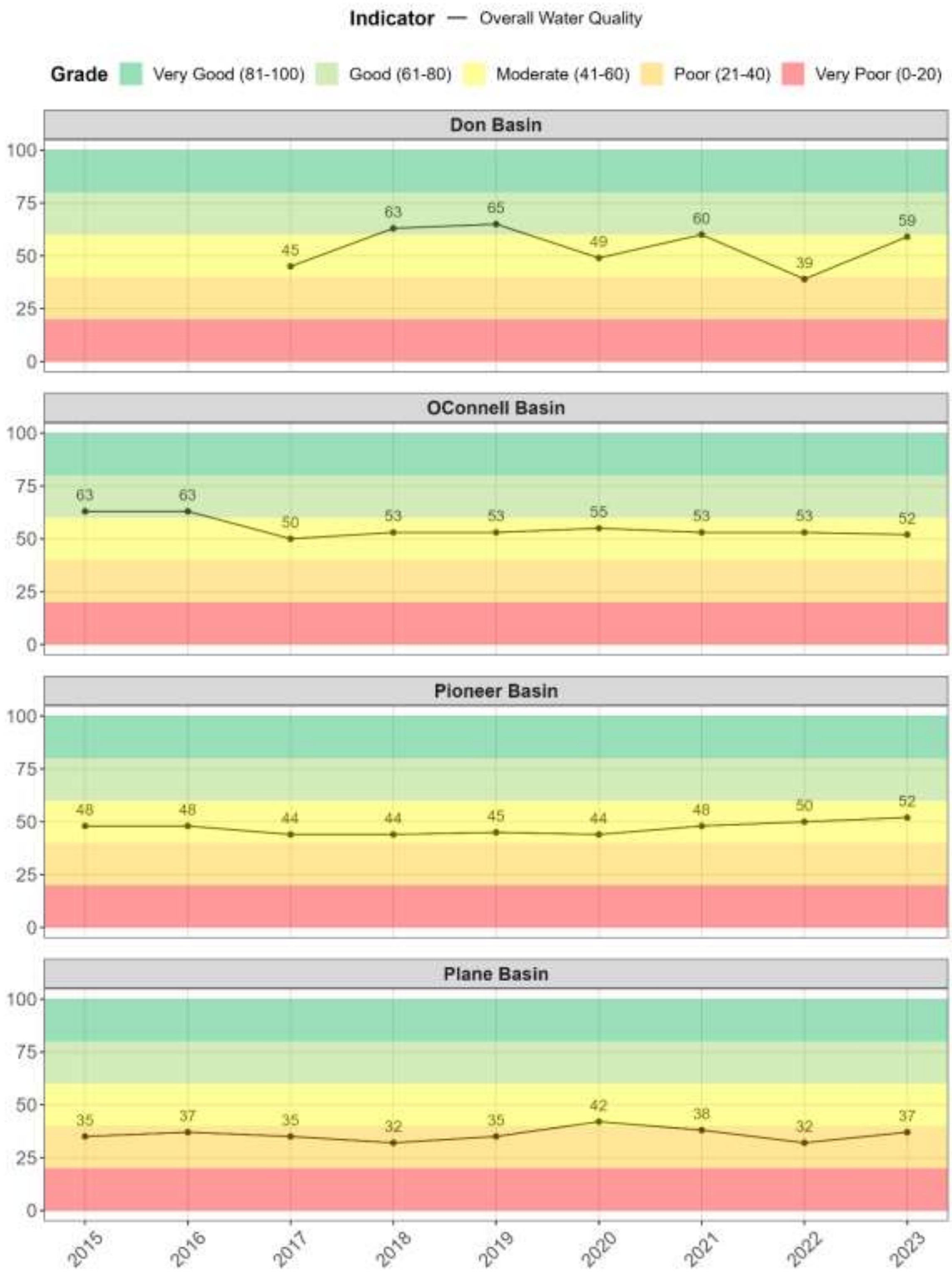

Figure 18. Results for water quality indicator categories and overall index scores in freshwater basins for the 2024 Report Card (2022-23 data) in comparison to –historic scores. Scores from 2017 have been back-calculated to incorporate updates to freshwater pesticides made in the 2018 Report Card and are not directly comparable to previously reported scores. Both Plane and O'Connell Basin scores incorporate two sites from 2018.

2.1.4.1 Confidence

The Report Card scores were rated in terms of the confidence and uncertainty based on methods and data used in the development of each score. A detailed summary of confidence methods and scoring is provided in the Methods Report (MWI HR2RP, 2024).

Confidence in water quality scores for Mackay-Whitsunday-Isaac (MWI) basins varied depending on the indicator category and basin (Table 10). Most basins were given a moderate rank of confidence, primarily due to the limited spatial representativeness of the monitoring program. However, the Don Basin was given a 'low' rank for water quality monitoring periods due to a lack of surface flow over much of the year which decreased annual temporal representativeness. Scores are calculated based on data from one to two sites per basin and therefore can only be inferred as representing the entire basin with moderate confidence (MWI HR2RP, 2024).

Table 10. Confidence associated with water quality index results in freshwater basins in the Mackay-Whitsunday-Isaac (MWI) Report Card. Confidence criteria are scored 1–3 and then weighted by the value identified in parentheses. Final scores (4.5–13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1 to 5 (very low–very high), which indicates the final confidence level. Where confidence in results for the Don Basin differ from the other basins, the relevant confidence score for the Don is presented in square parentheses. Unless specified, confidence in results is the same across basins.

Indicator Category	Maturity of Methodology (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured Error (x0.71)	Final	Rank
Sediment	3	3	1 [0.5]	3	2	8.8 [7.8]	3 [2]
Nutrients	3	3	1 [0.5]	3	2	8.8 [7.8]	3 [2]
Pesticides	3	3	1 [0.5]	3	2	8.8 [7.8]	3 [2]
Water Quality Index						**8.3 [7.8]**	**3 [2]**
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.							

2.2 Habitat and Hydrology in Freshwater Basins

The habitat and hydrology index comprises four indicator categories. The flow indicator is updated annually in both Pioneer and Plane Basins, whereas the other indicators (in-stream habitat modification, riparian extent, and wetland extent), are reviewed every three to four years.

2.2.1 In-stream Habitat Modification

The in-stream habitat modification indicator category score is derived from an average of fish barriers and impoundment length indicator scores. Results for the fish barrier indicator were updated in the 2024 Report Card, based on a recent assessment on regional fish barrier prioritisation (Power et al., 2022) and a corresponding report (Moore & Power, 2023). The impoundment length indicator was last updated for the 2022 Report Card (2021-22 data).

2.2.1.1 Fish Barriers

The fish barrier indicator is based on an assessment of three metrics: 'barrier density', 'proportion of stream length to the first barrier', and 'proportion of stream length to the first low passability barrier' (MWI HR2RP, 2024).

Notes on data interpretation

Updated aerial imagery: Previous reporting cycles referenced 2013 aerial imagery at 50 cm resolution[22] while the current reporting references updated 2019 aerial imagery at 20 cm resolution[23], resulting in the ability to identify additional barriers that potentially existed in previous reporting yet were unable to be distinguished.

Updated waterway spatial layer: Updates to the Queensland drainage network waterway layer has resulted in identification of increased streamlines/length, which have been incorporated into the scoring for the Fish Barriers metric.

[22] 2013 Imagery - "Central Qld coastal 2013, 50 cm resolution, SISP, peri-urban; Accessed via QGlobe, Qld Government".
[23] Central QLD coastal 2019 aerial imagery, 20 cm resolution, SISP, peri-urban: Sourced via Reef Catchments NRM via Spatial Imagery Subscription Plan, QLD Government, 2019

Results (Table 11, Figure 18)

Table 11. Results for fish barrier indicator metrics in freshwater basins in the 2024 Report Card (2022-23 data). Metrics were assessed on Stream Orders (SO) ≥3 or ≥4 as indicated.

Freshwater Basin	2024 Report Card (2022-23 data)							
	Barrier Density		Stream to the 1st Barrier		Stream to the 1st Low "Passability" Barrier		Fish Barriers	
	km per barrier on SO ≥3	Score	% of stream before first barrier on SO ≥3	Score	% of stream before first low pass barrier on SO ≥4	Score	Total Score	Fish Barriers (standardised)
Don	**5**	**3**	**53**	**3**	**68**	**3**	**9**	**50**
Proserpine	**4**	**3**	**39**	**3**	**80**	**4**	**10**	**60**
O'Connell	**3**	**2**	**25**	**2**	**80**	**4**	**8**	**41**
Pioneer	**4**	**2**	**2**	**1**	**2**	**1**	**4**	**20**
Plane	**2**	**1**	**35**	**3**	**79**	**4**	**8**	**41**

Barrier Density: ■ Very Poor = 0 to 2 km (1) | ■ Poor = >2 – 4 km (2) | ■ Moderate = >4 – 8 km (3) | ■ Good = >8 – 16 km (5) | ■ Very Good = >16km (5) | ■ No score/data gap

% of Stream Before 1st Barrier: ■ Very Poor = 0 to <10% (1) | ■ Poor = >10 – 30% (2) | ■ Moderate = >30-70% (3) | ■ Good = >70-90% (5) | ■ Very Good = >90% (5) | ■ No score/data gap

% of Stream to 1st Low Passability Barrier: ■ Very Poor = 0 to 50% (1) | ■ Poor = >50 – 60% (2) | ■ Moderate = >60-70% (3) | ■ Good = >70-95% (5) | ■ Very Good = >95% (5) | ■ No score/data gap

Total Score: ■ Very Poor = 3-4 | ■ Poor = 5-7 | ■ Moderate = 8-10 | ■ Good = 11-13 | ■ Very Good = 14-15

Standardised: ■ Very Poor = 0-20 | ■ Poor = 21-40 | ■ Moderate = 41-60 | ■ Good = 61-80 | ■ Very Good = 81-100

Key Messages (Moore & Power, 2023):

1) Score decline for the barrier density metric in the Don Basin was largely due to the construction of new waterway barriers which may be tied to land clearing and development in the form of intensive horticulture. Unimpeded connection is particularly important in the Don Basin as the freshwater streams are ephemeral in nature; typified by episodic flow, channels with sandy substrates, and characterised by few permanent freshwater habitats. Therefore, the unimpeded connection between limited permanent waterholes is important to prevent fragmentation of fish populations and for sustaining aquatic ecosystem health (Moore, 2016).

2) Improved scores for the stream length to 1st barrier metric in the Plane Basin were due to the remediation of two fish barriers located on Flaggy Rock and Sandy Creeks. Both sites were remediated with rock ramp fishways at the 1st barriers upstream from the estuary, resulting in increased connected stream length.

3) In the Proserpine Basin, improved scores for the distance to 1st low passability barrier metric were due to the removal of a high head loss sand dam located near the freshwater/estuarine interface. This dam had blocked access to >90% of the waterway and had not been reinstated at the time of reporting.

4) The Pioneer Basin consistently scores poorer in the fish barrier indicator than all other basins in the region. The Pioneer Basin is home to the largest population centre in the region, (Mackay), and land use activities include both urban developments and intensive agriculture.

To support these activities, construction of transport infrastructure (e.g., roads and causeways), as well as irrigation and water supply storages (e.g., weirs) have been required, creating barriers to fish passage.

Figure 19. Results for the fish barrier indicator in freshwater basins in the 2024 Report Card (2022-23 data) compared to the historic record. Fish barrier scores are updated every four years. Updates are indicated by point and annotation, in years without assessment updates, the most recent score is incorporated into the overall freshwater basin score.

2.2.1.2 Impoundment Length

This indicator was selected to describe how much 'natural' channel habitat remained in the region compared to artificially ponded channel habitat, which has relatively little diversity in terms of depth, flow rate, and natural wetting and drying cycles. Water impoundment may result in an extended inundation of riparian vegetation, contributing to potential increased erosion if submerged vegetation dies. Impoundment may also affect the efficacy of the fishway, which enables migratory fish to travel upstream.

Results (Table 12, Figure 20)

Table 12. Results for the impounded stream indicator in freshwater basins in the 2024 Report Card (2022 23 data).

Freshwater Basin	Not Impounded (km)	Impounded (km)	Total (km)	% Total	Standardised Impoundment
Don	954	0	954	0.0	**100**
Proserpine	528	37	565	6.6	**43**
O'Connell	600	14	614	2.4	**72**
Pioneer	498	54	552	9.8	**22**
Plane	671	28	698	4.0	**60**

Impoundment (% total): ■ Very Poor = ≥10% | ■ Poor = 7 to <10% | ■ Moderate = 4 to <7% | ■ Good = <4 to 1% | ■ Very Good <1% | ■ No score/data gap

Standardised impoundment: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

Key Messages:

1) Removal of a sand dam on the Proserpine River that had previously impounded ~4 km of stream in the 2018 assessment led to a return to 'moderate' for this waterway in 2022-23.

2) O'Connell recorded an improved score in 2022 due to the removal of an unauthorised sand dam.

The **Pioneer Basin** was 'poor', with 9.8% of the total length of streams of order three or higher impounded by artificial structures.

There were no impoundments on streams (of order three or higher) in the **Don Basin**, giving it a grade of 'very good'.

Figure 20. Results for impoundment length indicators in freshwater basins in the 2024 Report Card (2022-23 data) compared to the historic record. Impoundment length is updated every four years, updates indicated by point and annotation. Proserpine Basin scores were re-calculated in 2022-23 due to the removal of a sand dam that was identified in the fish barriers assessment, other basins recorded no changes.

2.2.1.3 In-stream Habitat Modification Indicator Category

The impoundment and fish barrier indicators were averaged to create the in-stream habitat modification indicator category. As highlighted above, fish barrier scores for the 2024 Report Card were updated in the current reporting cycle, while impoundment length is based on repeat data from 2021-22 (bar Proserpine Basin, where an update was identified during fish barrier assessments).

Results (Table 13, Figure 21)

Table 13. Results for the in-stream habitat modification indicator category in freshwater basins for the 2024 Report Card.

Freshwater Basin	2024 Report Card		
	Impoundment Length (2022-23 data)	Fish Barriers (2022-23 data)	In-stream Habitat Modification
Don	100	50	75
Proserpine	43	60	52
O'Connell	72	41	56
Pioneer	22	20	21
Plane	60	41	50

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

Key Messages:

1) Grade decline in the Don Basin was due largely to increased habitat modification from development.
2) Grade decline in the O'Connell Basin was largely due to improved data accuracy from ground-truthing barriers.
3) Improvement in the score for the Proserpine Basin was due to the removal of a sand dam downstream of the Myrtle Confluence.
4) Remediated barriers in the Plane Basin improved the stream length to the first barrier, however identification of additional barriers caused barrier density scores to decline, and overall scores remained the same.

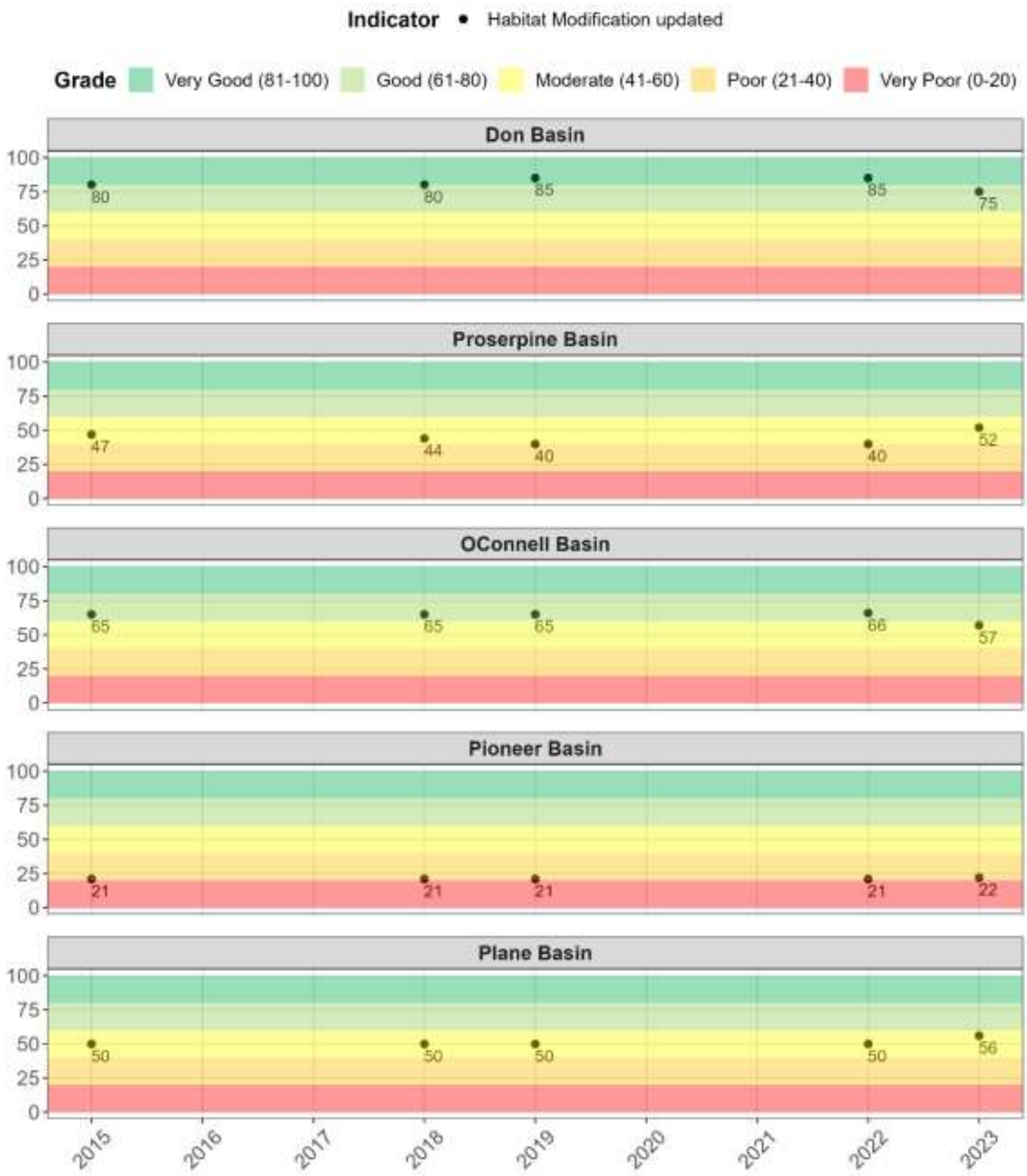

Figure 21. Results for the in-stream habitat modification indicator category in freshwater basins for the 2024 Report Card compared to historic results. Updates in data are indicated by point and annotation.

2.2.2 Riparian and Wetland Extent

2.2.2.1 Riparian Extent

Riparian extent scores were derived from 2013 Landsat foliage projective cover data that has been compared against the pre-development extent of riparian forest Regional Ecosystem (RE) mapping data (assumed to be 100% forested).

Results (2013-14 data, Table 14)

Table 14. Results showing % of riparian and wetland extent loss compared to pre-clearing conditions for the 2024 Report Card. Scores are repeated from the 2019 Report Card, in which scores were back-calculated from updated methodology as assessed using 2013/14 (riparian extent) and 2017/18 (wetland extent) data. The wetland assessment pertains to palustrine wetlands only.

Freshwater Basin	2024 Report Card				2024 Report Card	
	Wetland extent (2017-18 data)		Riparian extent (2013-14 data)		Standardised Wetland Extent	Standardised Riparian Extent
	Hectares lost since pre-development	% loss since pre-development	Hectares lost since pre-development	% loss since pre-development		
Don	0*	-3*		29	100	41
Proserpine	848	16		22	59	50
O'Connell	334	66		22	14	51
Pioneer	1,279	70		20	12	54
Plane	930	47		29	23	41

Riparian and Wetland extent (% loss): ■ Very Poor = >50% | ■ Poor =>30 to 50% | ■ Moderate = >15 to 30% | ■ Good = >5 to 15% | ■ Very Good ≤5% | ■ No score/data gap

Standardised riparian and wetland extent: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

*Negative values denote an increase in area since pre-development. In this instance, however, representation masks the losses of converted estuarine wetlands and losses of freshwater wetlands in other locations (Section 2.2.2).

Key Messages:

1) Overall, the percent loss of riparian extent since pre-clearing ranged from 20–30% within the basins assessed. As a result, all basins were graded moderate for the condition of riparian extent.
2) This assessment is based on the oldest dataset from any indicator in the 2024 Report Card (2013–14 data), which should be noted when interpreting these results.

Riparian extent: The riparian extent indicator is updated with spatial data produced by the Remote Sensing Centre, Department of Environment, Science, and Innovation (DESI). Consequently, the reporting frequency period is generally every four years. However, the data collected in 2017 was subject to considerable change (amendments to the satellite imagery and data processing which improved the resolution and accuracy of vegetation mapping) and not fit for purpose at the spatial extents required by Regional Report Cards. Once revised mapping and methods for calculating riparian extent are produced, they will need to be reviewed by the Technical Working Group (TWG) to ensure that they are suitable. It is anticipated that this information will be available in future report cards.

2.2.2.2 Wetland Extent

Updated datasets and scores based on new wetland mapping methodology (Queensland Regional Ecosystem Version 5.1 Wetland Mapping), including the most recent assessment scores, supersede all previously reported results of wetland extent.

Results (2017-18 data, Table 15)

Key Messages:

1) 'Very good' grade in the Don Basin is a somewhat false representation masking the losses of estuarine wetlands converted to freshwater wetlands through damming or bunding, and significant losses of freshwater wetlands in other locations.
2) Although no natural or modified wetlands have been lost since the previous assessment, 'poor' and 'very poor' scores in the O'Connell, Pioneer, and Plane Basins reflect the significant historical loss estimated in regional wetlands. It is estimated that there has been a 44% reduction in wetland extent in the region because of development. Declines at the basin level are particularly pronounced for the O'Connell and Pioneer Basins, where palustrine wetlands have lost 66% and 71% of their pre-clearing extent, respectively.

In the **Don Basin**, net increases in the extent of freshwater wetland observed were attributed to the conversion of estuarine wetlands to freshwater wetlands through damming or bunding. For example, the historical loss of 1,109 hectares of freshwater wetland in the Don catchment is masked by a gain of 1,184 hectares due to conversion from estuarine to freshwater wetland.[24] In this instance, decreases in wetlands extent driven by land modification and filling were moderated by increases associated with anthropogenically driven changes in hydrology. Whilst the ecological value of new or expanded modified wetlands is acknowledged, net increases in the extent of freshwater wetland are not necessarily an indication of a healthy riverine system. Instead, they are indicative of modification activity. The current extent is larger than the pre-clearing extent because of the inclusion of modified wetlands (e.g. the bunding of estuarine areas to become freshwater).

[24] https://www.reefplan.qld.gov.au/__data/assets/pdf_file/0020/82910/report-card-2017-2018-results-wetland-extent.pdf

2.2.3 Flow

Flow scores are only reported for Pioneer and Plane Basins due to concerns that results did not accurately reflect on-ground flow observations in the O'Connell Basin (Figure 22). In the O'Connell Basin this was primarily connected to unusually prolonged periods of low or no flow relating to the dry climate conditions and effects of water extractions that occurred during this period. The resulting low to no flows interrupted important processes that support a healthy river ecosystem. This includes deterioration of important riffle habitats, decline of water quality in water holes (e.g., low dissolved oxygen and high water temperatures) and a reduced capacity for fish migration (King et al., 2015). Flow was not assessed for the Don or Proserpine Basins due to the lack of either pre-development modelled data or availability of open gauging stations.

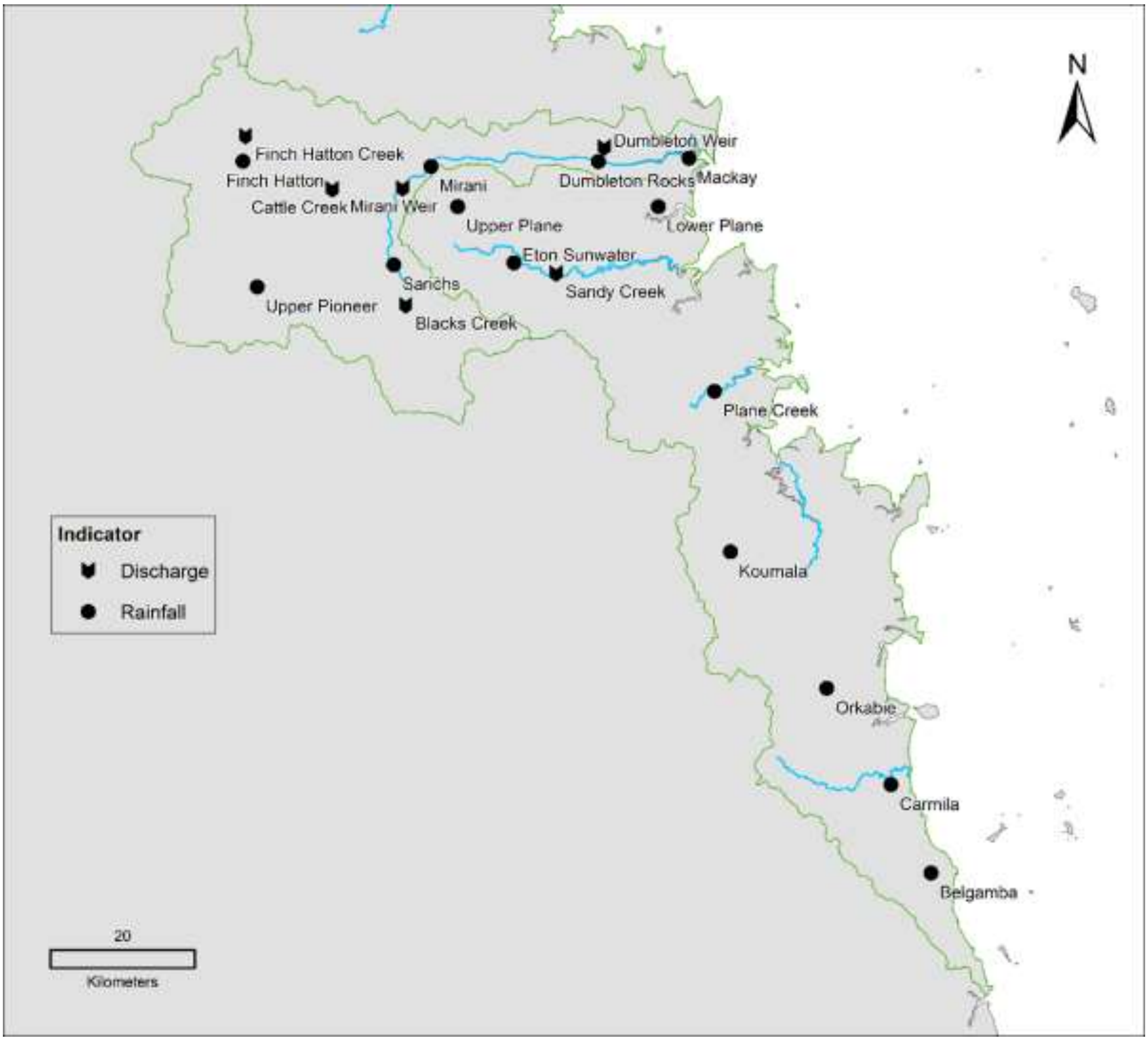

Figure 22. Locations of flow gauges and rainfall stations in the MWI region Pioneer and Plane Basins for the 2024 Report Card. Flow rainfall data provided by the Bureau of Meteorology (BoM) and the QLD SILO database. Flow discharge data provided by the Queensland Department of Regional Development, Manufacturing and Water (DRDMW).

Notes on data interpretation

Data sources*:* Some differences can occur between climate type (based on rainfall) produced by the flow indicator tool and the BoM climate reporting. This is due to differences in spatial coverage and the analysis applied to assess rainfall in the flow indicator tool. The data source will be specified in each instance to minimise confusion.

Climate impact on flow indicator measurement: While rainfall does affect freshwater flows, the flow indicator tool has been designed to take this natural variability into account and produce scores that reflect anthropogenic impacts on flow (measured against the pre-development period).

Monitoring sites: The Pioneer Basin flow score was assessed from five stream gauging stations while flow in the Plane Basin was based on one monitoring location (Appendix 8.2.2).

Climate: The climate type for 2022–23 was classed as 'average' for both the Plane and Pioneer Basins using the flow indicator tool (Table 15). Conditions were drier than average in the Plane in December 2022, and in both the Pioneer and the Plane in August 2022, February, May, and June 2023. Both basins experienced wetter than average conditions in July, September, and October 2022 and January 2023 (Table 4). The annual average was classed as 'average' in comparison to the long-term average annual rainfall for those basins, as calculated by both the flow indicator tool and according to data sourced from Australian Water Outlook (AWO) (Table 15, Table 4).

Results (Table 15. Figure 23, Appendix 8.2.2)

Table 15. Results for the flow indicator for freshwater basins for the 2024 Report Card (2022-23 data) and the climate type based on average rainfall, as compared to the historic scores. Climate type is added for reference only, as the flow indicator aims to assess waterway condition in regard to industrial and agricultural water extraction irrespective of climate.

Freshwater Basin	2022-23		2021-22		2020-21		2019-20		2018-19		2017-18	
	Climate	Score	Climate	Score	Climate	Score	Climate	Score	Climate	Score		
Don^												
Proserpine ^												
O'Connell*											Dry	78
Pioneer	Average	71	Dry	55	Drought	45	Dry	49	Average	72	Drought	66
Plane	Average	61	Dry	61	Drought	61	Average	43	Average	35		

Standardised flow scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

^ No pre-development reference data are available.

*The O'Connell Basin was omitted from reporting due to anomalous scores.

Key Messages:

1) The flow indicator category grade remained 'good' in the Plane Basin with no change from the previous reporting year.

2) The Pioneer Basin grade improved to 'good', potentially reflecting changes in agricultural water use.

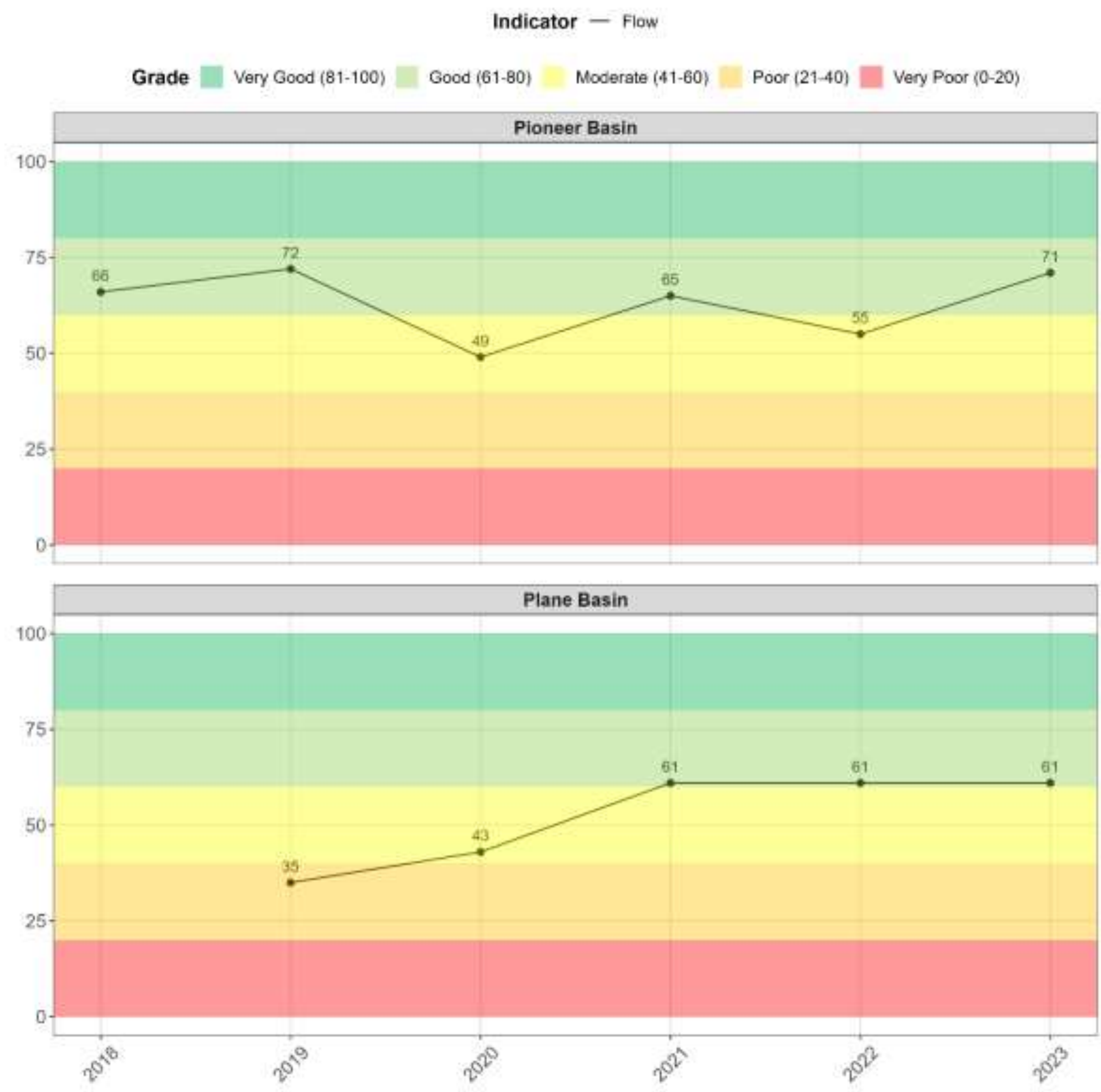

Figure 23. Results for the flow indicator for freshwater basins for the 2024 Report Card (2022-23 data) and the climate type based on average rainfall, as compared to the historic scores.

2.2.4 Habitat and Hydrology Index Scores

Overall habitat and hydrology scores include repeat data (Table 5) and changes in scores within this index are due to updates in fish barriers, and in the Pioneer Basin, flow. Repeat data does not fully capture changes in conditions associated with major weather events (including TC Debbie) or potential anthropogenic impacts which may have occurred since they were last updated.

<u>**Results** (Table 16, Figure 24)</u>

Table 16. Results for habitat and hydrology indicator categories and the aggregated index in freshwater basins in the 2024 Report Card. In-stream habitat modification and Flow use data from this reporting period, all others use repeat data.

Freshwater Basin	2024 Report Card				
	In-stream habitat modification	Flow	Riparian Extent	Wetland Extent	Habitat and Hydrology Index
Don	75		41	100	72
Proserpine	52		50	59	54
O'Connell	57		51	14	41
Pioneer	22	71	54	12	39
Plane	55	61	41	23	45

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

Figure 24. Results for habitat and hydrology indicator categories and the aggregated index in freshwater basins in the 2024 Report Card compared to the historic scores. Data updates are indicated by point and annotation. A) Scores resulting from the 2017 QLD Wetlands model (including modified wetlands). B) Scores resulting from the 2019 QLD Wetlands model (excluding modified wetlands).

2.2.4.1 Confidence

Overall confidence for the habitat and hydrology indicator category was 'moderate' (Table 17).

Table 17. Confidence associated with habitat and hydrology index results in freshwater basins for the 2024 Report Card. Confidence criteria are scored 1–3 and then weighted by the value identified in parentheses. Final scores (4.5–13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1 to 5 (very low–very high), which indicates the final confidence level. Where confidence in results for the Don Basin differ from the other basins, the relevant confidence score for the Don is presented in brackets. Unless otherwise specified, confidence in results is the same across basins.

Indicator Category	Maturity of Methodology (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured Error (x0.71)	Final	Rank
Impoundment	2	2	3	2	1	10.3	4
Fish Barriers	1	2 [1]	3 [1]	2	2 [1]	10.6 [5.2]	4 [1]
In-stream Habitat Modification*						**10.4 [7.7]**	**4 [2]**
Riparian Extent	2	2	2	2	2	9	3
Wetland Extent	2	2	2	2	2	9	3
Flow	1	1	2	2	1	7.2	2
Habitat and Hydrology Index						**9**	**3**

*The in-stream habitat modification rank is based on the median final score of impoundment and fish barriers indicators.
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.

2.3 Fish in Freshwater Basins

The fish community index is based on proportions of native and pest fish caught during field surveys. Fish scores are repeated data from 2020-21 monitoring and are due to be updated in the upcoming reporting cycle (Table 5). The fish community index is assessed predominantly using backpack electrofishing techniques, with field monitoring surveys, data collection, and analysis conducted by DESI at sites within each basin in the MWI Region (Figure 25).

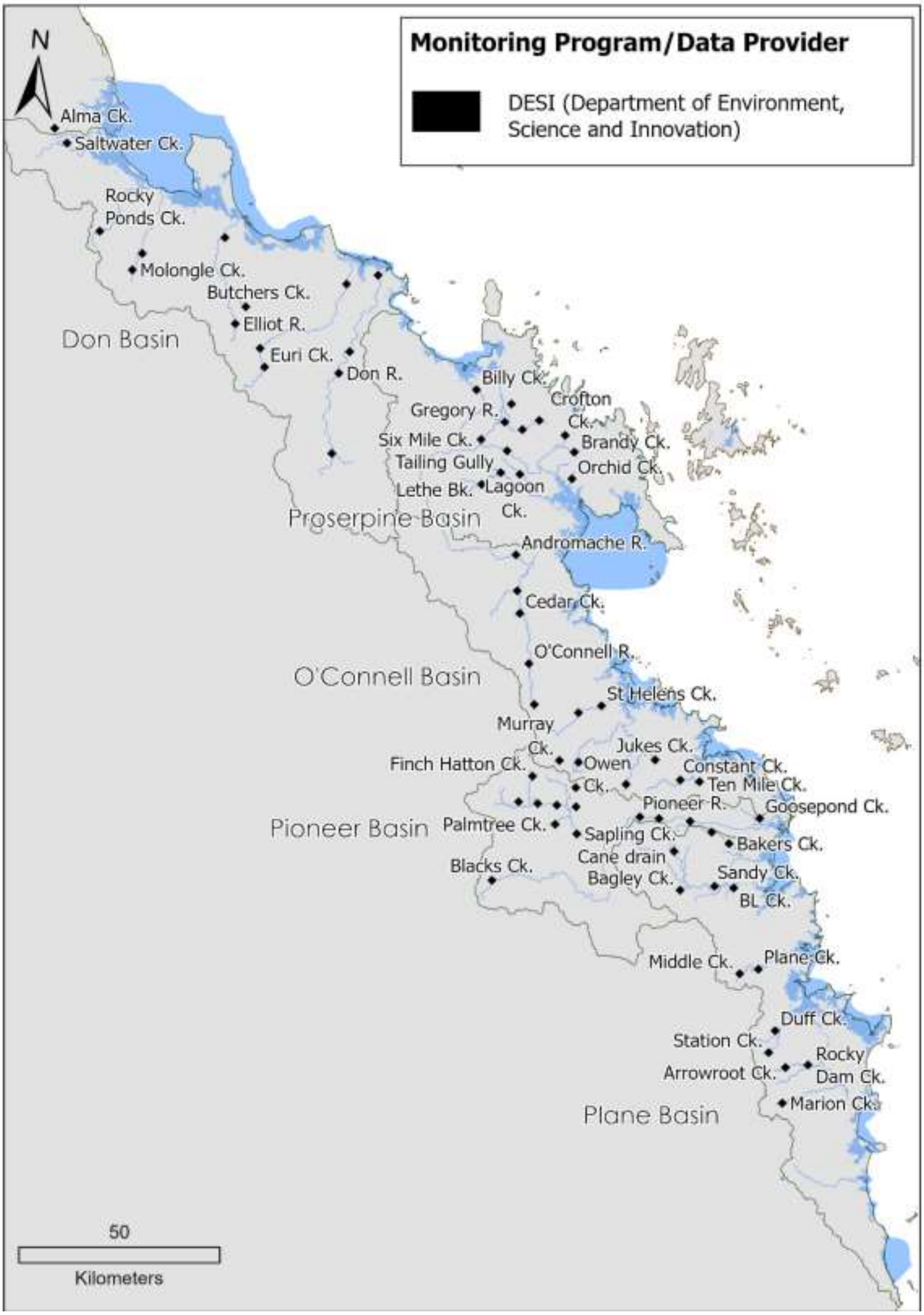

Figure 25. Sampling locations for fish monitoring in the MWI region for the 2024 Report Card (last monitored 2020-21). Fish data provided by the Department of Environment, Science, and Innovation (DESI).

Notes on data interpretation for Report Card results

Baseline: Species richness of sites within the MWI region was assessed using a regression line describing the relationship between the species richness of the 10% most specious samples in relation to the variables describing the natural variation of species richness across the region (D. Moffatt, pers. comm. 19/04/2022). As a pre-development baseline is not available, the results here are relative to this derived baseline to track changes over time (MWI HR2RP, 2024).

Pesticide risk to fish: The ‘good’ to ‘very good’ fish grades appear to be inconsistent with the grades for freshwater pesticides, which are ‘very poor’ in three of the five basins (Section 2.1.3 Pesticides). However, fish grades represent the *species richness* (the number of different species present within a region), rather than the *abundance* or *health* of a species within each waterway.[25] Furthermore, the Pesticide Risk Metric (PRM) is based on the results of toxicity tests that provide measures of the effects of pesticides upon a range of (predominantly non-fish) species. For example, herbicides are designed to target plants (weeds) and are generally 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 are generally 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 likely effected by pesticides are components of fish habitat (e.g. aquatic algae and plants) and diet (e.g. aquatic macroinvertebrates), and there is evidence that agricultural runoff may influence species richness (Parikh et al., 2024) and health (Hook et al., 2018) of fish communities in the region.

Individual site conditions: Grades are calculated based on the median of site-level scores and the overall fish index grades do not necessarily reflect the condition of individual sites. For example, there were sites in each basin that fell into the ‘poor’ grading range for the POISE indicator (Figure 23).

Interpreting grades: Reference condition guideline values for each indicator are reported with discrete ranges to capture broad indicator condition trends over time (MWI HR2RP, 2024). However, this means that the scoring difference between a site being assigned a certain grade (e.g., 'good' versus 'moderate') can be minimal. In the 2020 fish assessment, this should be noted when interpreting the indicator grades for some basins that have medians close to the border of a grade range, such as the Pioneer and Plane Basins for the POISE indicator.

[25] https://healthyriverstoreef.org.au/news/answering-your-questions-on-freshwater-fish-pesticides-and-waterway-health/

Results (2020-21 data, Table 19, Figure 26-28):

Table 18. Results for fish indicators in freshwater basins in the 2024 Report Card (2020–21 data).

2024 Report Card (2020-2021 data)			
Basin	**Proportion of Indigenous Species Expected (POISE)**	**Proportion of Non-Indigenous Fish (PONI)**	**Fish Index**
Don	76	100	**88**
Proserpine	74	86	**80**
O'Connell	69	98	**83**
Pioneer	64	87	**75**
Plane	60	86	**73**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

Key Messages:

1) The Don Basin scored the highest of all basins in the most recent assessments.
2) The Pioneer Basin recorded a grade decline to 'good' in the most recent assessments.
3) The proportion of alien (pest) fish in catches (samples) were graded as 'very good' across all basins in the MWI region for the second consecutive assessment.
4) Native fish species richness in the O'Connell declined from 'very good' to 'good' in the most recent assessments.

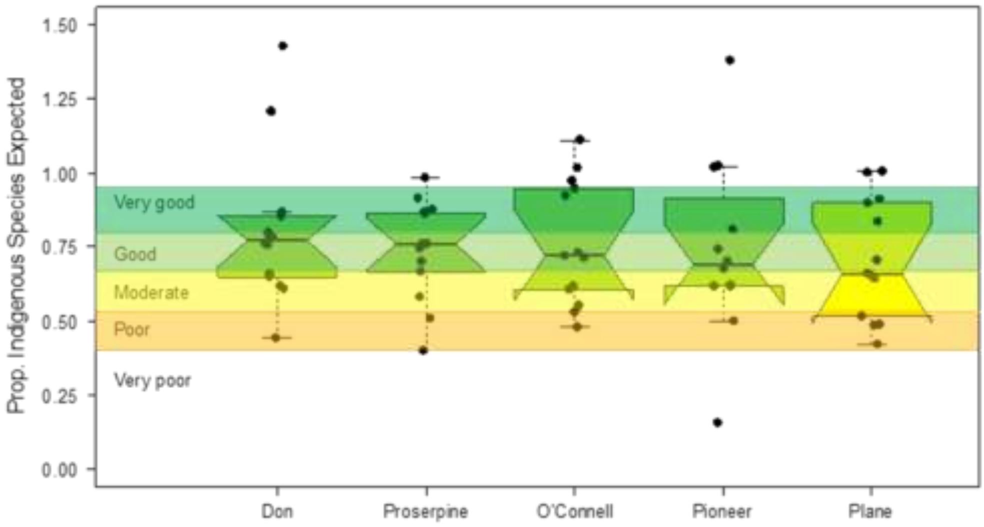

Figure 26. Distribution of the median proportion of indigenous species expected (POISE) for freshwater fish, showing the variability amongst sites within each basin of the MWI region. Coloured bands indicate the range of values that fall within each grade zone. The median value is represented by a horizontal black line, upper and lower whiskers are 1.5 * IQR (inter-quartile range), and notches represent ~95% of median value. Non- overlapping notches suggest significant differences. Folded corners indicate uncertainty of the true median value.

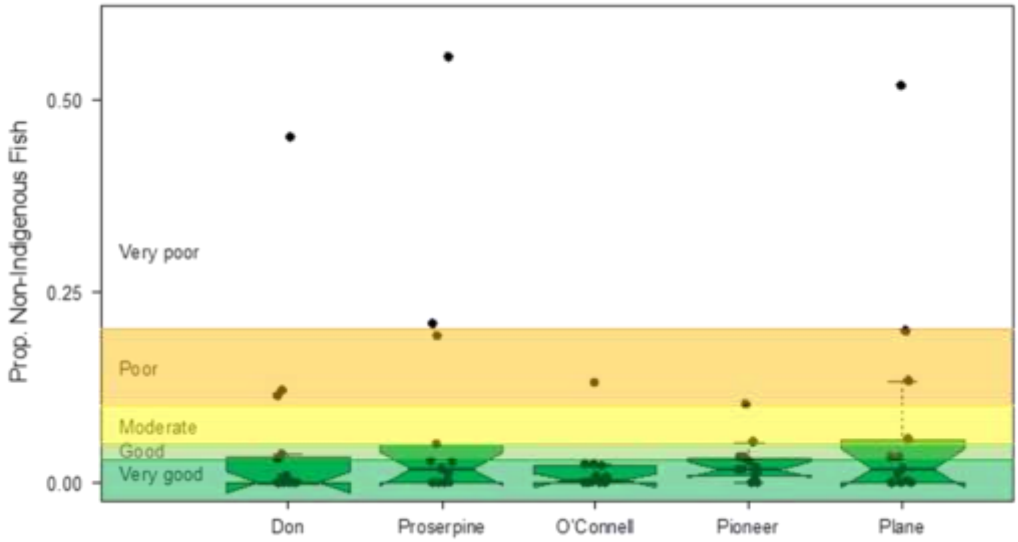

Figure 27. Distribution of the median proportion of non-indigenous (PONI) freshwater fish species, showing the variability amongst sites within each basin of the MWI region. Coloured bands indicate the range of values that fall within each grade zone. The median value is represented by a horizontal black line, upper and lower whiskers are 1.5 * IQR (inter-quartile range), and notches represent ~95% of median value. Non-overlapping notches suggest significant differences. Folded corners indicate uncertainty of the true median value.

Figure 28. Results for fish indicators in freshwater basins in the 2024 Report Card (2020-21 data) compared to historic scores. Historic scores are based on a superseded methodology and are not directly comparable. Fish index is updated every three years, indicated by point and annotation.

2.3.1 Confidence

Confidence associated with freshwater fish results was ‘moderate’ (Table 19).

Table 19. Confidence associated with fish index results in freshwater basins. Confidence criteria are scored 1–3 and then weighted by the value identified in parentheses. Final scores (4.5–13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1 to 5 (very low–very high), which indicates the final confidence level. Unless otherwise specified, confidence in results is the same across basins.

Index	Maturity of Methodology (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured Error (x0.71)	Final	Rank
Proportion of Indigenous Fish Richness (POISE)	2	2	2	3	1	9.0	3
Proportion of Non-Indigenous Fish	2	2	2	3	1	9.0	3
Fish Index						**9.0**	**3**

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.

2.4 Overall Basin Condition

As scores for many indicators are based on repeat data, changes to the overall basin scores in the 2024 Report Card were driven by the water quality index, fish barriers, and flow. There were no grade changes in comparison to the previous Report Card.

Results (Table 20, Figure 29)

Table 20. Condition grades and scores of freshwater basins for the 2024 Report Card.

Freshwater Basin	2024 Report Card				
	Water Quality	Habitat and Hydrology	Fish	Basin Score and Grade	
Don	**59**	**72**	88	**73**	**B**
Proserpine		**54**	80	**67**	**B**
O'Connell	**52**	**41**	83	**58**	**C**
Pioneer	**52**	**39**	75	**55**	**C**
Plane	**37**	**45**	73	**51**	**C**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

Key Messages:

1) The Don Basin recorded the largest difference in score, where an improvement in water quality (likely due to the increase in sampling) counterbalanced the decline in fish barriers score (due to habitat modification from development).

2) The northern basins (Don and Proserpine) generally scored higher across water quality indicators than the southern Pioneer and Plane Basins, potentially indicating differences in land use intensity across the region, and the exclusion of the water quality index from Proserpine Basin reporting.

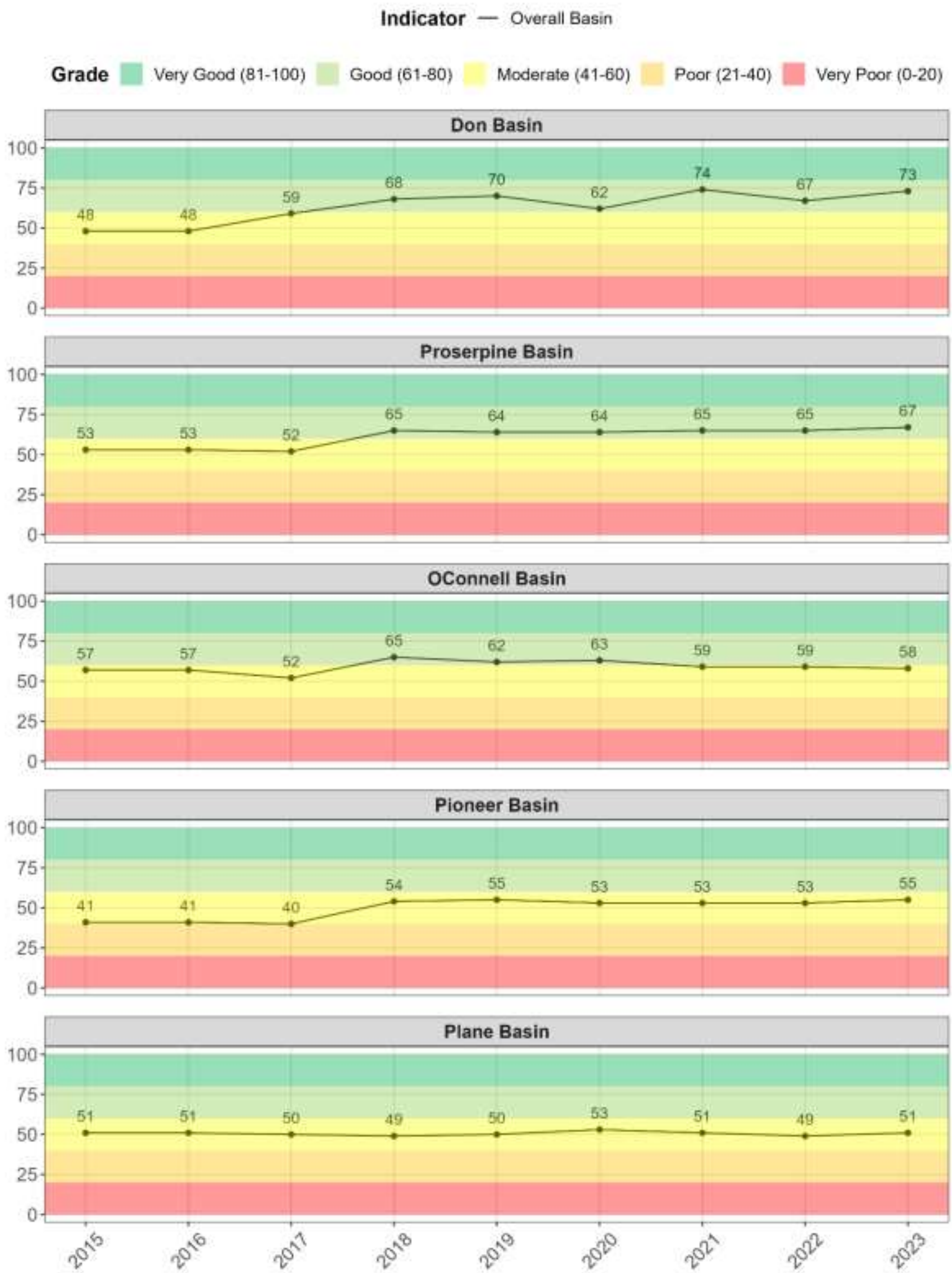

Figure 29. Condition grades and scores of freshwater basins for the 2024 Report Card compared to the historic record. Data updates are indicated by point and annotation. A) Scores resulting from the 2017 QLD Wetlands model (including modified wetlands). B) Scores resulting from the 2019 QLD Wetlands model (excluding modified wetlands).

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3 Estuary Results

The overall estuary grade is derived from the habitat and hydrology and water quality indices (Figure 30). There is no established methodology for the assessment of estuarine fish, therefore no score is reported for this index. Due to minimal data availability, flow is currently not reported for estuaries. Indicator categories and indicators within two indices, water quality and habitat and hydrology, are reported annually or on four-year cycles respectively (Table 21).

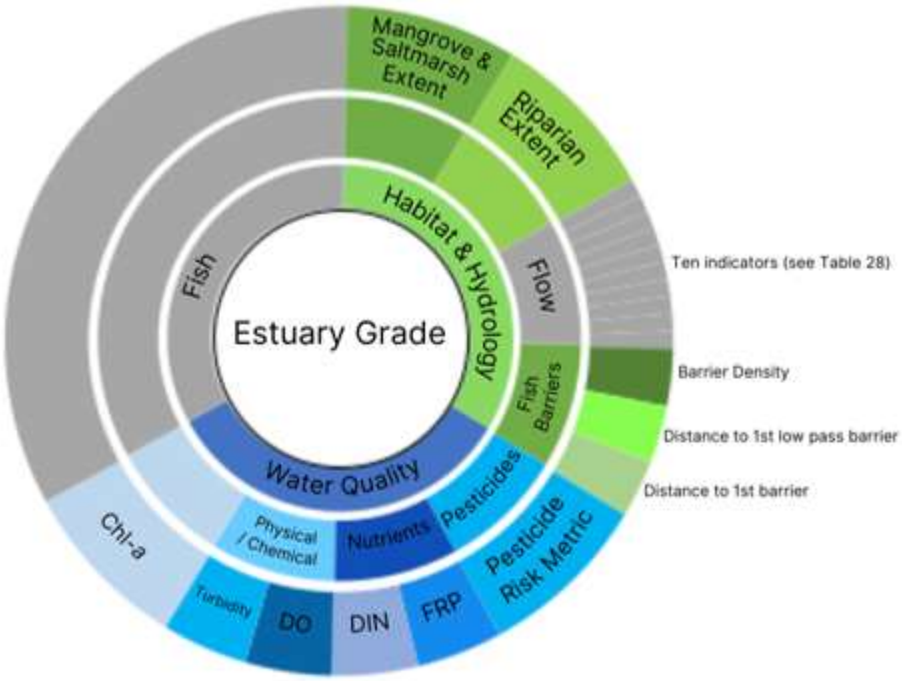

Figure 30. Estuary Indicators (outer ring), indicator categories (middle ring) and indices (inner ring) that contribute to overall scores.

Table 21. Estuary frequency of reporting for specific indicator categories and their update status for the 2024 Report Card.

Index	Indicator Categories	Frequency of Reporting	Last Updated
Water Quality	Phys–chem	Annually	**2023**
	Nutrients	Annually	**2023**
	Chlorophyll-*a*	Annually	**2023**
	Pesticides	Annually	**2023**
Habitat and Hydrology	Flow		
	Riparian Vegetation	4 Yearly	**2022**
	Mangrove and Saltmarsh	4 Yearly	**2022**
	Fish Barriers	4 Yearly	**2023**
Fish			

3.1 Water Quality in Estuaries

Scores and grades for estuaries reported in the MWI Region are based on monitoring conducted in the following tidal waterways: Gregory River, O'Connell River, St Helens Creek, Murray Creek, Vines Creek, Sandy Creek, Plane Creek, Rocky Dam Creek, and Carmila Creek (Figure 31). Indicators used to report on the water quality index in estuaries include nutrients (DIN, FRP), physical-chemical (turbidity, dissolved oxygen (DO)), Chlorophyll-*a* (Chl-*a*), and pesticides (which are reported using the PRM).

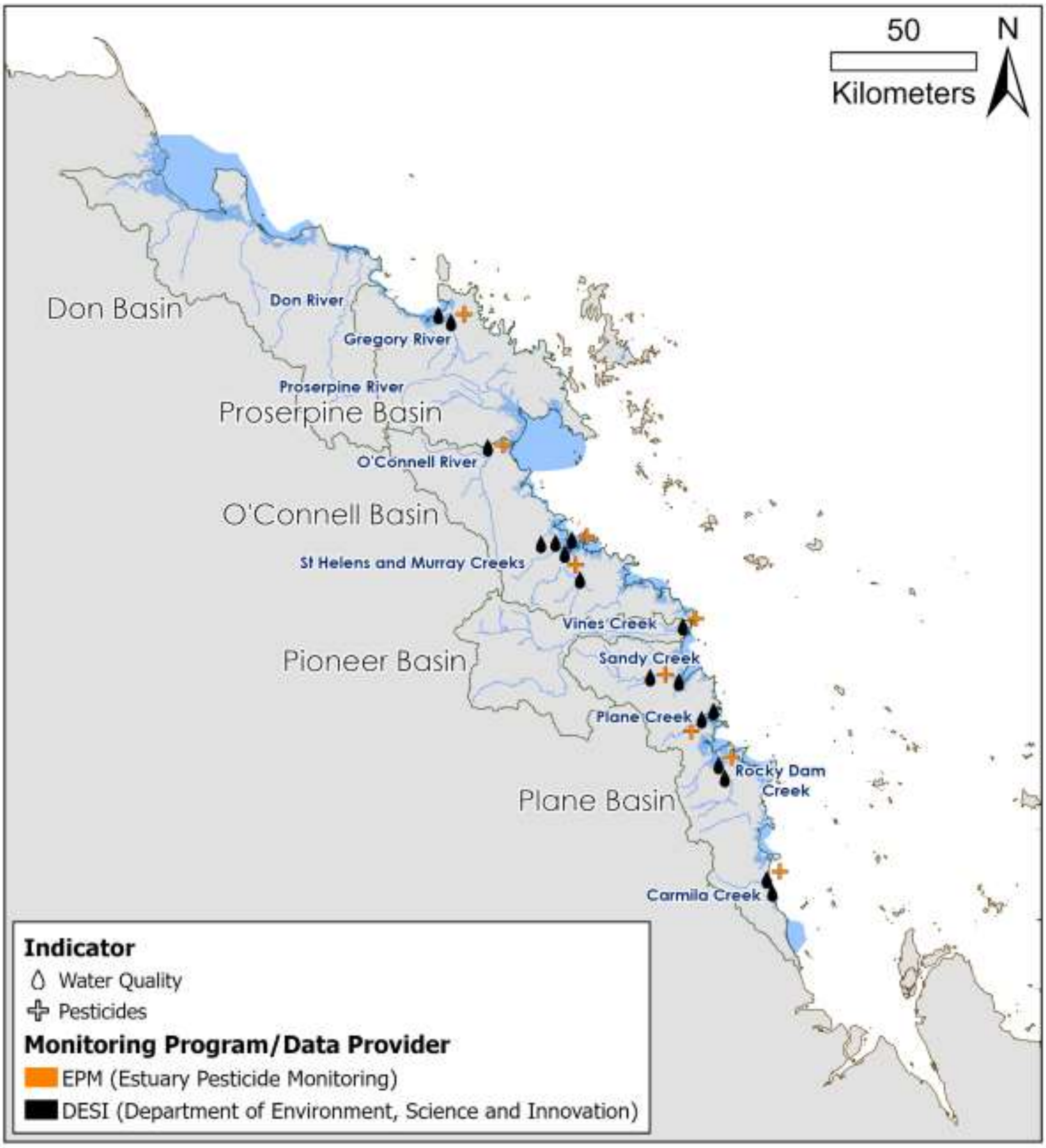

Figure 31. Sample locations for estuary water quality and pesticides monitoring for the MWI region for the 2024 Report Card. Water quality data (including pesticides) provided by the QLD Department of Science and Innovation (DESI); additional pesticide data provided by a Partnership-funded initiative and the CLMP.

Notes on data interpretation for Report Card results

Sampling regime and climatic variability: Estuarine water quality samples in this Report Card are collected via ambient grab sampling at a regular interval (i.e., one sample per month for most indicators) and may be influenced disproportionately by the timing of rainfall events (e.g., rainfall) relative to the sampling schedule.

3.1.1 Nutrients

Nutrient scores were based upon the reported concentrations of DIN (Oxidised nitrogen [$NO_2 + NO_3$] + ammonia [NH_3]) and FRP.

Results (Table 22, Figure 32, Figure 33, Appendix 8.3)**:**

Table 22. Results for DIN and FRP indicators and nutrients indicator category in estuaries for the 2024 Report Card (2022-23 data).

Estuary	2024 Report Card (2022-23 data)		
	DIN	FRP	Nutrients
Gregory River	69	90	**79**
O'Connell River^	60	78	**69**
St Helens/Murray Creek	52	73	**63**
Vines Creek	30	90	**60**
Sandy Creek	47	62	**54**
Plane Creek	61	90	**75**
Rocky Dam Creek	46	90	**68**
Carmila Creek	56	90	**73**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = assigned 90 | ■ No score/data gap

^ DIN and FRP concentration data for the O'Connell River estuary are taken from the basin monitoring site.

Key Messages:

1) Gregory was the only estuary to record a change in grade, declining from 'very good' to 'good' due to increased concentrations of DIN.
2) All estuaries recorded a grade of 'good' or above for FRP.
3) DIN grades declined in Carmila Estuary ('good' to 'moderate')
4) DIN grades improved in Rocky Dam and Sandy Creek Estuaries (both 'poor' to 'moderate'). This marks the second consecutive year of improvement for DIN in Sandy Creek.

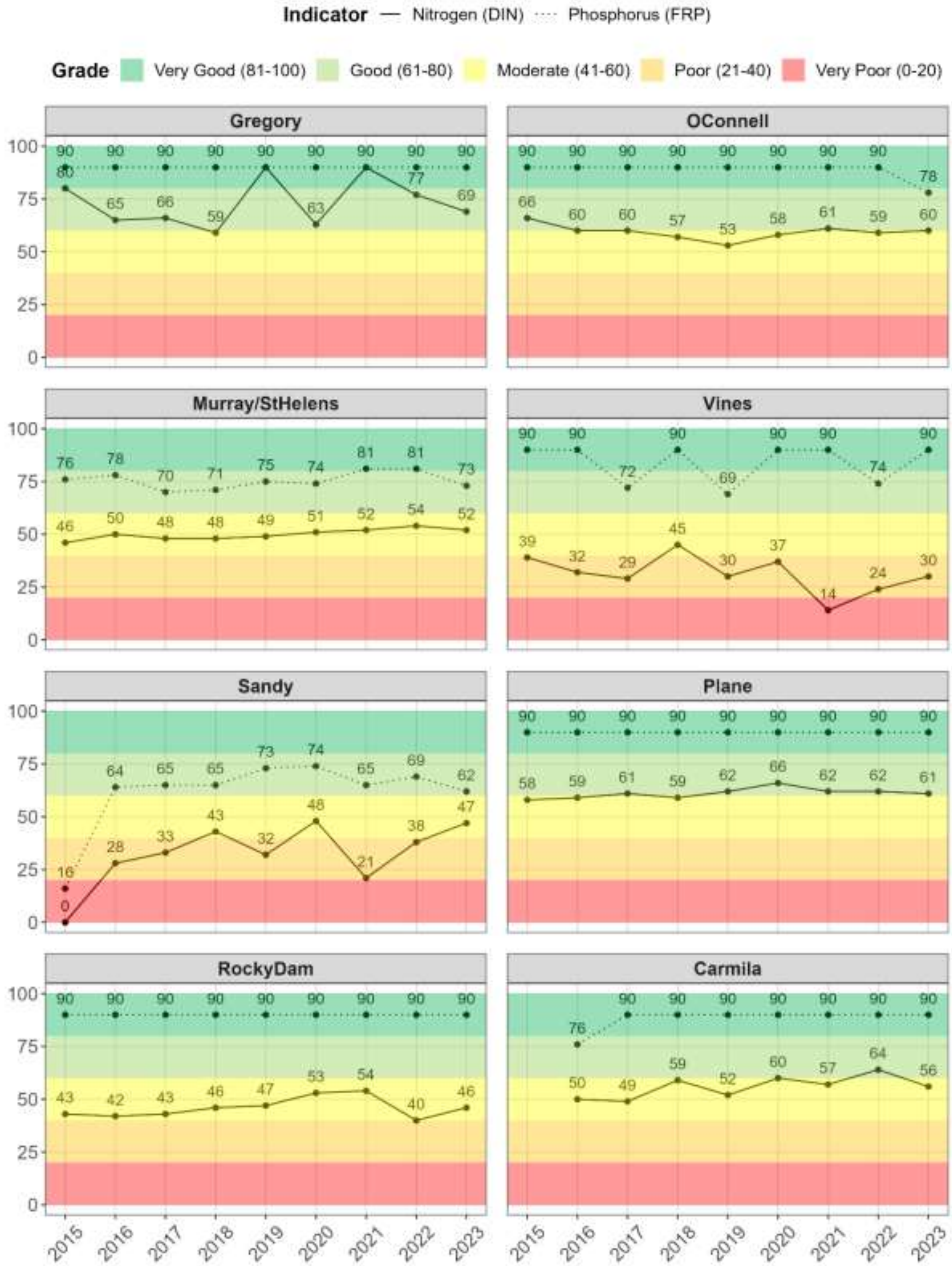

Figure 32. Results for nutrients indicators (DIN and FRP) in estuaries for the 2024 Report Card (2022-23 data) compared to the historic record.

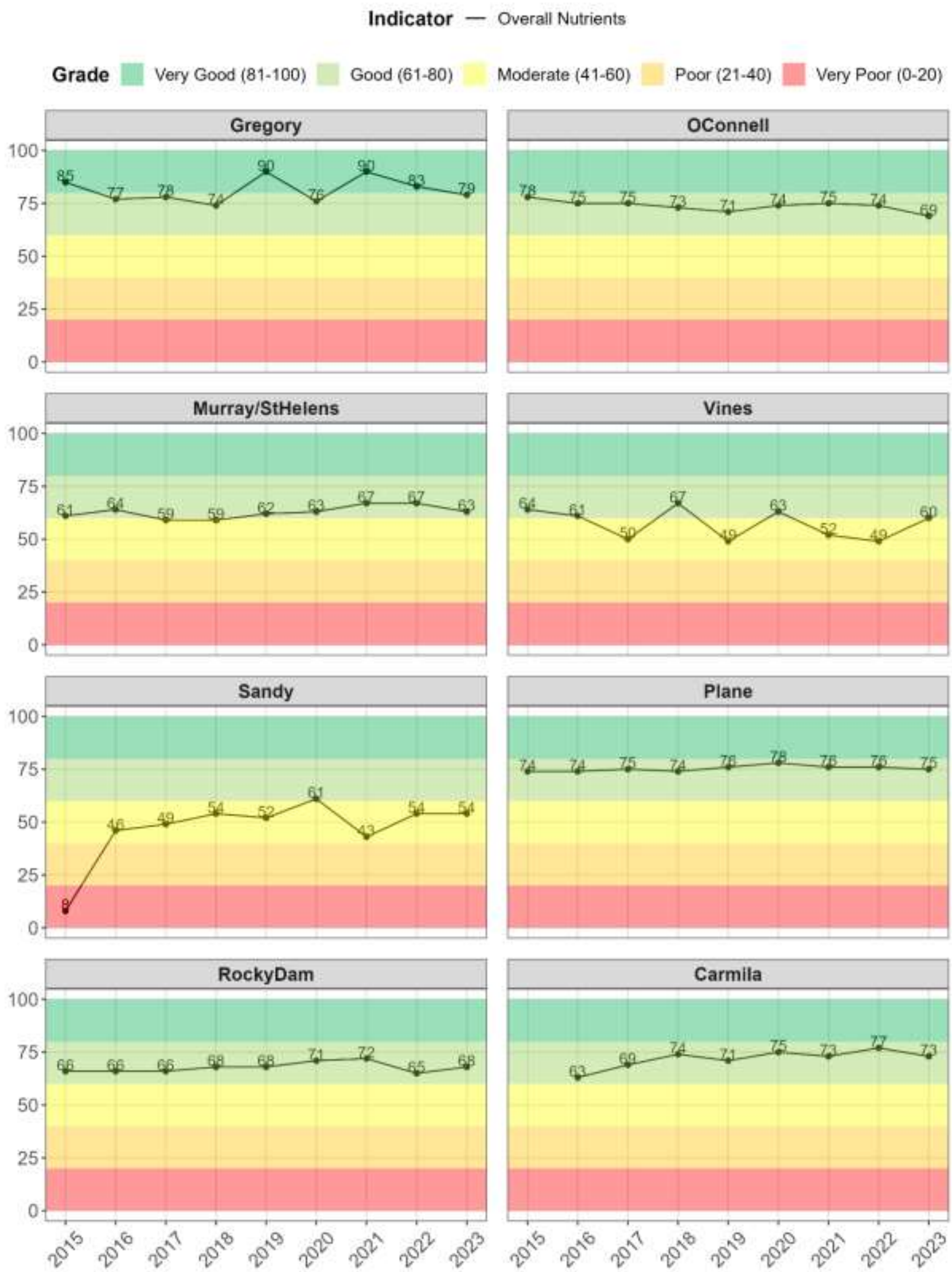

Figure 33. Results for nutrients indicator category in estuaries for the 2024 Report Card (2022-23 data) compared to the historic record.

3.1.2 Chlorophyll-*a*

Results (Table 23, Figure 34, Appendix 8.3)

Table 23. Chlorophyll-*a* (Chl-*a*) indicator scores within estuaries for the 2024 Report Card (2022-23 data).

Estuary	2024 Report Card (2022-23 data)
	Chl-*a*
Gregory River	52
O'Connell River^	41
St Helens/Murray Creek	32
Vines Creek	46
Sandy Creek	77
Plane Creek	69
Rocky Dam Creek	32
Carmila Creek	34

■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

^ Data used to evaluate the O'Connell River estuary are taken from an end-of-catchment monitoring site within the O'Connell River, which is also used to monitoring nutrients within freshwater basins.

Key Messages:

1) Chl-a scores improved by 24 points in both Rocky Dam and Carmila Estuaries, reversing a decreasing trend over the previous years.
2) The Gregory and Murray/St Helens Estuaries recorded their worst chl-*a* scores (52, and 32, respectively) since the Report Card's inception.

Since the inception of the Report Card, there has been a **general increasing trend for chl-*a* concentrations** in the Gregory, and Murray/St Helens estuaries. Despite the noticeable trend, no obvious reasons have been identified (A. Moss, pers. comm. 24/01/2023). Continued monitoring may help to determine if this is due to natural variability or other causes.

Rocky Dam Estuary reversed the decreasing trend in Chl-*a* scores, improving from 'very poor' to 'poor'. Both Rocky Dam and **Carmila Creek Estuary** saw improvements during the 2022-23 reporting cycle. Chl-*a* often exceeds guideline values at Carmila Creek; however, it is usually not found at extremely high concentrations. Results of a recent Partnership-funded pilot study conducted by CQUniversity's Coastal Marine Ecosystems Research Centre suggested that the timing of sampling in relation to rainfall events is relevant to interpretation of these results. The small size of the catchment and creek and the large tidal range are likely to influence results at this site (Flint et al., 2022).

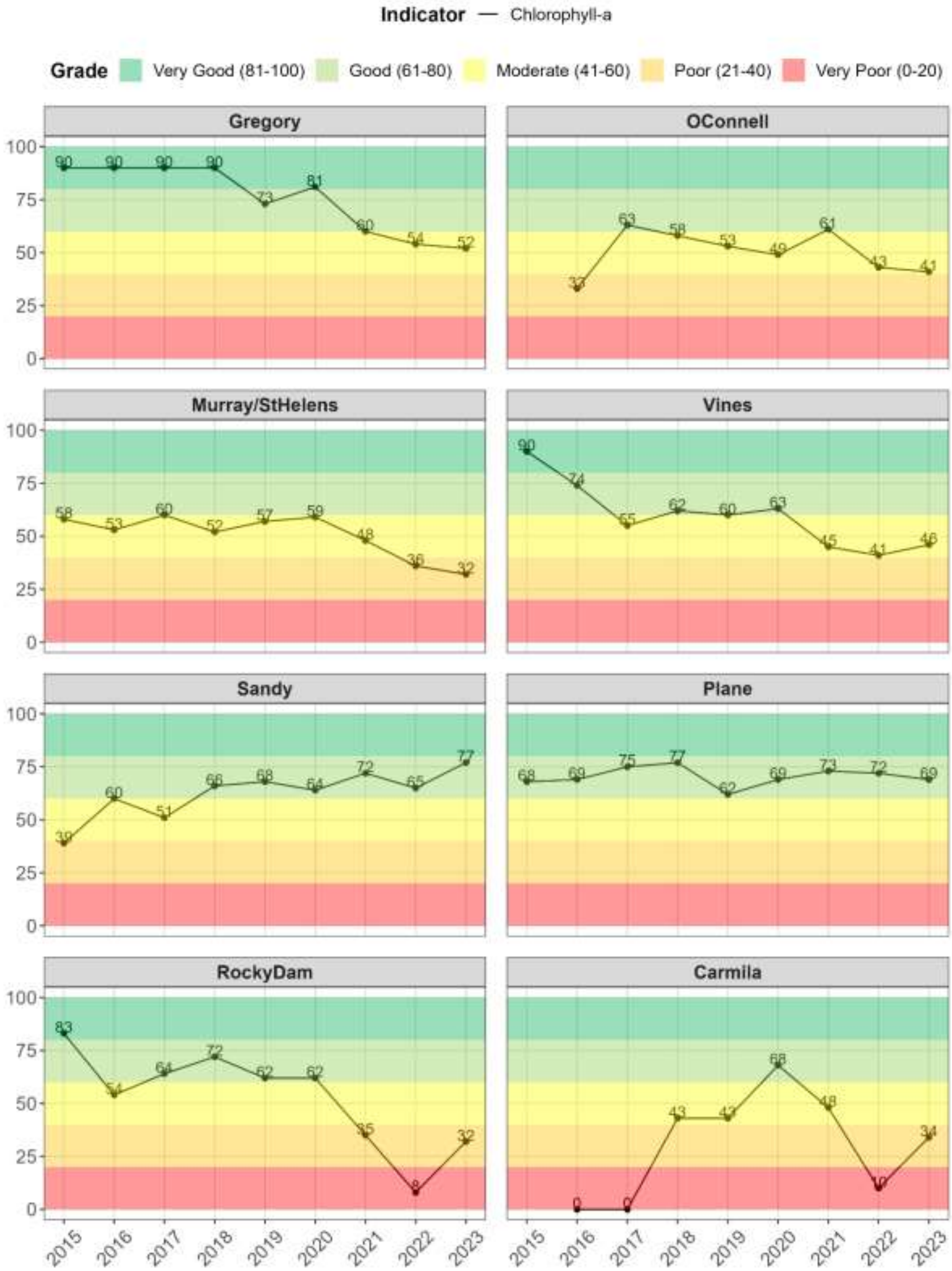

Figure 34. Chlorophyll-*a* (Chl-*a*) indicator scores within estuaries for the 2024 Report Card (2022-23 data) compared to the historic record.

3.1.3 Phys–chem

Notes on data interpretation for Report Card results

Phys–chem scores: The phys–chem indicator category scores were generated by the aggregation of the turbidity and DO indicators. The reported DO indicator scores were based on two metrics derived from percent oxygen saturation of each sample, with lower DO comparing saturation against lower limit GV, and upper DO comparing percent saturation against upper limit GV. To avoid over-representation of the DO indicator in the final score, the worst scoring result of the two (upper and lower DO) was adopted as the DO score for aggregation into the phys-chem indicator category.

Lack of guideline values: A turbidity score was not calculated for the four estuaries south of Mackay (Sandy, Plane, Rocky Dam, and Carmila Creek Estuaries), as the draft guidelines for MWI estuaries characterised turbidity as too variable to derive a suitable guideline (Newham et al., 2017).

Results (Table 24, Figure 35, Figure 36, Appendix 8.3):

Table 24. Results for turbidity, DO, and aggregated phys–chem indicator category within estuaries for the 2024 Report Card (2022-23 data). The aggregated phys–chem score is calculated by averaging the poorer DO score with the turbidity score. In the absence of a suitable turbidity score phys–chem results are derived from the condition of DO.

Estuary	**2024 Report Card (2022-23 data)**			
	Turbidity	**Lower DO**	**Upper DO**	**Phys–chem**
Gregory River	76	90	90	**83**
O'Connell River^	73	90	56	**65**
St Helens/Murray Creek	57	90	90	**73**
Vines Creek	78	81	90	**79**
Sandy Creek		90	90	**90**
Plane Creek		90	90	**90**
Rocky Dam Creek		90	90	**90**
Carmila Creek		90	71	**71**

Scoring range ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ No score/data gap

DO and turbidity ■ Very Good = assigned 90 |**Phys–chem** ■ Very Good = 81 to 100

^ Data used to evaluate the O'Connell River estuary are taken from an end-of-catchment monitoring site within the O'Connell River, which is also used to monitor nutrients within freshwater basins.

Key Messages:

1) Phys–chem grades improved in the **Gregory River** and **Vines Creek** estuaries. Both had an improved lower DO grade. The turbidity score improved at Vines Creek, while a decline in turbidity grade at Gregory River did not negatively influence the overall phys-chem grade.

2) **O'Connell River** grade remained 'good', where a decline in upper DO grade balanced an improvement in turbidity grade.

Turbidity scores in the O'Connell improved from 'poor' to 'good', likely due to the timing of samples relative to rainfall events.

DO Both Gregory and Vines Estuaries improved lower DO grade. The fluctuation at Vines in recent years may be related to the timing of sampling in relation to rainfall events (A. Moss, pers. comm. 24/01/2023). Vines was the only estuary where the lower DO score was poorer than the upper DO. O'Connell River declined from 'very good' to 'moderate' in upper DO.

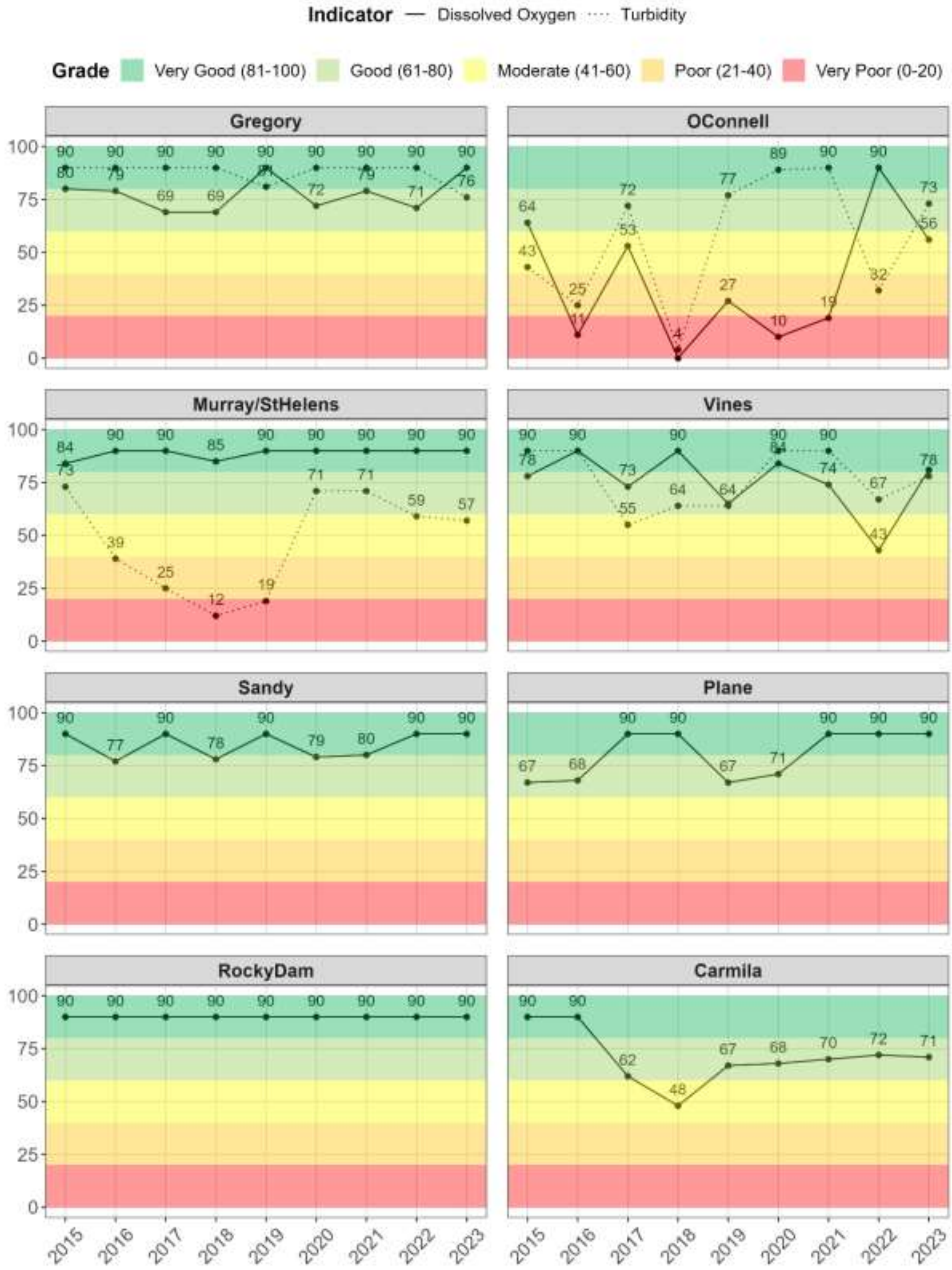

Figure 35. Results for phys-chem indicators (DO and NTU) in estuaries for the 2024 Report Card (2022-23 data) compared to the historic record. The southern most-estuaries in the region do not record turbidity as there is no suitable Guideline Value.

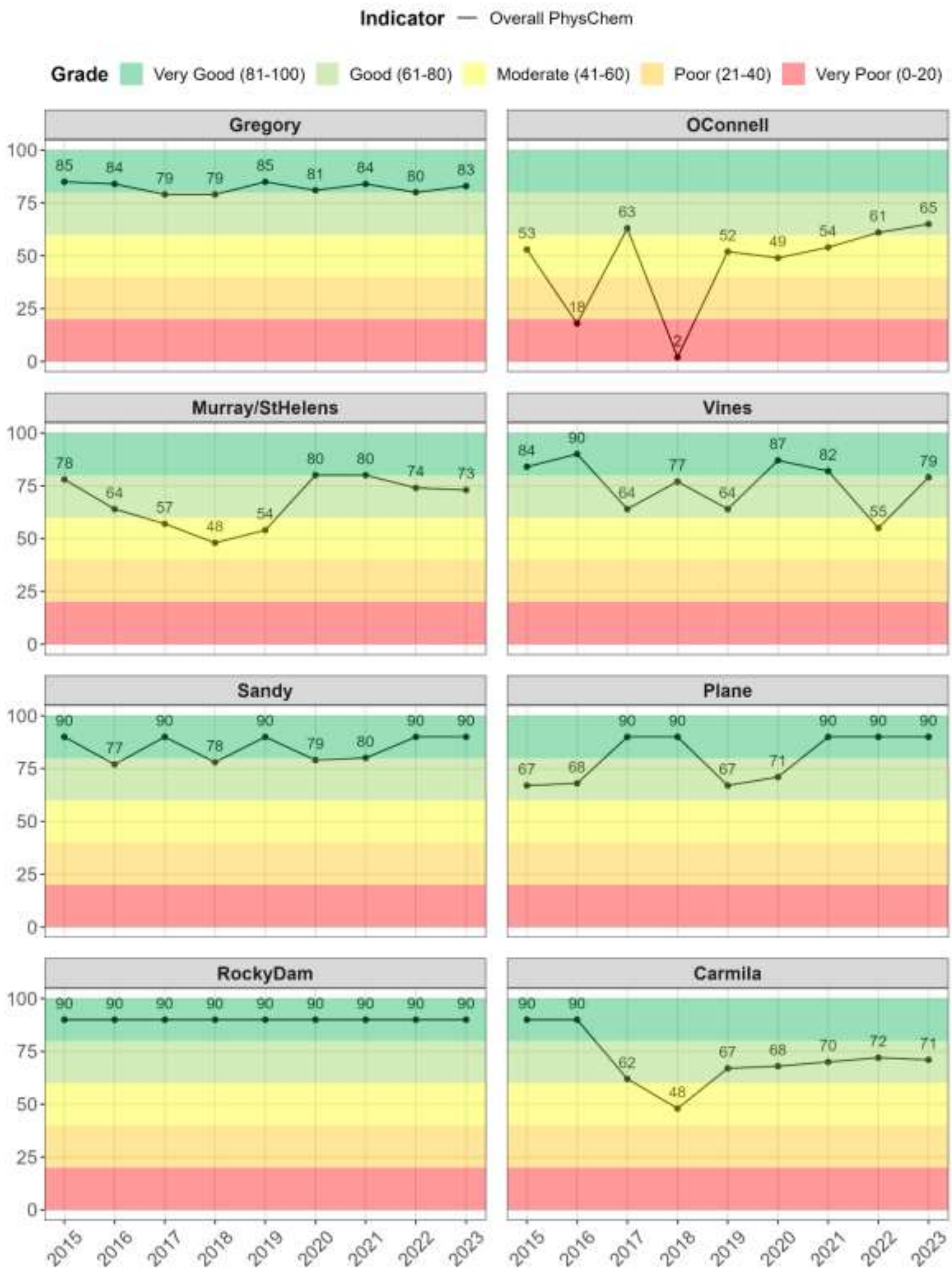

Figure 36. Results for aggregated phys–chem indicator category within estuaries for the 2024 Report Card in comparison to historic scores for phys–chem. The aggregated phys–chem score is calculated by averaging the poorer DO score with the turbidity score. In the absence of a suitable turbidity score, phys–chem results are derived from the poorer DO score.

3.1.4 Pesticides

Reporting of pesticides in the MWI estuaries follow methods adopted for freshwater basins, where measured concentrations of up to 22 different pesticides in each sample are converted to a Pesticide Risk Metric (PRM). The PRM is expressed as a level of risk in terms of the percentage of aquatic species that may be adversely affected/protected by a mixture of pesticides (Warne et al., 2020, 2023). Further information is presented in the Methods Report (MWI HR2RP, 2024).

Results (Table 25, Figure 37, Figure 38)**:**

Table 25. Results for the Pesticide Risk Metric (PRM) indicator accounting for 22 pesticides, expressed as aquatic species protected (%) and associated standardised pesticide score, for eight estuaries in the MWI Region in the 2024 Report Card (2022-23 data).

Estuary	2024 Report Card (2022-23 data)	
	PRM (% species protected)	Standardised Pesticide Score
Gregory River	98	**80**
O'Connell River^	88	**37**
St Helens/Murray Creek	95	**65**
Vines Creek	96	**68**
Sandy Creek	84	**30**
Plane Creek	98	**79**
Rocky Dam Creek	88	**37**
Carmila Creek	99	**92**

Species protected scoring range: ■ Very Poor = <80% | ■ Poor = <90 to 80% | ■ Moderate = <95 to 90% | ■ Good = <99 to 95% | ■ Very Good = ≥99% | ■ No score/data gap
Pesticides grade scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap
Risk level: ■ Very high risk | ■ High risk | ■ Moderate risk | ■ Low risk | ■ Very low risk
^ Data used to evaluate the O'Connell River estuary are taken from an end-of-catchment monitoring site within the O'Connell River which is also used to monitor nutrients within freshwater basins.

Key Messages:

1) The Sandy Creek, O'Connell River, and Rocky Dam estuaries recorded results that highlight 'high' risk that estuarine species experience toxic effects due to pesticide concentrations. There is a strong need to adopt management measures to mitigate impacts to aquatic biota in the catchments where the pesticides are applied.

2) Diuron, imidacloprid, and to a lesser extent, metolachlor, imazapic, and atrazine, were key contributors to the overall PRM throughout the region. Exceptions included Plane Creek, where metsulfuron-methyl (a herbicide) was a key contributor. Metsulfuron-methyl is not registered for use in sugarcane and applications may be related to urban and/or industrial use.

3) Grade improvements were seen in Murray/St Helens, Vines (both 'moderate' to 'good'), and Sandy Creek ('very poor' to 'poor'). Vines Estuary saw the largest improvement of all monitored estuaries (due in part to reduced concentrations of metsulfuron-methyl detected during sampling), although diuron (a herbicide) and fipronil (an insecticide) remained key contributors to the risk.

4) Rocky Dam was the only estuary that had a grade decline in the current reporting period, from 'moderate' to 'poor'. This was due to increased risk from diuron.

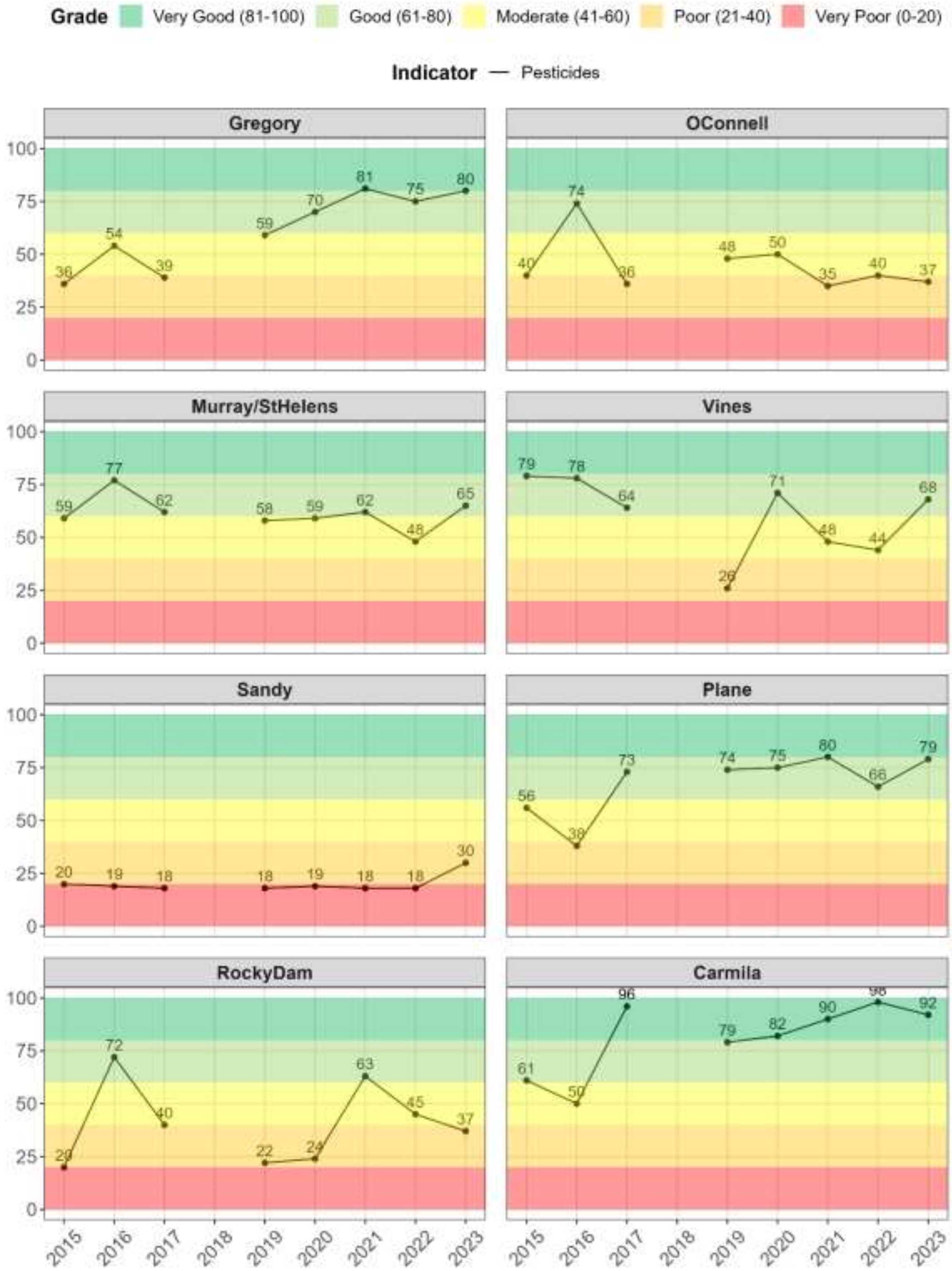

Figure 37. Results for the Pesticide Risk Metric (PRM) indicator accounting for 22 pesticides, expressed as standardised pesticide score, for eight estuaries in the MWI Region in the 2024 Report Card (2022-23 data) compared to the historic record. Note that there were no estuary pesticides scores in 2018 due to a gap in funding.

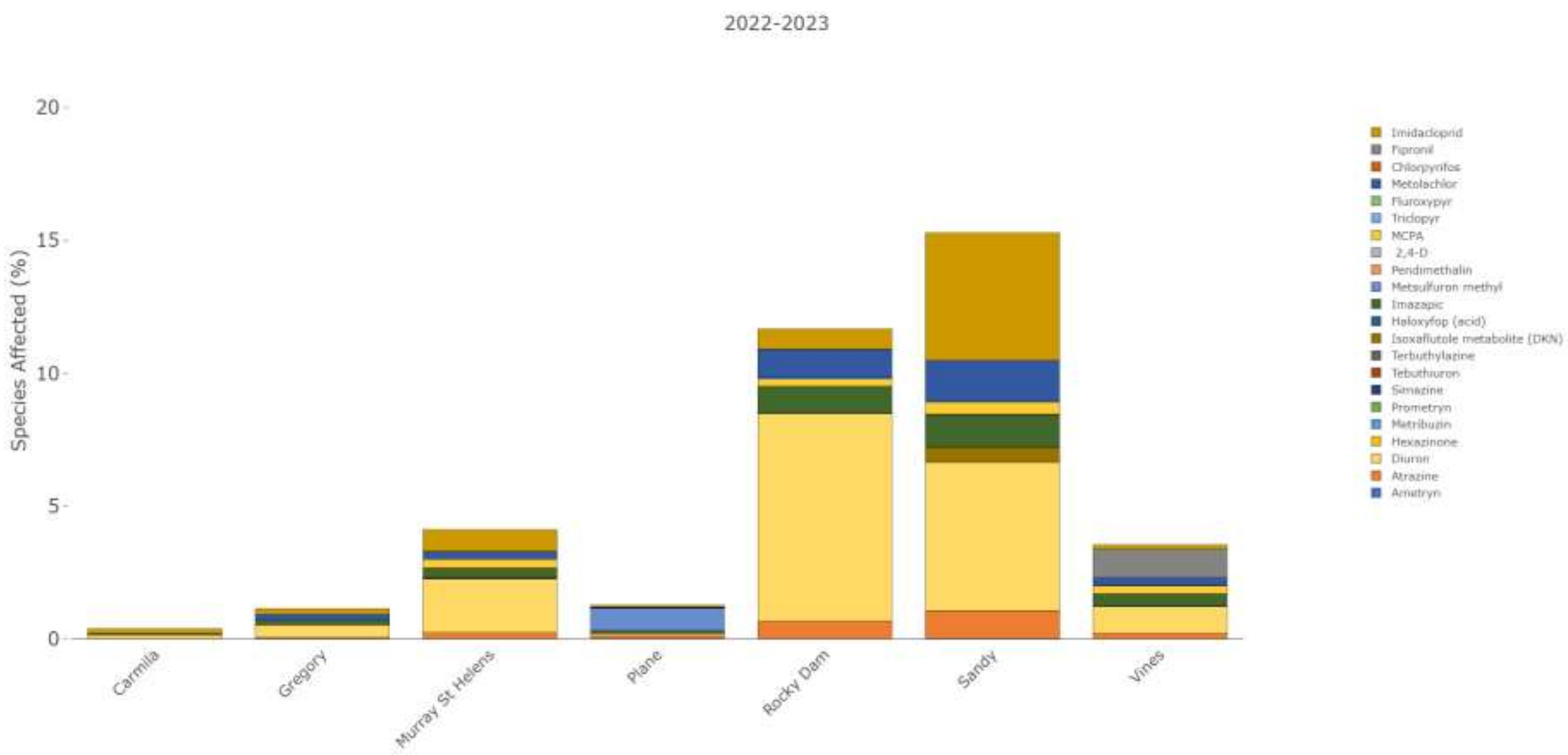

Figure 38. Proportional contribution of each pesticide to as the total percentage of species affected (PAF) as calculated using the Pesticide Risk Metric (PRM) for the 2022–23 reporting year in the MWI estuaries. Source: QLD Government, GBR CLMP.

3.1.5 Water Quality Index Scores

Notes on data interpretation for Report Card results

O'Connell data source: Data used to derive the O'Connell River Estuary water quality index are taken from an end-of-catchment monitoring site on the O'Connell River, which is also used to monitor water quality within freshwater basins.

Results (Table 26, Figure 39, and Appendix 8.3)**:**

Table 26. Results for water quality indicator categories and overall index scores in estuaries for the 2024 Report Card (2022-23 data).

Estuary	2024 Report Card (2022-23 data)				
	Phys–chem	Nutrients	Pesticides	Chl-*a*	Water Quality Index
Gregory River	83	79	80	52	73
O'Connell River^	65	69	37	41	53
St Helens/Murray Creek	73	63	65	32	58
Vines Creek	79	60	68	46	63
Sandy Creek	90	54	30	77	63
Plane Creek	90	75	79	69	78
Rocky Dam Creek	90	68	37	32	56
Carmila Creek	71	73	92	34	68

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

^ Data used to evaluate the O'Connell River estuary are taken from an end-of-catchment monitoring site within the O'Connell River, which is also used to monitor nutrients within freshwater basins.

Key Messages:

1) Improvement in Sandy Creek Estuary grade from 'moderate' to 'good' was driven by improvements in both pesticides and chl-*a* scores.
2) Improvement in Vines Estuary grade from 'moderate' to 'good' was influenced by improvements in all indicator categories, with the largest improvements in phys-chem and pesticides.

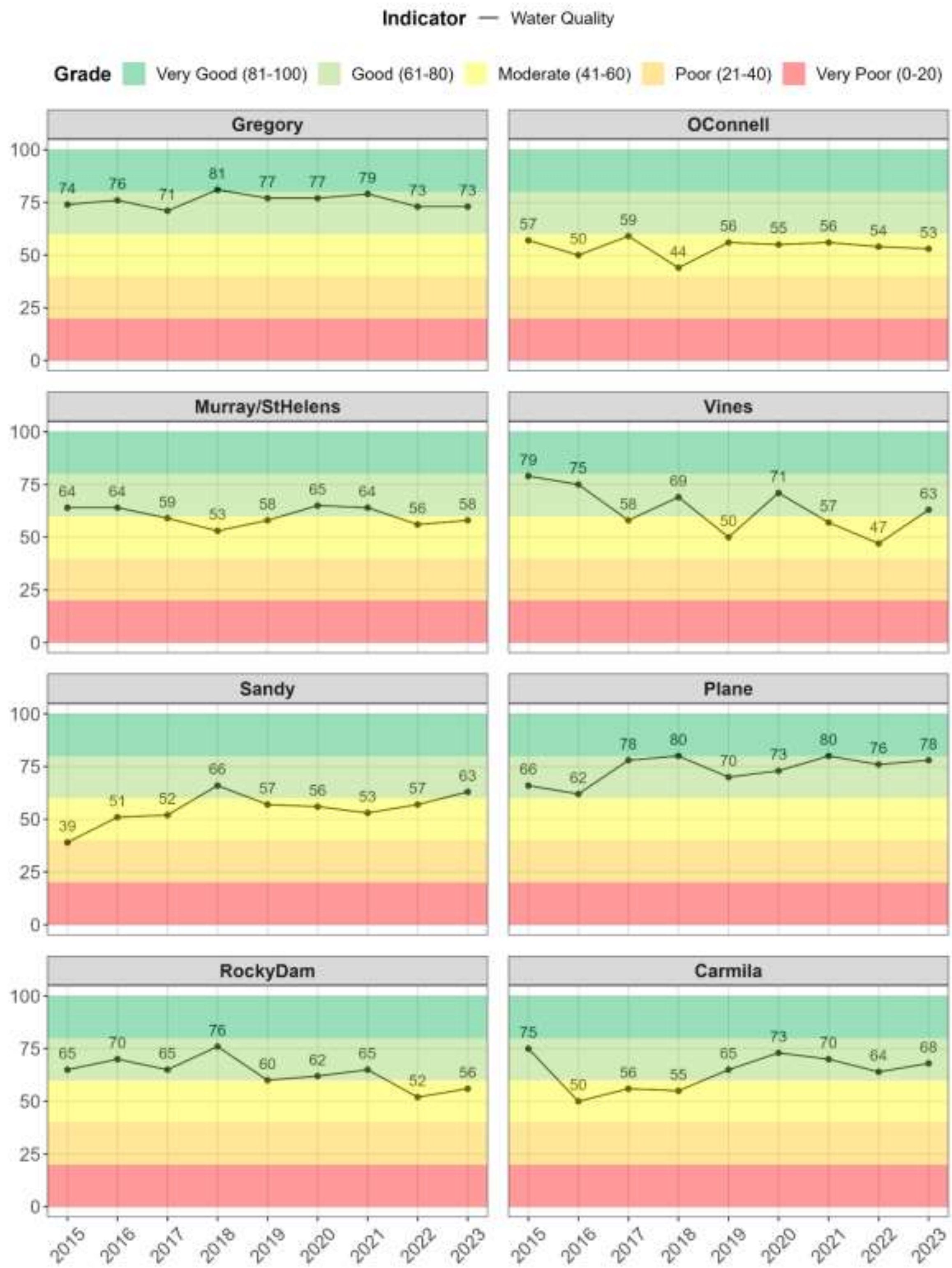

Figure 39. Results for overall water quality index scores in estuaries for the 2024 Report Card (2022-23 data) in comparison to historic Report Card scores.

3.1.5.1 Confidence

Lower confidence scores in some O'Connell, Vines, and Carmila Creek estuary water quality scores (designated by brackets) are due to data collection occurring at only one sample site. Higher confidence scores in other estuaries reflects higher spatial representation (Table 27).

Table 27. Confidence associated with water quality index results in estuaries for the 2024 Report Card (2022-23 data). Confidence criteria are scored 1–3 and then weighted by the value identified in parentheses. Final scores (4.5–13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1 to 5 (very low–very high), which indicates the final confidence level. Where confidence in results for the O'Connell River and Vines Creek and Carmila Creek estuaries differ from the other estuaries, the relevant confidence scores for these estuaries are presented in brackets. Unless otherwise specified, confidence in results is the same across estuaries.

Indicator Category	Maturity of Methodology (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured Error (x0.71)	Final	Rank
Phys–chem	3	3	1.5 [0.5]	3	1	9.1 [7.1]	3 [2]
Nutrients	3	3	1.5	3	1	9.1 [7.1]	3 [2]
Chl-*a*	3	3	1.5	3	1	9.1 [7.1]	3 [2]
Pesticides	3	3	1	3	2	8.8	3
Water Quality Index						**10.1 [8.1]**	**3 [2]**
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.							

3.2 Habitat and Hydrology in Estuaries

Habitat and hydrology assessments in the estuaries are derived from three indicators: fish barriers, riparian extent, and mangrove/saltmarsh extent. Vegetation condition in estuaries is assessed using the same principles as in basins, where the target area begins at the estuary mouth and continues upstream to the tidal limit. Reporting cycles for the habitat and hydrology indicators are detailed in each section below and in Table 22.

3.2.1 Fish Barriers

Similar to freshwater basins, the estuary fish barriers indicator is updated every four years, most recently in the current reporting cycle. An assessment on fish barriers for the MWI region (Power et al., 2022) provided the basis for a report on fish barrier scores (Moore & Power, 2023).

Results (2022-23 data, Table 28, Figure 40):

Table 28. Results for fish barrier indicators in estuaries in the 2024 Report Card (2022-23 data).

Estuary	2024 Report Card (2022-23 data)							
	Barrier Density		Stream (%) to the First Barrier		Stream (%) to 1st Low "Passability" Barrier		Fish Barriers	
	km per barrier on SO ≥3	Score	% of stream before 1st barrier on SO ≥3	Score	% of stream before 1st low pass barrier on SO ≥4	Score	Total Score	Fish Barriers (standardised)
Gregory River	17.4	5	90.9	4	96.7	4	13	80
O'Connell River	4.7	3	81	4	98	4	11	61
St Helens/Murray Creek	2.3	2	65.1	3	83.5	3	8	41
Vines Creek	6.7	3	83	4	NLPB	5	12	70
Sandy Creek	2.7	2	62.1	3	90.1	4	9	50
Plane Creek	1.7	1	43.8	2	71.3	2	5	21
Rocky Dam Creek	4.7	3	68	3	NLPB	5	11	61
Carmila Creek	NB	5	NB	5	NLPB	5	15	100

Barrier Density: ■ Very Poor = 0 to 2 km (1) | ■ Poor = >2 – 4 km (2) | ■ Moderate = >4 – 8 km (3) | ■ Good = >8 – 16 km (5) | ■ Very Good = >16km (5) | ■ No score/data gap

% of Stream Before 1st Barrier: ■ Very Poor = 0 to 10% (1) | ■ Poor = >10 – 30% (2) | ■ Moderate = >30-70% (3) | ■ Good = >70-90% (5) | ■ Very Good = >90% (5) | ■ No score/data gap

% of Stream to 1st Low Passability Barrier: ■ Very Poor = 0 to 50% (1) | ■ Poor = >50 – 60% (2) | ■ Moderate = >60-70% (3) | ■ Good = >70-95% (5) | ■ Very Good = >95% (5) | ■ No score/data gap

Total Score: ■ Very Poor = 3-4 | ■ Poor = 5-7 | ■ Moderate = 8-10 | ■ Good = 11-13 | ■ Very Good = 14-15

Standardised: ■ Very Poor = 0-20 | ■ Poor = 21-40 | ■ Moderate = 41-60 | ■ Good = 61-80 | ■ Very Good = 81-100

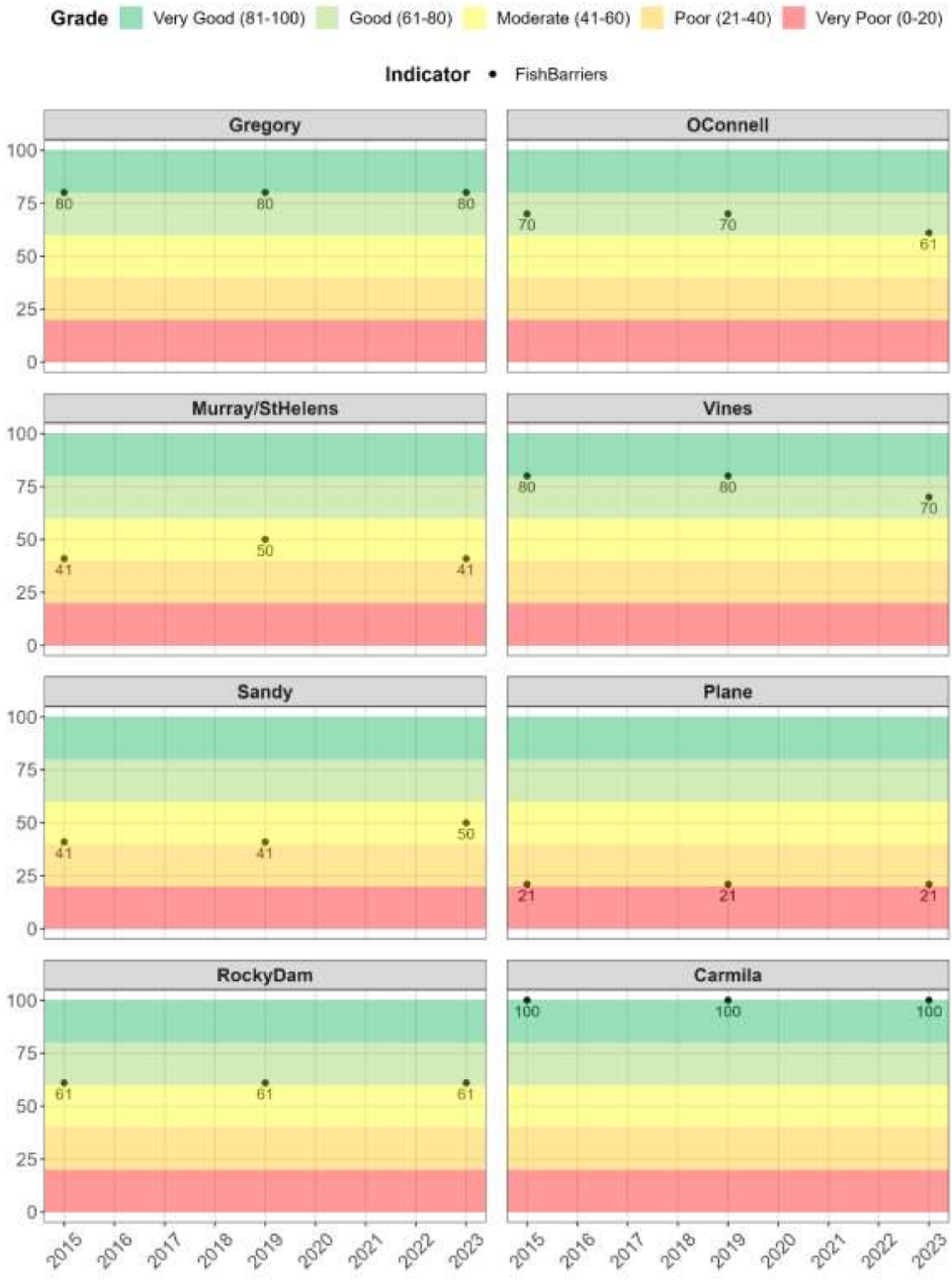

Figure 40. Results for fish barrier indicators in estuaries in the 2024 Report Card (2022-23 data) compared to historic scores. Fish barriers are updated every four years, indicated by point and annotation.

Key Messages:

1) In 2019, the first barrier upstream from the Sandy Creek Estuary (Palm Tree Road causeway) was remediated with a rock ramp fishway, resulting in an improved score for this metric.
2) Identification of an additional low passability barrier on Gibson Creek associated with the expansion of a new intensive cropping development influenced score decline in the O'Connell Estuary in the 2023 report.
3) Score decline in both Vines Creek and Murray/St Helens Estuaries was due to increased barrier density and may be influenced by improved aerial imagery which allowed identification of barriers that potentially existed in previous reporting yet were unable to be distinguished.
4) Carmila, Rocky Dam, and Vines Estuaries recorded no 'low passability' barriers. Carmila Creek Estuary reported no barriers to fish passage, although fish barriers are located above the estuary extent.

Plane Creek Estuary recorded the lowest fish barrier grade of 'poor'. The Plane Creek catchment is largely grazing and forestry, with some sugarcane production. The creek also flows through Sarina, a population centre of 5,500 residents where a sugar mill is located adjacent to the creek. Several low passability fish barriers have been constructed in the lower reaches of Plane Creek to provide drinking water for the Sarina community, irrigation, and water supplies for the sugar mill. These low passability barriers contributed to the 'poor' score recorded for the Plane Creek Estuary.

3.2.2 Riparian and Mangrove/Saltmarsh Extent

Coastal and near-shore marine ecosystems are among the most diverse and productive in the world, providing critical habitat for a range of plants, fish, and other wildlife. Coastal wetlands such as mangrove and saltmarsh environments also provide a variety of ecosystem services, including coastal protection, erosion control, water filtration, maintenance of coastal fisheries, and carbon sequestration. Despite this, coastal river systems and vegetation have been significantly impacted by land development activity, die back, altered hydrology, and pollution (Chamberlain et al., 2020; Duke & Wolanski, 2001). To understand continuing threats to estuarine riparian vegetation extent and mangrove/saltmarsh extent, indicators are assessed regularly and were reviewed in the current reporting cycle. These scores represent changes only in the extent of vegetation since pre-clearing, not changes in the condition of the vegetation assessed.

Results (Table 29, Figure 41, Figure 42, 2018-19 data):

Table 29. Results for riparian and mangrove/saltmarsh extent loss since pre-clearing (%), hectares remaining, and standardised riparian and mangrove/saltmarsh extent in estuaries in the 2024 Report Card (2018 2019 data with methodology updated in 2022). Hectares were rounded to the nearest whole number.

Estuary	2024 Report Card (2018-19 data, methodology updated in 2022)					
	Mangrove/Saltmarsh Extent		Riparian Extent		Standardised Mangrove/ Saltmarsh Extent	Standardised Riparian Extent
	Hectares lost since pre-clear	% loss since pre-clear	Hectares lost since pre-clear	% loss since pre-clear		
Gregory River	91.7	3.1	8.4	4.2	88	84
O'Connell River	192.2	6.7	47.6	48.6	77	21
Murray/St Helens Creek**	6.5	-0.2*	54.2	17.1	100	58
Vines Creek	185.5	21.1	8.6	17.5	52	57
Sandy Creek**	411	14	54.4	27.14	63	44
Plane Creek	24.1	2.0	22.7	15.2	92	60
Rocky Dam Creek	291.4	4.6	11.9	4.4	82	83
Carmila Creek	11.4	2.9	0.2	0.4	88	98

Extent (% loss) scoring range: ■ Very Poor = >50% | ■ Poor =>30 to 50% | ■ Moderate = >15 to 30% | ■ Good = >5 to 15% | ■ Very Good ≤5% | ■ No score/data gap

Standardised scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

* Negative values denote scenarios where there has been an increase in the total area of riparian or mangrove/saltmarsh extent since pre-clearing.

**Sandy Creek and Murray/St Helens scores use the previous methodology as the spatial extent was not available. It is expected to be updated following release of this Report Card.

Key Messages:

1) The riparian extent grades ranged from 'poor' in the O'Connell River Estuary to 'very good' in the Gregory River, Rocky Dam, and Carmila Creek Estuaries. All other estuaries were in 'moderate' condition.
2) All estuaries were within guideline values for mangrove / saltmarsh extent except for the Vines Creek Estuary, which scored 'moderate'.

The extent of riparian vegetation in the **Carmila Creek Estuary** in 2017 was equal to the pre-clearing extent. Overall, there was no change in the extent of riparian vegetation observed between the 2013 and 2017 assessments. To evaluate any change in extent between assessment years, back-calculated values were developed for 2013 (Appendix 8.3.).

In the **Sandy Creek Estuary**, approximately 2.9 ha of mangrove and saltmarsh vegetation have been lost since the 2013 assessment (Appendix 8.3.). This included approximately 2.58 ha of Regional Ecosystem (RE) 8.1.3 (*Sporobolus virginicus* tussock grassland on marine sediments) and 0.27 ha of RE 8.1.2 (Samphire open forbland on saltpans and plains adjacent to mangroves). Both REs are listed with a biodiversity status 'Of concern' and are valued, in part, for the habitat they provide to endangered and significant species, respectively. Agricultural encroachment and changes to hydrology in Sandy Creek Estuary may have caused this reduction (Chamberlain et al., 2020).

There was a net increase in the areal extent of mangrove/saltmarsh vegetation in the **St Helens/Murray Creek Estuary** since pre-clearing. Such changes may occur as a result of extensive sediment deposition in nearshore environments. This sediment provides new areas of substrate in which mangroves can colonise. This process has previously been documented in the Pioneer River to the south of St Helens/Murray Creek (Duke & Wolanski, 2001). It is important to emphasise that such increases in net mangrove/saltmarsh extent are not necessarily indicative of a healthy estuarine system; rather, they are indicative of increased muddiness (Duke & Wolanski, 2001).

O'Connell Estuary was the only waterway to record a decrease in mangrove/saltmarsh extent in the 2021-22 Report Card, although the total loss was ~1 ha of tussock (RE 8.1.3). Overall, since pre-clearing, O'Connell Estuary has recorded loss of 60 ha of this habitat and an additional 86 ha of sedgeland (RE 8.1.4). These ecosystems are listed with a biodiversity status of 'Of concern' and 'Endangered' respectively.

Although **Rocky Dam Estuary** recorded an increase in mangrove (RE 8.1.1), samphire (RE 8.1.2), and tussock (RE 8.1.3) habitat since the previous reporting cycle, the total increase was less than 1 ha, and this estuary has the most ha lost across several habitats (samphire (RE 8.1.2), tussock (RE 8.1.3), and sedgeland (RE 8.1.4)) with over 700 ha of mangrove/saltmarsh lost since pre-clearing.

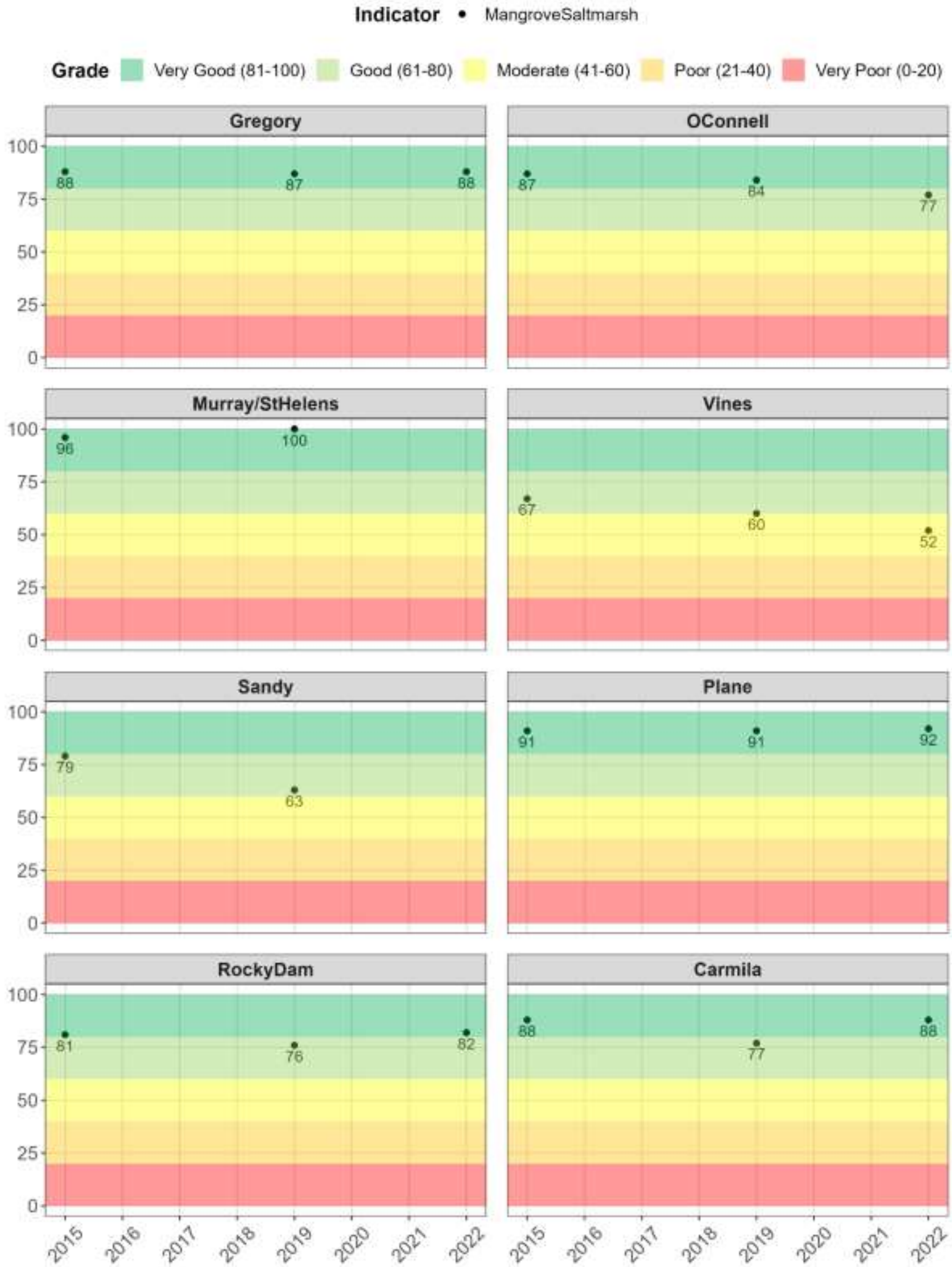

Figure 41. Results for mangrove/saltmarsh extent loss since pre-clearing 2024 Report Card (repeat data) compared to historic scores. Habitat extents are updated every four years as indicated by point and annotation.

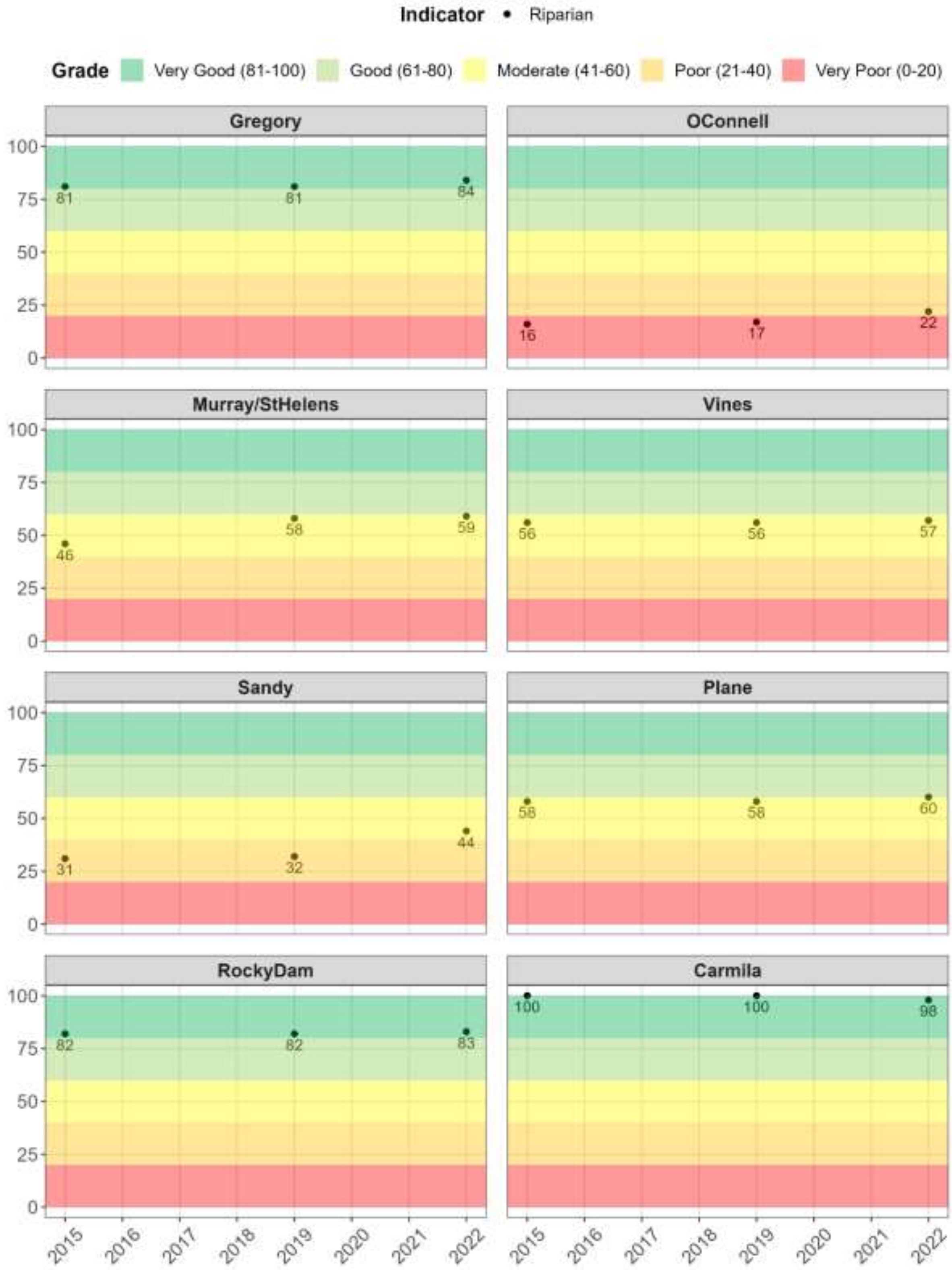

Figure 42. Results for riparian extent loss since pre-clearing 2024 Report Card (repeat data) compared to historic scores. Habitat extents are updated every four years as indicated by point and annotation.

3.2.3 Flow

Due to minimal data availability, scores for flow in estuaries were not able to be developed across most estuaries and have not been included in the habitat and hydrology index. A review of the flow tool to identify further refinements and updates is expected for future report cards. In addition, the Partnership has submitted a recommendation to BoM on priority sites for flow gauging stations to be implemented in MWI estuaries in the future.

3.2.4 Habitat and Hydrology Index Scores

Scores for fish barriers were updated in the current reporting cycle, however riparian and mangrove/saltmarsh extent were last updated in the 2022 Report Card (methods back-calculated with most recent data from 2018-19). Scores for habitat extents were back-calculated using new methodologies to facilitate comparison between datasets over time.

The consistency of scores between assessments reflects the gradual or infrequent nature of change associated with these indicators. In this regard, whilst these scores highlight the positive effect of implementing management measures to mitigate threats to habitat via direct clearing, development, or changes to hydrology, it also emphasises the investment required to remediate historical impacts and ultimately drive an improvement in condition grades.

<u>**Results** (Table 30, Figure 43, Appendix 8.3):</u>

Table 30. Results for habitat and hydrology indicator categories and index in estuaries for the 2024 Report Card. Fish Barriers was the only habitat and hydrology indicator updated in the current reporting cycle.

Estuary	2024 Report Card				
	Mangrove/ Saltmarsh Extent	Riparian Extent	Fish Barriers	Flow	Habitat and Hydrology Index
Gregory River	88	84	80		**84**
O'Connell River	77	22	61		**53**
Murray/St Helens	100*	59	41		**67**
Vines Creek	52	57	70		**60**
Sandy Creek	63*	44	50		**52**
Plane Creek	92	60	21		**57**
Rocky Dam Creek	82	83	61		**75**
Carmila Creek	88	98	100		**95**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

*Sandy Creek and Murray/St Helens scores use the previous methodology for mangrove/saltmarsh scores as the spatial extent was not available for the new method. It is expected to be updated after the release of this Report Card.

Key Messages:

1) The overall habitat and hydrology index grades for estuaries in the 2024 Report Card ranged from 'moderate' to 'very good' across the MWI Region.

2) An increase in the number of fish barriers identified on Vines Estuary influenced grade decline from 'good' to 'moderate' in the most recent assessment.

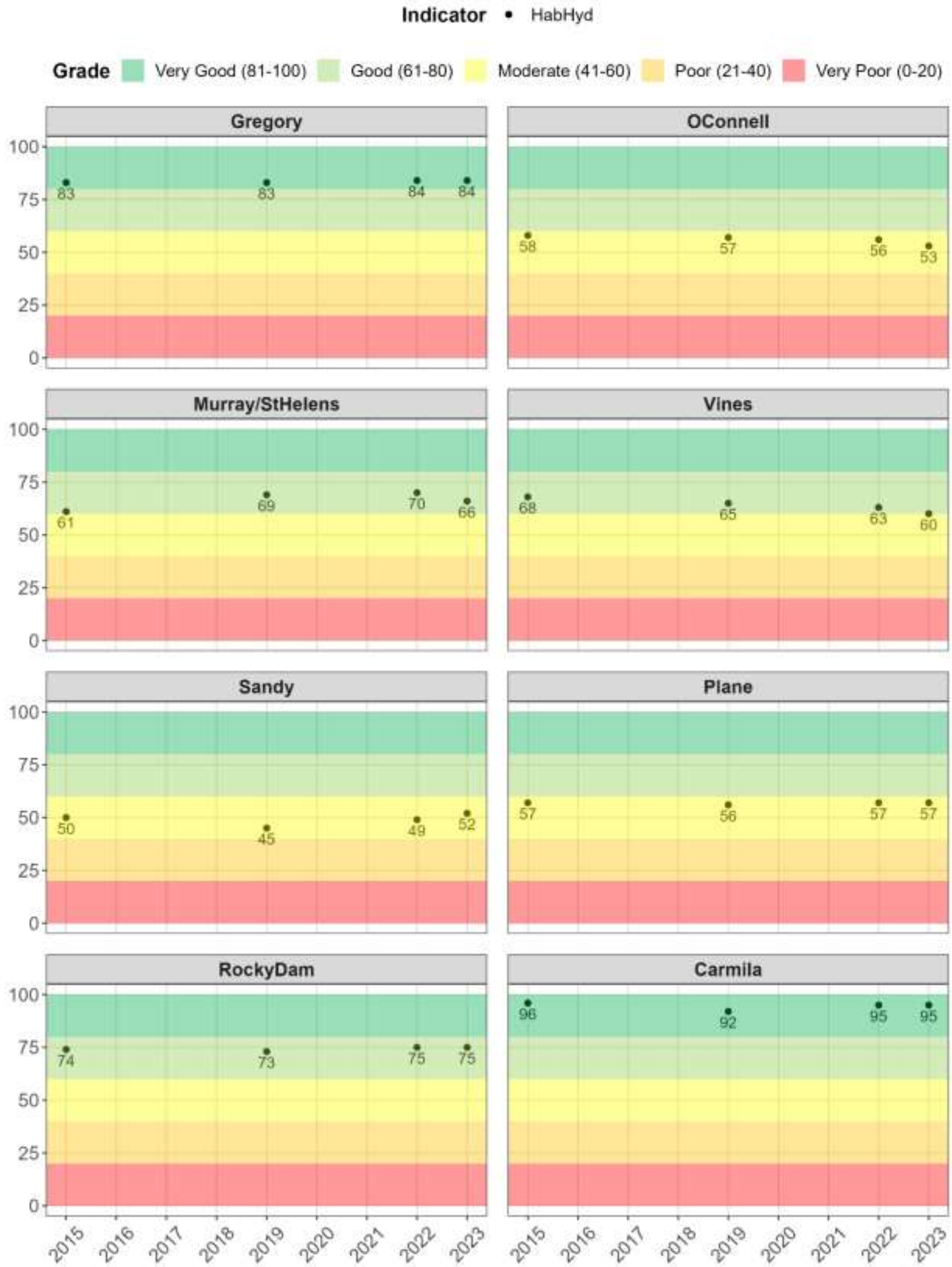

Figure 43. Results for habitat and hydrology index in estuaries for the 2024 Report Card compared to the historic scores. Points and annotation designate years where data was updated for at least one indicator.

3.2.4.1 Confidence

Overall confidence for the habitat and hydrology indicator category was 'moderate' (Table 31).

Table 31. Confidence associated with habitat and hydrology index results in estuaries for the 2024 Report Card. Confidence criteria are scored 1–3 and then weighted by the value identified in parentheses. Final scores (4.5–13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1 to 5 (very low–very high), which indicates the final confidence level. Unless otherwise specified, confidence in results is the same across estuaries.

Indicator Category	Maturity of Methodology (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured Error (x0.71)	Final	Rank
Fish Barriers	1	2	3	2	1	9.9	3
Riparian Extent	2	2	2	1	2	8.3	3
Mangrove/Saltmarsh Extent	2	2	2	1	2	8.3	3
Habitat and Hydrology Index						**8.3**	**3**
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.							

3.3 Fish in Estuaries

Identification of appropriate indicators and development of methodology are required to progress assessment of fish community condition in estuaries. Development of these indicators is anticipated to occur in collaboration with the TWG and other regional report card partnerships.

The Regional Report Card Partnerships commissioned a study regarding the validity of citizen science programs in 2021 and the potential use of the data collected for evaluating and reporting the condition of an ecosystem (Vinall, 2022). The results produced for estuaries showed limited validity due to the complexity and safety concerns of these environments. Currently, the only data collection identified is provided by local fishermen, which is spatially scattered and not suitable as an indicator for the ecosystem analysis and for Report Card grading metrics. Recommendations to improve the validity of these programs could include strengthening the surveys using cast nets and introducing mobile apps to collect catch rates from a selected group of fishermen to provide fish species diversity indicator.

3.4 Overall Estuary Condition

Results (Table 32, Figure 44, Appendix 8.3):

Table 32. Estuary overall condition alongside indicator category scores and grades for the 2024 Report Card (2022-23 reporting period).

Estuary	2024 Report Card				
	Water Quality	Habitat and Hydrology	Fish	Estuary Score and Grade	
Gregory River	73	84		79	B
O'Connell River^	53	53		53	C
St Helens/Murray Creek	58	67		62	B
Vines Creek	63	60		62	B
Sandy Creek	63	52		58	C
Plane Creek	78	57		68	B
Rocky Dam Creek	56	75		66	B
Carmila Creek	68	95		81	A

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

^ Data used to evaluate the O'Connell River estuary are taken from an end-of-catchment monitoring site within the O'Connell River which is also used to monitor nutrients within freshwater basins.

Key Messages:

1) Overall estuary grades in the 2022–23 monitoring period were the same as the previous year with the exception of both Vines Creek and Carmila Creek Estuaries, which improved to 'good' and 'very good' respectively.

2) Improvement in Carmila Estuary was largely due to the improvement of Chl-*a* score from 'very poor' to 'poor'.

3) Improvement in the Vines Creek Estuary was due to improvements in all water quality indicators.

4) The largest change in estuary score was in Sandy Creek and was driven by remediation of a fish barrier at Palm Tree Rd causeway, and improvements in both pesticides and Chl-*a* water quality indicators.

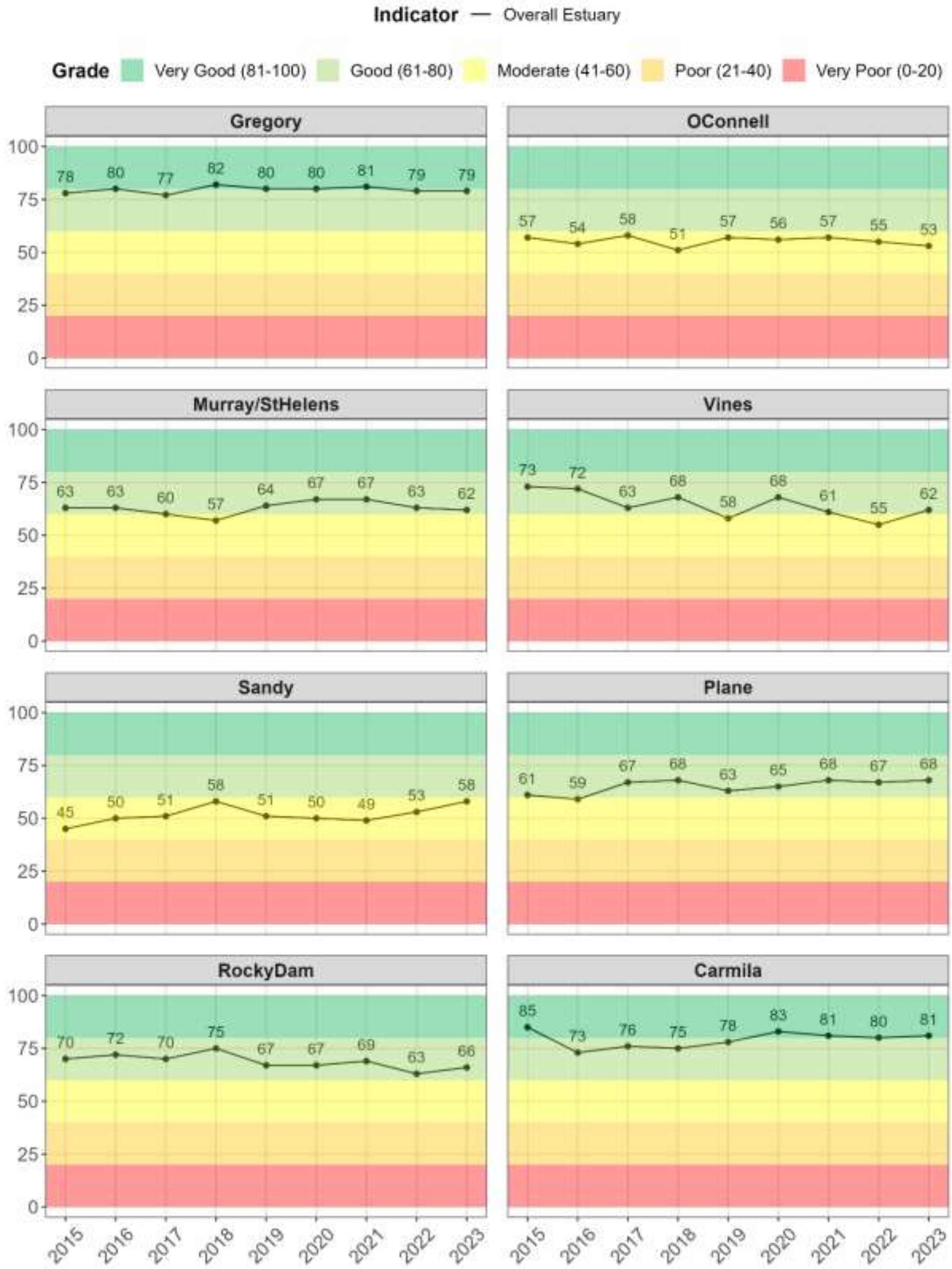

Figure 44. Overall condition scores and grades of estuaries for the 2024 Report Card (2022-23 reporting cycle) in comparison to historic scores.

4 Marine Results

The inshore marine region is divided into four zones: The Northern, Whitsunday, Central, and Southern Inshore Marine Zones. The offshore region is represented by the Offshore Marine Zone (Figure 1). Scores for each zone are calculated from a series of indices that consist of indicators under relevant indicator categories (Figure 45). All indicators reported in marine zones are updated annually.

Figure 45. Marine indicators (outer ring), indicator categories (middle ring) and indices (inner ring) that contribute to overall inshore (A) and offshore (B) grades. Where no indicator category is listed, this represents that the indicator/s (e.g. juvenile density) does not fit into any category below the index level (e.g. coral). Grey shading represents no data. Note: NOx = nitrogen oxides, PP = particulate phosphorus, PN = particulate nitrogen, TSS = total suspended solids, Chl-*a* = chlorophyll-*a* concentration, and sp. comp = species composition.

The North Queensland Bulk Ports Corporation Ltd (NQBP) Marine Monitoring Programs and the GBR Marine Monitoring Program (MMP) are significant contributors to the inshore marine dataset used to calculate scores. Monitoring reports for NQBP Monitoring Programs can be found on the NQBP website[26] while the MMP annual reports can be found in the GBRMPA e-library.[27] Identifying a data gap in Southern Zone monitoring, the Partnership initiated and funded the Southern Inshore Program (SIP) in 2017.[28] Data used to calculate offshore coral scores is sourced from the Long-term Monitoring Program (LTMP), and reports can be found on the AIMS website.[29] Water quality data for the Offshore Zone is currently not reported following the decommissioning BoM's marine water quality dashboard and new data sources are being investigated.

[26] https://nqbp.com.au/sustainability/research-and-reports
[27] https://elibrary.gbrmpa.gov.au/jspui/browse?type=series&value=Marine+Monitoring+Program
[28] https://healthyriverstoreef.org.au/southern-inshore-monitoring-project/
[29] https://www.aims.gov.au/reef-monitoring/gbr-condition-summary-2020-2021

4.1 Water Quality in Marine Zones

Inshore marine water quality in Mackay-Whitsunday-Isaac (MWI) region was assessed in four marine zones (Figure 46) and is influenced by five major regional river basins, and the Fitzroy Basin further south (Fabricius et al., 2014). Under strong discharge conditions the Pioneer River dominates waters inshore of the Whitsunday Islands while the offshore area is influenced by the Fitzroy River (Baird et al., 2019). The region may also be influenced by the Burdekin River (north of the Don Basin) during extreme events or through longer-term transport and mixing. MWI has higher variability in discharge and loads compared to surrounding regions such as the Wet Tropics (Waterhouse et al., 2018).

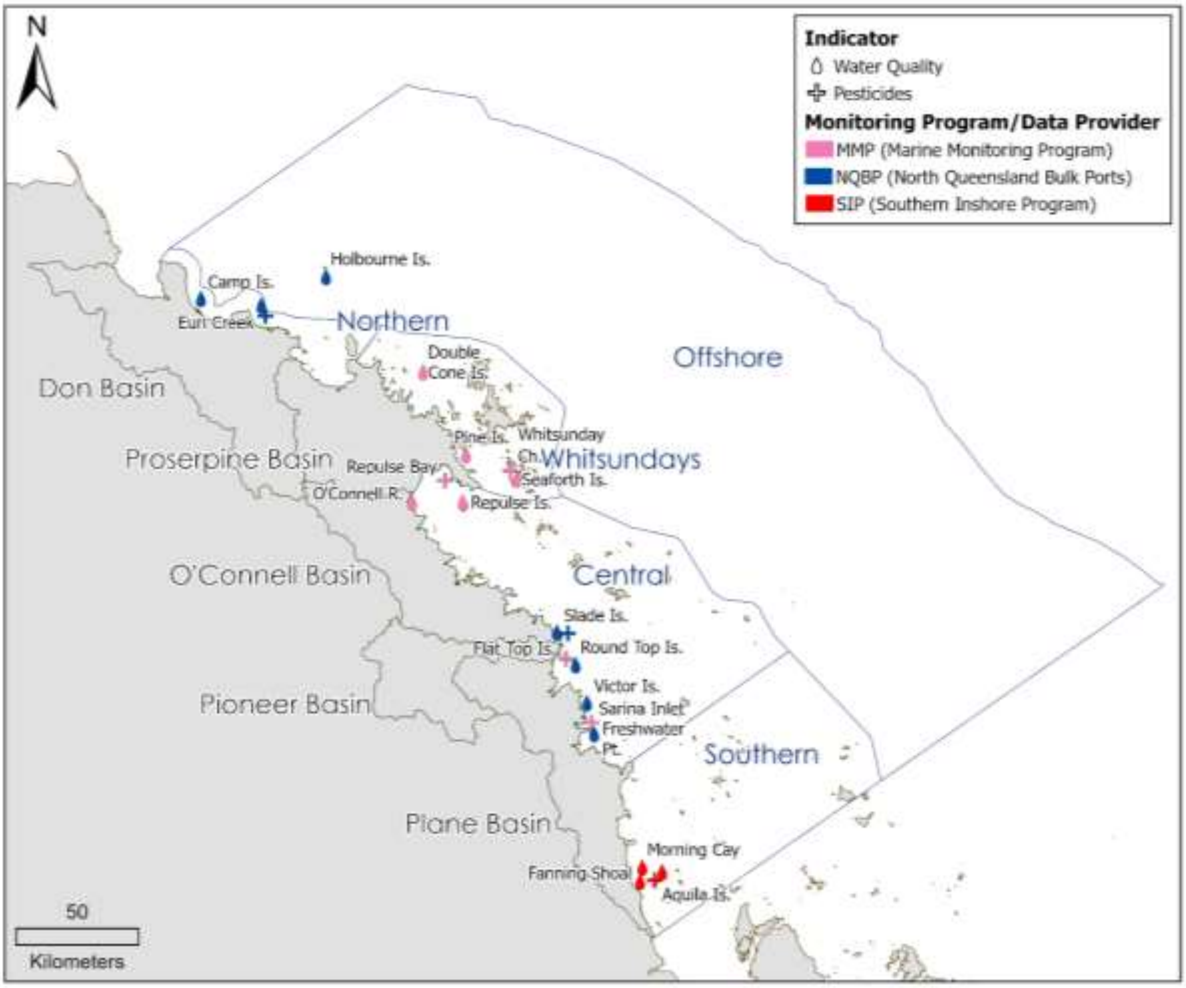

Figure 46. Water quality monitoring sites for the inshore marine zones during the 2022-23 reporting year. Sites in each zone are shown coloured according to data provider. MMP: Marine Monitoring Program; NQBP: Northern Queensland Bulk Ports, SIP: Southern Inshore Program funded by the Partnership.

Condition scores are calculated by comparing annual means or medians to guideline values[30] for each indicator at each site within a zone. Preliminary scores are aggregated across sites and indicators to produce the final nutrients, chl-*a*, and water clarity indicator category scores within a zone (MWI

[30] The Northern Zone does not yet have localised GVs and instead uses values defined by GBRMPA or central QLD-wide. While these GVs are current, they don't account for ambient conditions or representative transitions between water type boundaries. This is relevant as many other sites within the region use site-specific GVs. See page 70 of Methods for a table showing all GVs and their sources.

HR2RP, 2024). Offshore water quality is not currently assessed as the data sources and method are under review. See Section 4.1.6 for more detail and Appendix 8.4.1.7 for past results.

4.1.1 Nutrients

Nutrient indicator category scores for inshore zones are based upon reported concentrations of three indicators: oxidised nitrogen (NOx), particulate phosphorus (PP), and particulate nitrogen (PN). Nutrients grades in 2024 (2022-23 data) remained the same as the previous year in the Whitsunday and Central zones, while the Northern and Southern zones saw declines.

Results (Figure 47, Figure 48, Appendix 8.4.1)

Key Messages:

1) NOx scores improved in all monitored zones, influencing improved overall scores in the Whitsunday and Central zones. This indicator is not assessed in the Northern Zone.
2) Declines in the Northern and Southern zones were due to increased concentrations of both PP and PN, and in the Northern Zone influenced by the lack of NOx assessments.

In the **Northern Zone**, score decline was seen in PN and PP indicators at Camp Island and Euri Creek, while Holbourne Island indicators remained ‘good’ or above.

Improvements in nutrient scores in the **Whitsunday Zone** were largely driven by decreased concentrations of NOx at Double Cone and Seaforth Islands, where indicator scores improved from ‘poor’ to ‘good’.

In the **Central Zone**, improved nutrients scores were driven by the NOx indicator score at Repulse Islands site (the only Central Zone site to monitor NOx), which improved from ‘very poor’ to ‘very good’.

Nutrients scores declined in the **Southern Zone** due to increased concentrations of PN and PP at all monitored sites.

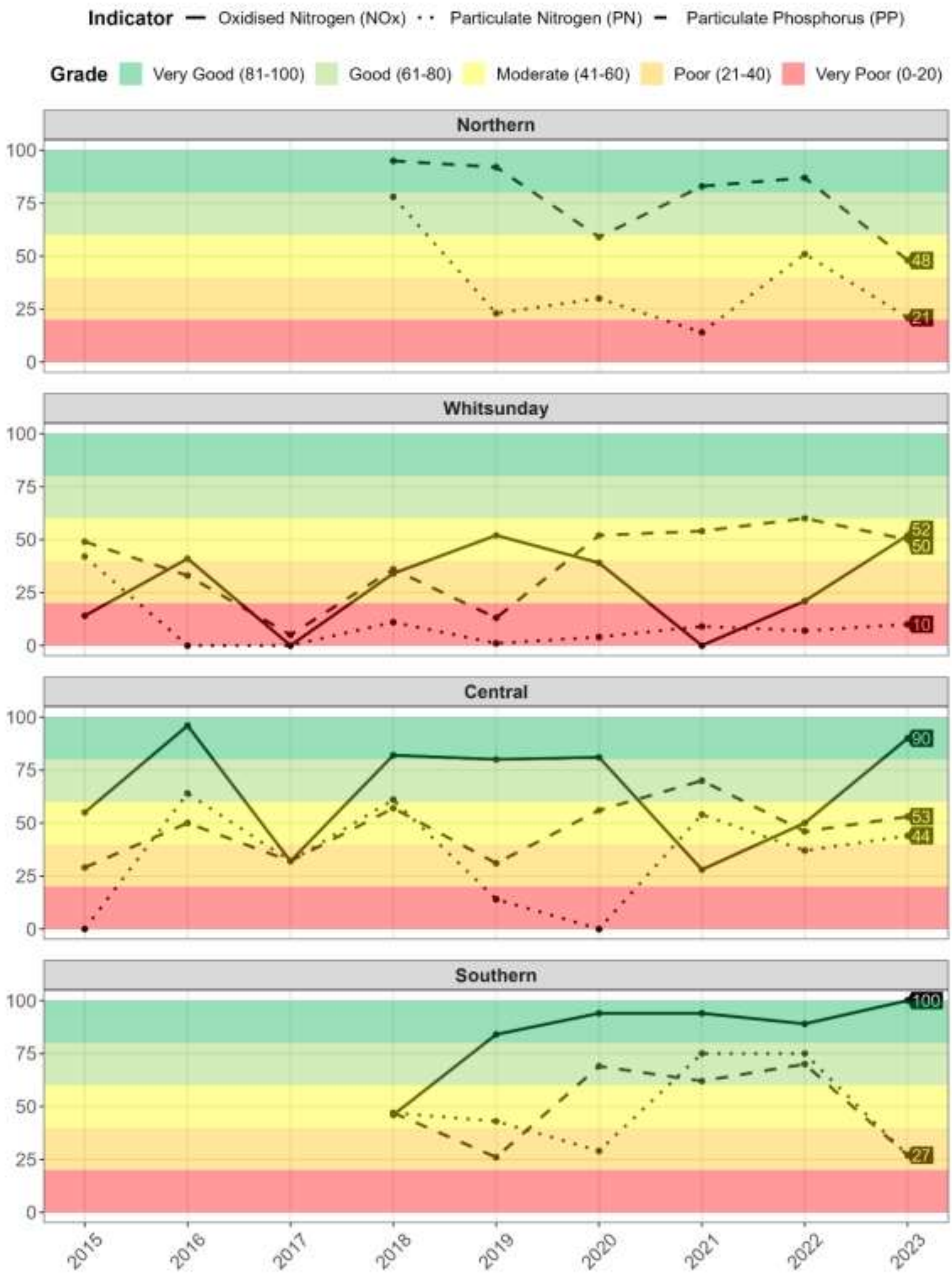

Figure 47. Marine zone nutrients indicators scores in the 2024 Report Card (2022-23 data) compared to the historic record. NOx is not recorded in NQBP monitoring, so cannot be included in Northern Zone nutrients indicator category scores.

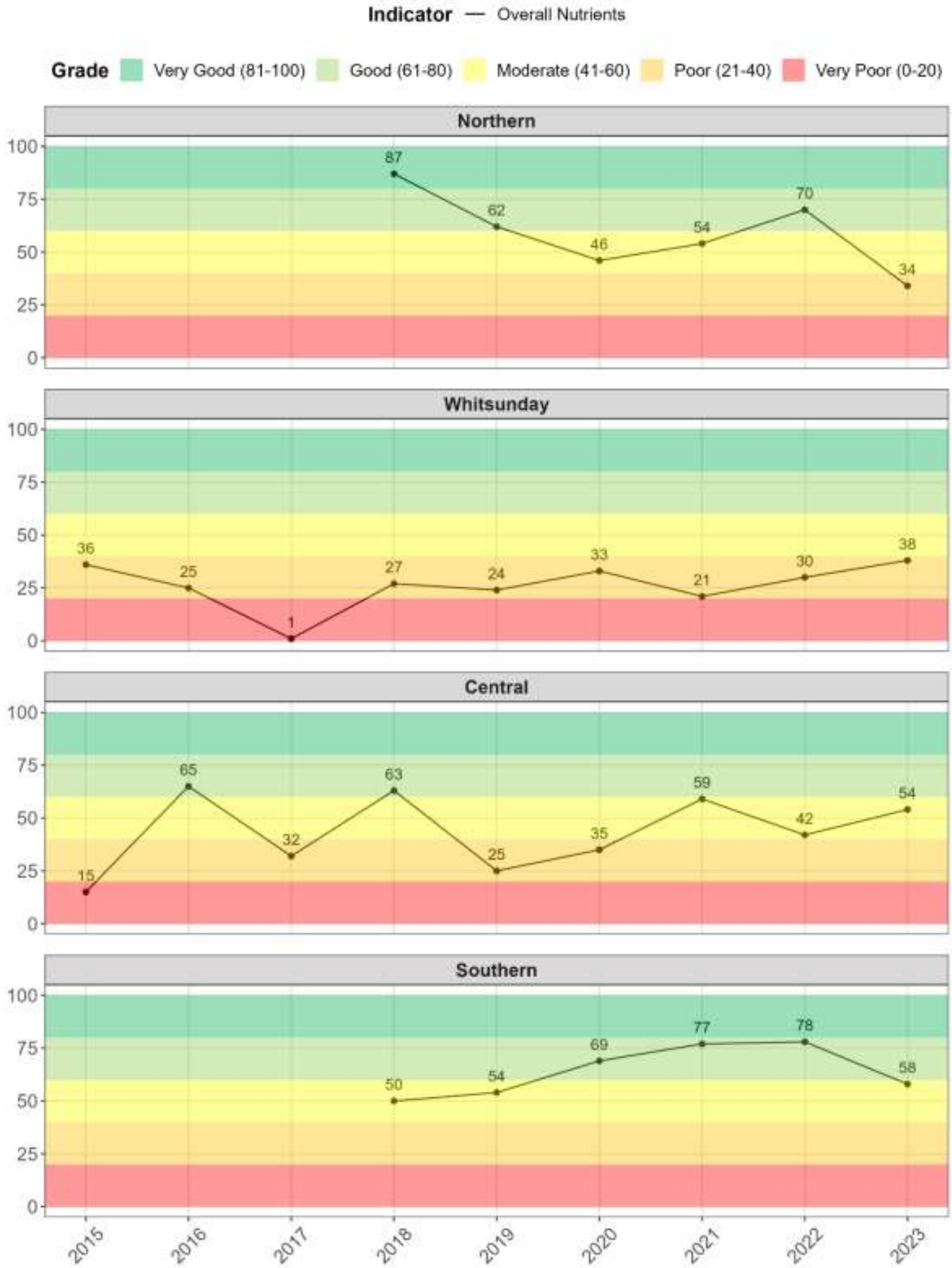

Figure 48. Marine zone nutrients scores in the 2024 Report Card (2022-23 data) compared to the historic record. The annotated solid black line (overall nutrients) is an average of the other three indicators shown in the previous figure. NOx is not recorded in NQBP monitoring, so cannot be included in Northern Zone nutrients indicator category scores.

4.1.2 Chlorophyll-*a*

Increased nutrient availability (e.g. agricultural runoff, soil erosion, discharges of sewage and aquaculture waste), often leads to a rise in chlorophyll-*a* concentrations in coastal waters because of increased phytoplankton biomass. Chl-*a* is used as a parameter for monitoring phytoplankton biomass and nutrient status as an index of water quality.[31] High levels of chl-*a* often indicate poor water quality while low levels suggest good conditions. Elevated chl-*a* concentrations are not necessarily negative; however the long-term persistence of elevated levels can indicate problems.[32]

<u>**Results** (Figure 49, Appendix 8.4.1)</u>

Key Messages:

1) Increased concentrations of chl-*a* influenced scores decline in the Northern and Southern zones.
2) The Whitsunday Zone saw improved scores, particularly at Pine and Double Cone Islands.

Chl-*a* scores decline in the **Northern Zone** was influenced primarily by Euri Creek dropping from 'good' to 'very poor', as chl-*a* scores improved at Camp Island ('very poor' to 'poor') and remained 'good' at Holbourne Island.

In the **Whitsunday Zone**, improvements in scores at both Pine Island and Double Cone Island (‘poor’ to ‘moderate’ and ‘moderate’ to ‘good’ respectively) influenced the overall improvement in chl-*a* scores.

In the **Central Zone**, chl-*a* grades remained similar to the previous reporting cycle, except at Round Top Island which saw a reversal of the previous years’ sharp decline and improved to ‘poor’. Repulse Island continued its gradual improvement for the fourth consecutive year and the chl-*a* grade improved to ‘moderate’.

The **Southern Zone** saw decline in chl-*a* score at all sites, most noticeably at Fanning Shoal (‘poor’ to ‘very poor’).

[31] https://www.aims.gov.au/docs/data-centre/chlorophyllmonitoring.html
[32] https://ozcoasts.org.au/indicators/biophysical-indicators/chlorophyll_a/

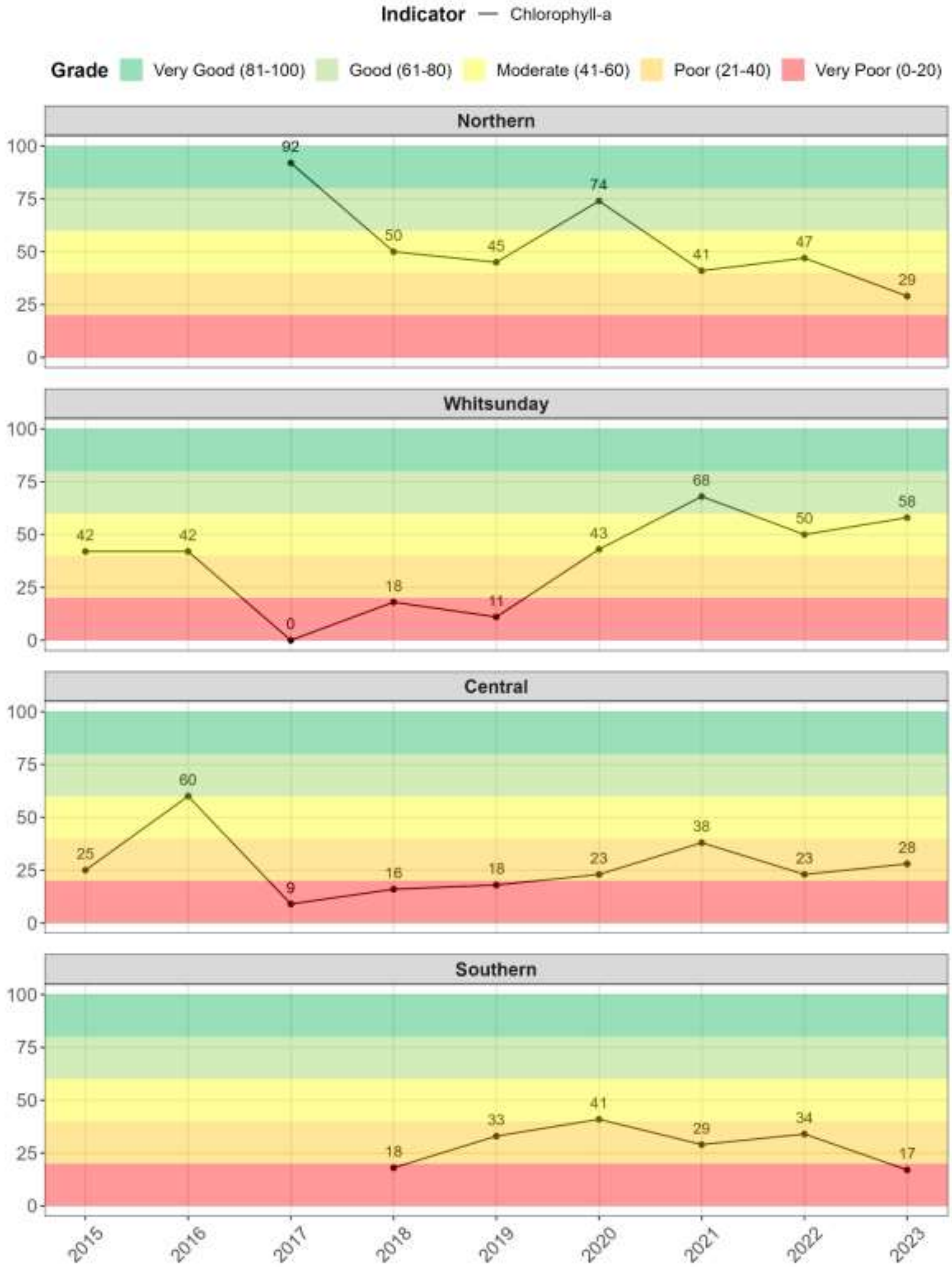

Figure 49. Marine inshore zone Chlorophyll-*a* scores in 2024 Report Card (2022-23 data) compared to the historic record.

4.1.3 Water Clarity

The water clarity indicator category is informed by Secchi depth (m), total suspended solids (TSS), and turbidity (NTU) indicators. Water clarity indicators (TSS, Secchi depth, and turbidity) are related but not completely comparable. The characteristics of suspended sediments can greatly influence turbidity measurements, where darker and finer-grained sediment will result in much higher turbidity readings than lighter-coloured and coarser sediments. The former is considered the most damaging to seagrass and coral growth (Bainbridge et al., 2018; Storlazzi et al., 2015).

Results (Figure 50, Figure 51)

Key Messages:

1) Water clarity indicator category scores remained similar in every zone during the 2022-23 reporting period.
2) The Southern Zone has recorded a 'very poor' grade in water clarity every year since monitoring began in 2018, although some improvement was seen in TSS scores. This may be a result of differences in sampling methods. Turbidity is influenced by strong tidal currents, wave action, and resuspension across a broader temporal scale, while TSS measurements capture suspended particulate matter at a point in time.

Water clarity indicator category scores in the **Northern Zone** improved at all sites for the second consecutive year, where all sites scored 'good' or above.

In the **Whitsunday Zone**, water clarity indicator category scores remained the same at Double Cone and Pine Island ('moderate' and 'poor' respectively), however Seaforth Island saw decline to 'poor' due to increased concentration of TSS.

Central Zone sites generally scored 'poor' or 'very poor' with exceptions at Round Top Island and O'Connell River mouth, where water clarity indictor category scores were 'good', and 'moderate'.

In the **Southern Zone**, water clarity indicator scores remained 'very poor' for the sixth year in a row. This pattern has likely been driven by the geophysical differences in this zone, where the proximity to silt-laden shallows and the large tidal range accompanied by strong currents often causes sediment to become resuspended in the water column. Particularly during periods of low rainfall, high turbidity is driven by re-suspension of sediment corresponding with wind/waves, currents, and tidal patterns (Cartwright et al., 2023). TSS scores rose to 'poor' at the Fanning Shoal site, the first time that a water clarity indicator improved above 'very poor' since monitoring began in the Southern Zone.

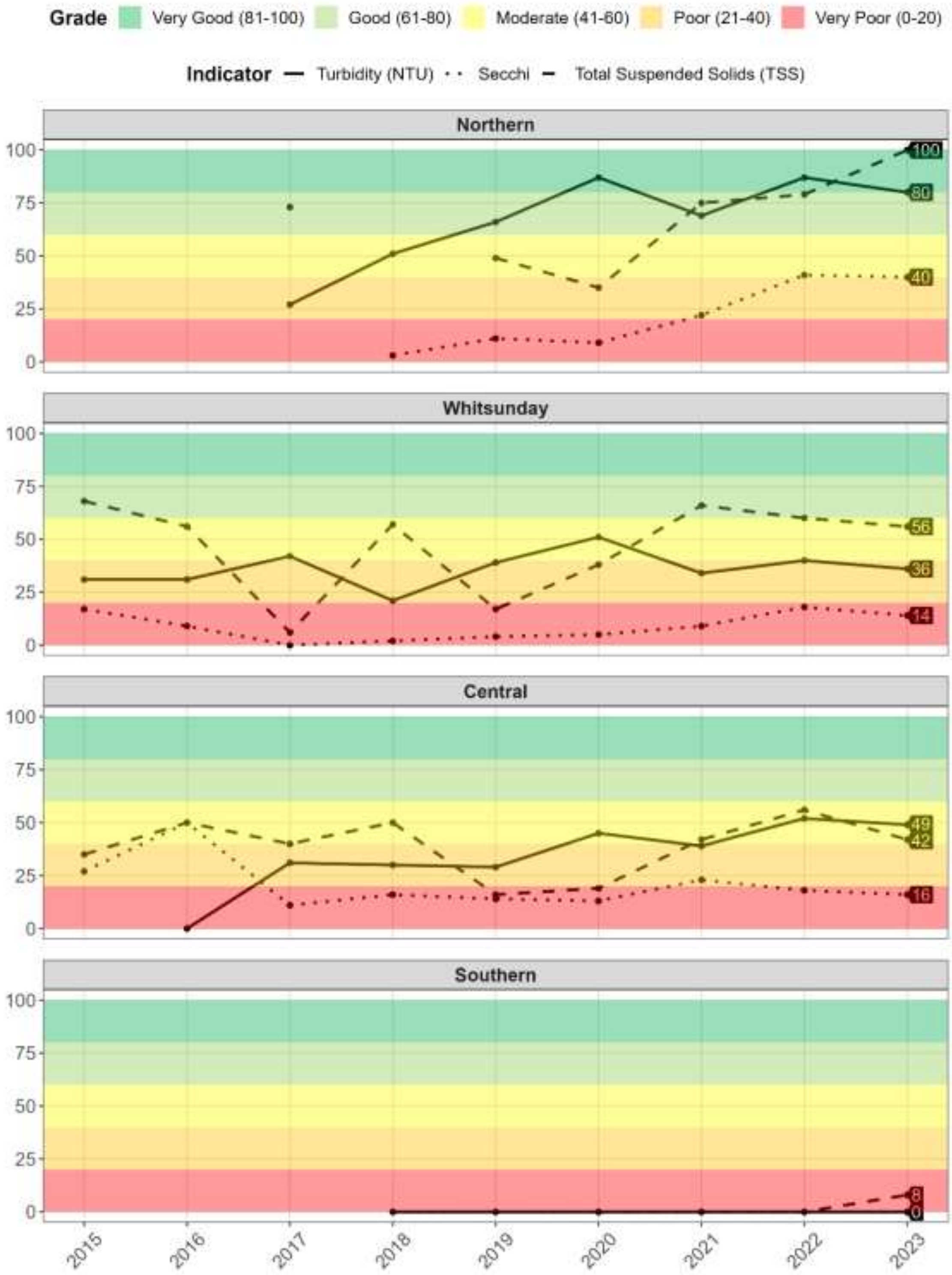

Figure 50. Marine inshore zone water clarity indicator scores in 2022-23 compared to the historic record.

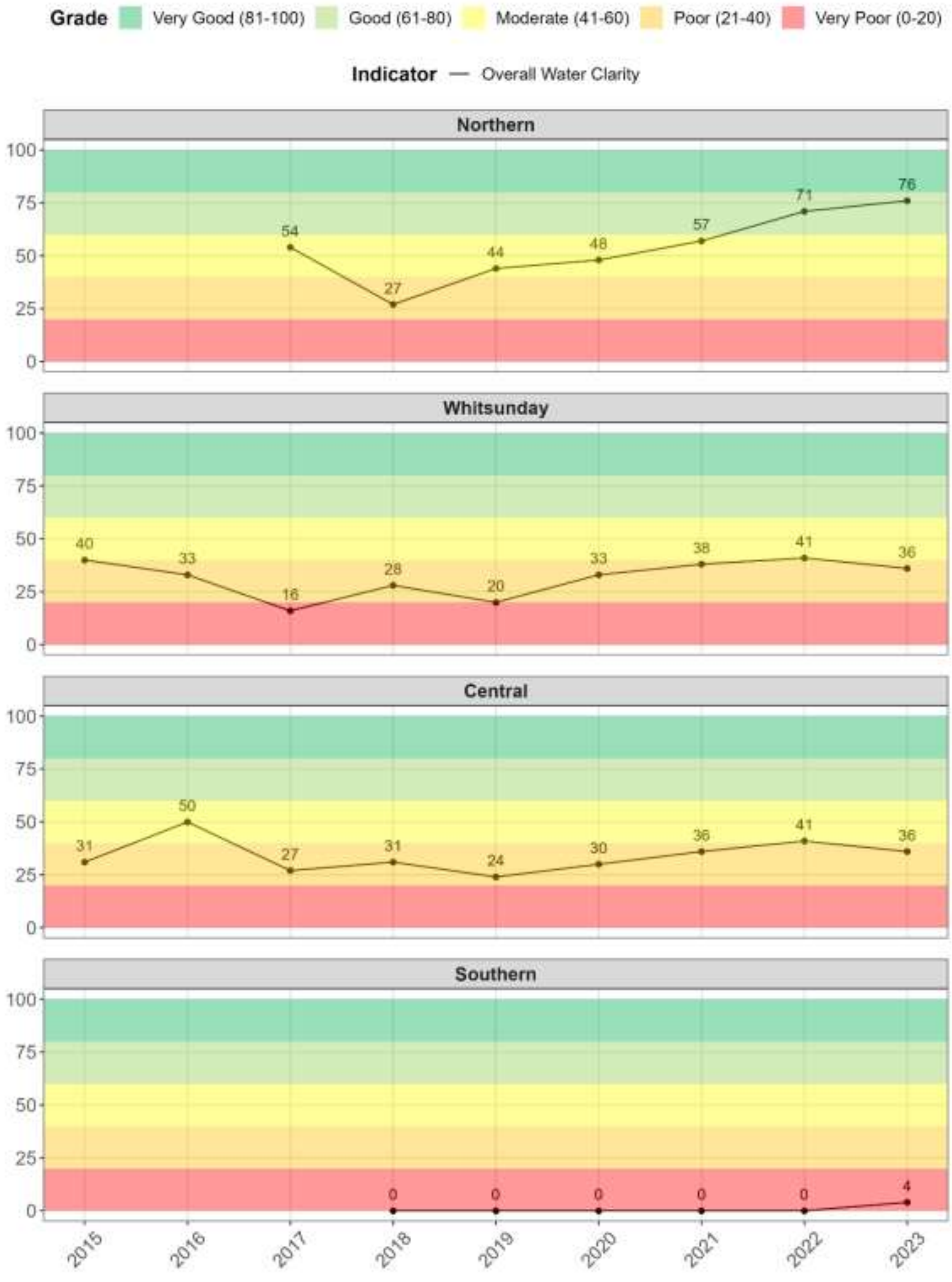

Figure 51. Marine zone water clarity scores in 2022-23 compared to the historic record. The annotated solid black line (overall water clarity) is an average of the three indicators shown in the previous figure.

4.1.4 Pesticides

Pesticides in the marine inshore are reported using the Pesticide Risk Metric (PRM) (Warne et al., 2020, 2023). This approach considers pesticides with multiple Modes of Action (MoA) that exert their toxicity by different means.

In the 2024 Report Card (2022-23 data), 19 pesticides were measured in the Northern and Central zones, and 17 in the Whitsunday and Southern zones. It is expected that additional pesticides will be included in future Report Cards to align with Reef 2050 Water Quality Improvement Plan (WQIP) pesticide targets. Due to the additive nature of the PRM calculations, this may result in pesticide scores declining in future years as more pesticides are assessed.

Notes on data interpretation for Report Card results

Sampling methods: Pesticides data were collected using passive polar samples with up to five deployments at each site throughout the wet season. The specific pesticides included in the analysis have changed since previous years. Pesticide sampling relies exclusively on Empore® disks. Therefore, pesticide reporting does not include three of the analytes in the PRM (chlorpyrifos, pendimethalin, and isoxaflutole).

Reporting: Passive sampler deployments record a time-averaged estimate of pesticide concentrations, and the highest (poorest) score is used to report risk. For the purposes of reporting, the percentage species protected (the inverse of percentage species affected) is reported alongside the final PRM score.

Whitsunday Zone: Previously, pesticides were not monitored in the Whitsunday Zone as investigations by GBRMPA Marine Monitoring Program (MMP) determined that, with no major creeks or rivers flowing into this zone, pesticide risk was low. Following publication of a paper investigating long-term trends in pesticide concentrations (Taucare et al., 2022), monitoring requirements were reassessed by the Independent Science Panel (ISP) in March 2022. A site in Whitsunday Channel was selected, and the Whitsunday Zone included a score for the marine pesticides indicator category for the first time in the 2022-23 reporting season.

MMP program redesign: MMP pesticides monitoring did not occur during the 2021-2022 season as modelling results suggested uncertainty around the locations of the samplers. It was thought that sites may have been missing the plume of the first flush of the wet season and a redesign of the program was discussed, including at ISP in March 2022. Monitoring requirements were reassessed, and MMP pesticides monitoring was reinstated for the 2022-2023 wet season. This increased spatial and temporal coverage of the Central and Northern zones and included monitoring in the Whitsunday Zone for the first time. The program redesign is reflected in the confidence score for pesticides (Section 4.1.7).

<u>Results</u> <u>(Table 33, Appendix 8.4.1.6):</u>

Table 33. Standardised pesticide scores for the 2024 Report Card, comparison between Passive Polar and Grab sample results. Scores are calculated from the Pesticide Risk Metric (PRM) reporting on the percentage of aquatic species protected (%) for inshore zones. NQBP = North Queensland Bulk Ports, MMP = Marine Monitoring Program, SIP = Southern Inshore Monitoring Program.

2024 Report Card (2022-23 data)			
	Program	**Passive Polar Sampler Scores**	**Grab Sample Scores***
Northern	NQBP / MMP	81	81
Whitsunday	MMP	100	30
Central	MMP/NQBP	95	63
Southern	SIP	81	

Pesticide scoring range: ■ Very Poor = 0 to 20 | ■ Poor = >20 to 40 | ■ Moderate = >40 to 60 | ■ Good = >60 to 80 | ■ Very Good = >80 | ■ No score/data gap

*Grab samples used as reference but not incorporated into Water Quality scores.

Key Message:

1) In the 2024 Report Card the pesticides grade was 'very good' for all marine zones.
2) Grab sample results provide reference to passive polar samplers and demonstrate that although potential spikes in concentration can cause short-term 'high' risk, dilution in the marine environment is such that the annual risk to marine species is 'very low'.

Despite current scores showing 'very low' risks from pesticides in inshore zones it is important to note that passive polar sampling results are time averaged across a deployment period and may not capture spikes in concentration. Grab samples conducted during the 2022-23 reporting year recorded higher, albeit short-term, risks associated with pesticides (Table 33, Appendix 8.4.1.6). Pesticide management and load reduction plans may reduce the flow of pesticides into the marine environment at a site level, however chemicals such as diuron can attach to sediments (Mercurio et al., 2016). Long term trends in the region suggest that concentrations of several PSII herbicides are increasing at monitoring sites within the Great Barrier Reef Marine Park, potentially due to the long half-lives of PSII herbicides in the marine environment (Taucare et al., 2022).

4.1.5 Overall Marine Water Quality Index

In the 2024 Report Card (2022-23 data), grades declined in the Northern and Southern zones, improved in the Whitsunday Zone, and remained the same in the Central Zone. Appendix 8.4.1. presents boxplots along with site-level and historic scores for individual indicators.

Results (Table 34, Figure 52, and Appendix 8.4.1)

Table 34. Water quality indicator category and overall scores and grades for the 2024 Report Card (2022-23 data) for marine inshore zones.

Marine Zones	2024 Report Card (2022-23 data)				
	Nutrients	Chl-*a*	Water Clarity	Pesticides	Water Quality Index
Northern	34	29	76	81	**55**
Whitsunday	38	58	36	100	**58**
Central	54	28	36	95	**55**
Southern	58	17	4	81	**40**

Scoring range: Very Poor = 0 to <21 | Poor = 21 to <41 | Moderate = 41 to <61 | Good = 61 to <81 | Very Good = 81 to 100 | No score/data gap

Key Messages:

1) Chlorophyll-*a* was an issue in 2022-23 monitoring cycle, as it scored 'poor' or below in Northern, Central, and Southern zones.
2) The improved grade in the Whitsunday Zone was influenced by improvements in nutrients and chl-*a* indicator categories, and largely due to the incorporation of pesticides monitoring for the first time.

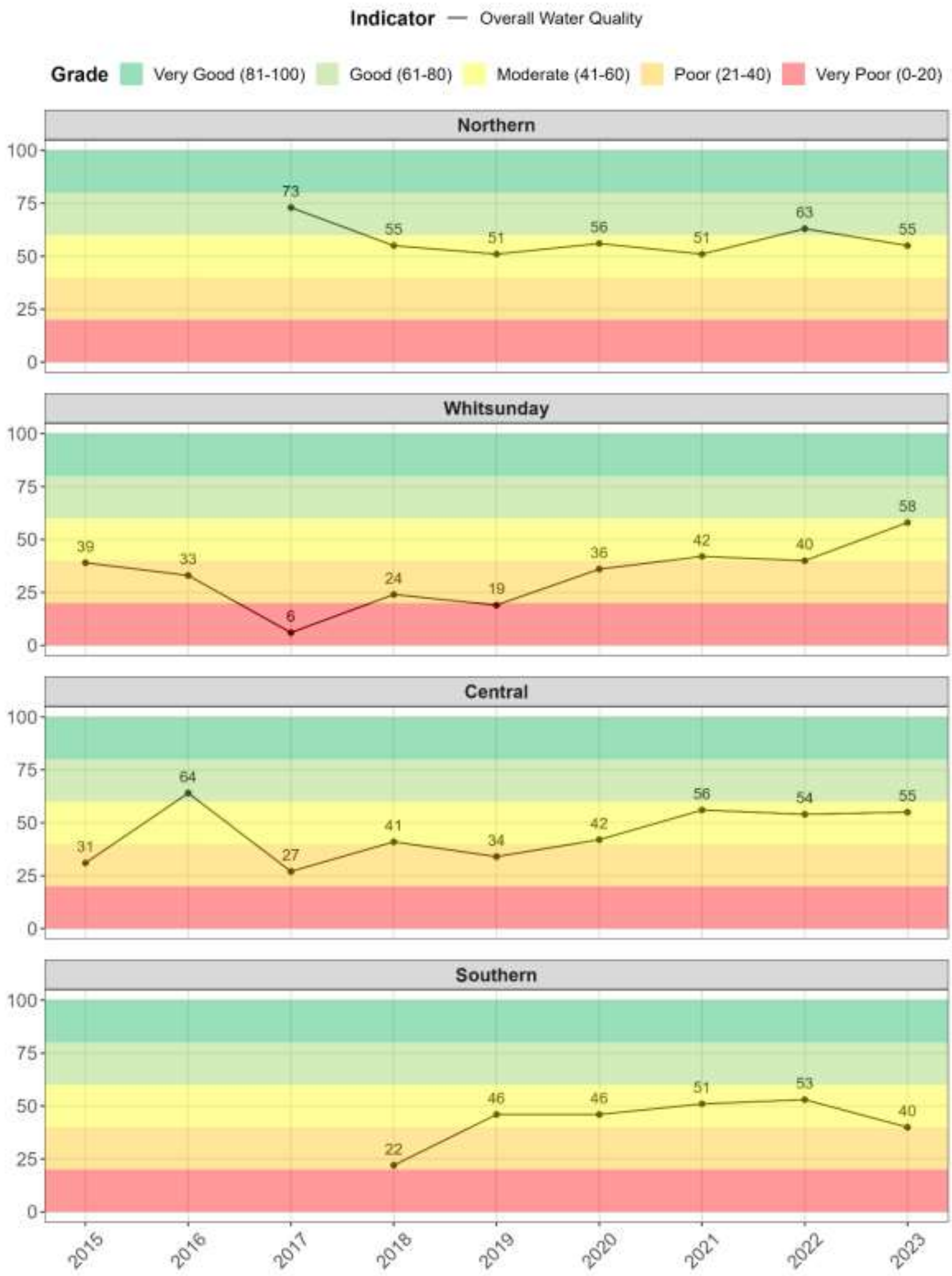

Figure 52. Water quality scores and grades for the 2024 Report Card (2022-23 data) for marine inshore zones compared to the historic record. Scores from the 2015 Report Card have been back-calculated to exclude pesticide scores in the Whitsunday Zone so that they are directly comparable to 2016 and 2017 scores. Scores from the 2024 Report Card include pesticide monitoring in the Whitsunday Zone and Northern Zone for the first time and are not directly comparable to previous scores.

4.1.6 Offshore Marine Zone

Offshore marine water quality scores were previously sourced from the BoM Marine Water Quality (MWQ) dashboard. During 2019–20 there were limitations in the technical support for maintaining the MWQ processing scripts and satellite data streams. Consequently, in early 2021, the BoM advised that the MWQ dashboard had been decommissioned and that the underlying data would be discontinued during the year. Alternative data sources are currently being identified for reporting offshore water quality for future reporting. See Appendix 8.4.1.7 for a historic record of Offshore Zone water quality results.

4.1.7 Confidence

Confidence in water quality index scores in the inshore zones is presented in Table 35.

Table 35. Confidence associated with water quality index results in marine zones for the 2024 Report Card (2022-23 data). Confidence criteria are scored 1–3 and then weighted by the value identified in the parentheses. Final scores (4.5–13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1 to 5 (very low–very high), which indicates the final confidence level. Confidence in results for the Central Zone differs from the other marine zones due to the increased spatial and temporal representation from two monitoring programs and the relevant confidence scores are presented in brackets. Unless otherwise specified, confidence in results is the same across marine zones.

Indicator	Maturity of Methodology (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured Error (x0.71)	Final Score	Rank
Nutrients	3	3	1.5 [2]	3	3	9.76 [10.76]	3 [4]
Chl-*a*	3	3	1.5 [2]	3	3	9.76 [10.76]	3 [4]
Water Clarity	3	3	1.5 [2]	3	3	9.76 [10.76]	3 [4]
Pesticides	3	2	2 [2.5]	2	1	8.63 [9.63]	3
Inshore Water Quality Index						**9.5 [10.4]**	**3 [4]**
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							

4.2 Coral Index

Coral reef assessments are undertaken with the understanding that healthy and resilient coral communities exist in a dynamic equilibrium between acute disturbances and reef recovery. Disturbance events may include storm events, thermal bleaching, and outbreaks of crown-of-thorns starfish (COTS) (Thompson et al., 2018). Coral recovery is influenced by water quality, and reefs exposed to poor water quality recover more slowly from disturbances and are more susceptible to disease outbreaks (MacNeil et al., 2019). Reefs are assessed across four inshore and one offshore reporting zone (Figure 53) using metrics that respond to both acute stressors, and the recovery capability of reef ecosystems (Castro-Sanguino et al., 2021).

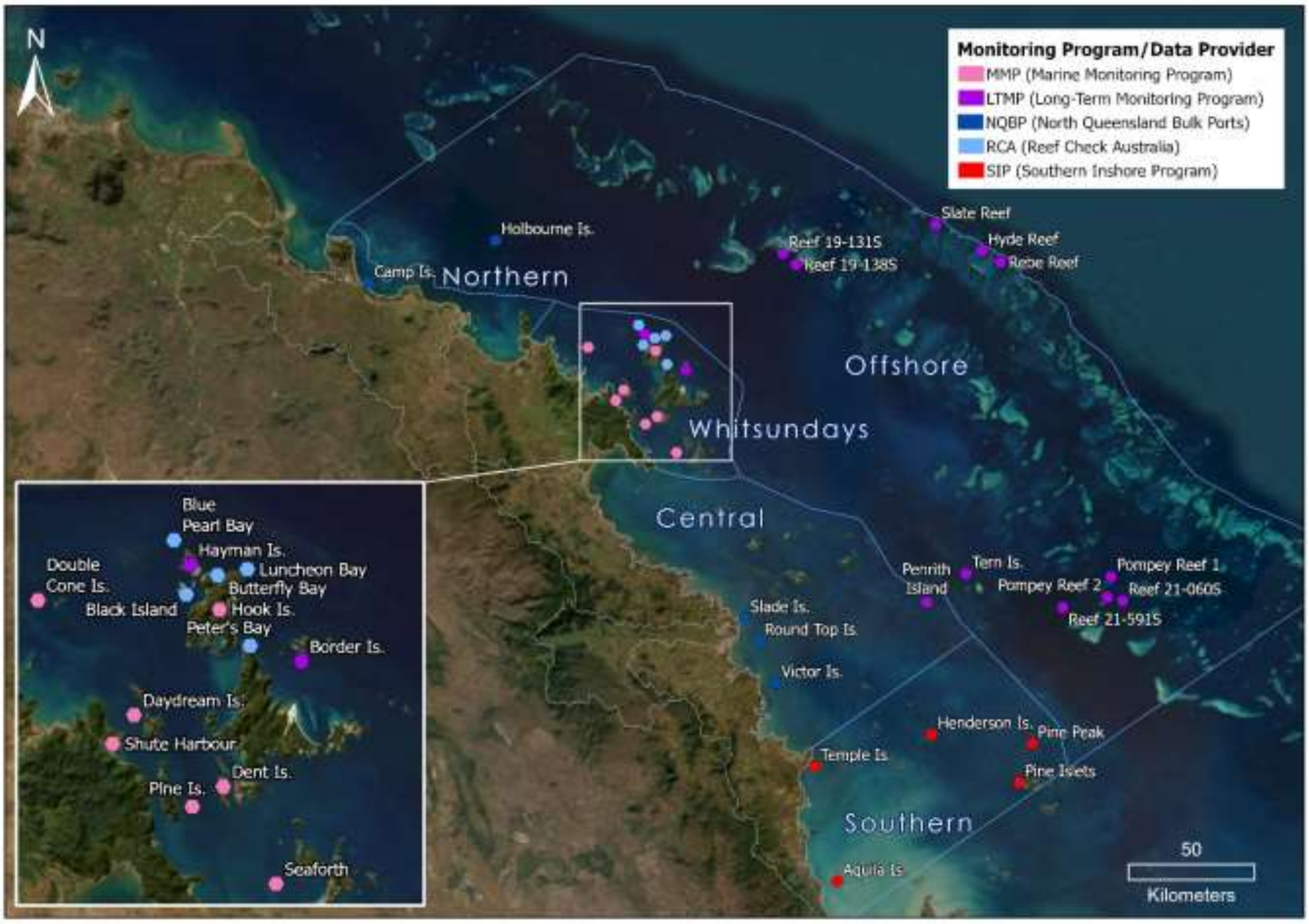

Figure 53. Coral monitoring sites for inshore and offshore zones during the 2024 Report Card (2022-23 data). Sites in each zone are colour symbolised according to data provider.

Notes on data interpretation for Report Card results

Influence of Macroalgae: Abundance of macroalgae increases in areas exposed to high nutrient availability, including inshore zones impacted by river discharge. Macroalgae compete with corals by limiting available space and light, physically damaging corals by abrasion, interfering with recruitment, or promoting bacterial communities pathogenic to corals. In addition to these limiting factors, extensive macroalgae cover can influence scores of other indicators due to the sampling method. Macroalgae is factored into juvenile recruitment indicator scores in an adjustment of available substrate, it can obscure underlying corals which make them difficult to count and impacts the cover change indicator score which compares observed hard coral cover change to a modelled expectation of change. This likely impacts coral scores throughout the region, however is particularly relevant in the Southern Zone (Davidson et al., 2023; Thompson et al., 2024).

4.2.1 Inshore Marine Zones

Results (Table 36, Figure 54, Figure 55, Appendix 8.4.2)**:**

Table 36. Inshore and Offshore coral scores and grades for the 2024 Report Card (2022-23 data).

Marine Zones	2024 Report Card (2022-23 data)					
	Cover	Macroalgae	Juvenile	Cover Change	Composition	Coral Index
Northern	30	50	33	27		**35**
Whitsunday	30	39	50	34	19	**35**
Central	41	45	70	35		**48**
Southern	38	0	14	31		**21**
Offshore	51		95	51		**66**

Coral index scoring range: ■ Very Poor = 0 to 20 | ■ Poor = >20 to 40 | ■ Moderate = >40 to 60 | ■ Good = >60 to 80 | ■ Very Good = >80 | ■ No score/data gap

Key Messages:

1) Coral scores in the Whitsunday Zone continued to improve incrementally for the second consecutive year, largely due to increasing densities of juvenile corals and to a lesser extent, increases in coral cover at some reefs (Thompson et al., 2024, Appendix 8.4.2). This improvement reflected the gradual recovery of coral communities following TC Debbie in 2017 (Thompson et al., 2022, 2024).

2) Recovery since Tropical Cyclone (TC) Debbie was likely to have been influenced by poor water quality, as demonstrated by 'poor' or 'very poor' scores in recent years (Section 4.1.1.1). High turbidity was a continued cause for concern to coral communities in the Whitsunday Zone. Coral species tolerant of turbid conditions tend to be slower growing, and poor water quality favours macroalgae that make it difficult for juvenile corals to establish themselves, both factors that lead to slow recovery at highly impacted reefs (Thompson et al., 2022, 2024).

3) Macroalgae cover was the limiting factor in further growth of coral communities in the Southern Zone (Davidson et al., 2023).

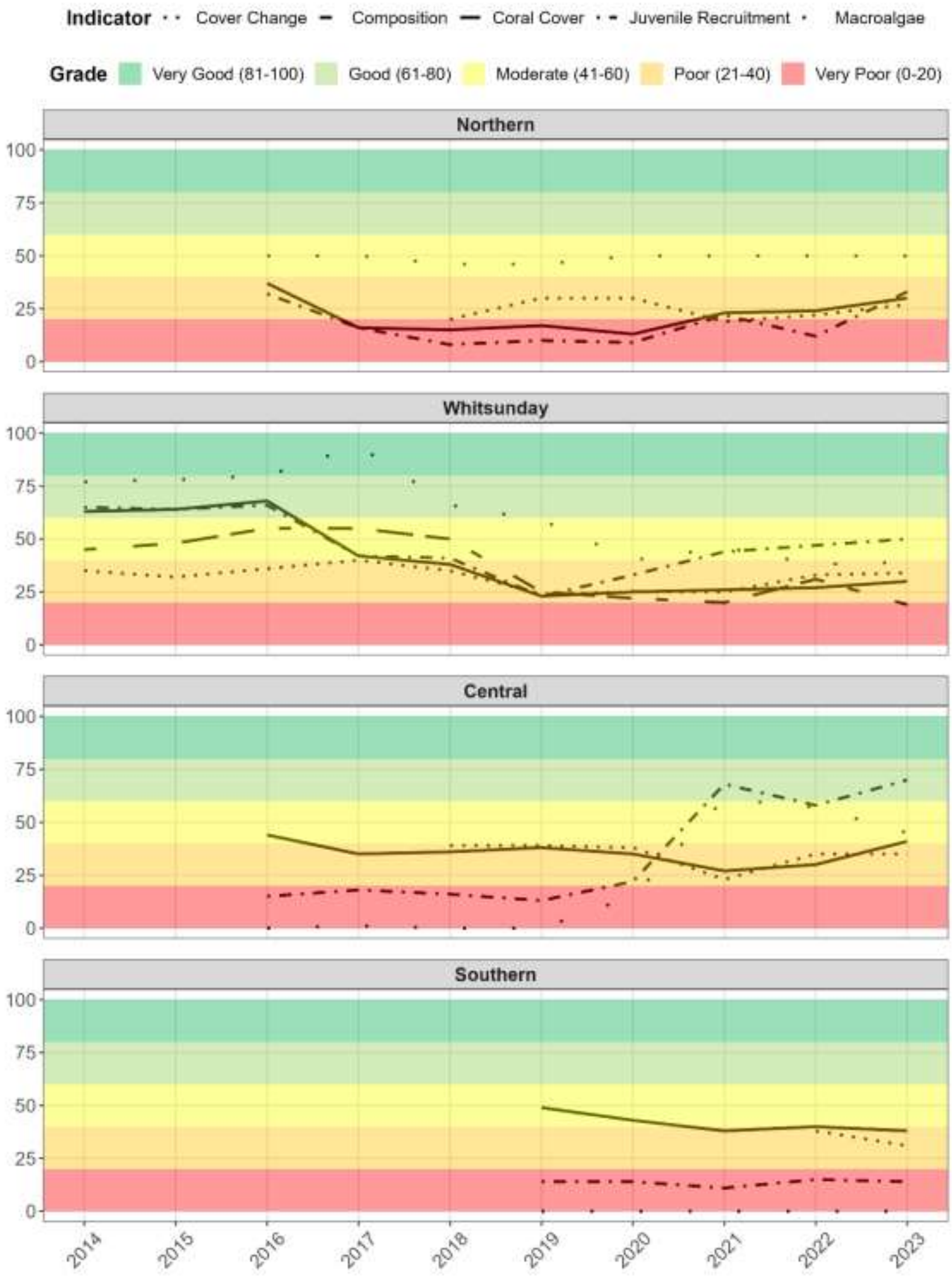

Figure 54. Inshore coral indicator scores and grades for the 2024 Report Card (reporting on 2022-23 data) compared to the historic record. Scores in the Northern Zone before 2020 have been adjusted due to changes in reef aggregation level.

Improvements in the **Northern Zone** were driven largely by increased juvenile recruitment at both sites, yet the overall score for the zone remained 'poor'. This zone also saw improvements in the coral cover and cover change indicators.

Coral scores in the **Whitsunday Zone** remained 'poor', although incremental improvement since 2021 demonstrates the ongoing recovery of coral communities since the severe impacts of TC Debbie. Hard coral cover has increased in line with expectations for inshore reefs at both Haymon and Daydream islands. Loss of coral cover at Dent Island was caused by a disease that impacted branching *Acropora* between 2017 and 2020, although cause of disease is unknown. Shute Harbour, where coral communities were not severely impacted by TC Debbie, consistently remains the reef with the highest overall scores (Thompson et al., 2024).

Both coral cover and juvenile recruitment indicators increased a grade in the **Central Zone**, yet the overall score remained 'moderate'.

Coral scores in the **Southern Zone** remained 'poor', despite favourable conditions and a lack of disturbances. Resilience of these ecologically isolated coral communities continues to be challenged by high cover of macroalgae and low density of juvenile hard corals, where persistent algae cover impedes hard coral recruitment. Henderson Island, with less macroalgae cover, is the only reef demonstrating continued recovery following the bleaching event in 2020 (Davidson et al., 2023).

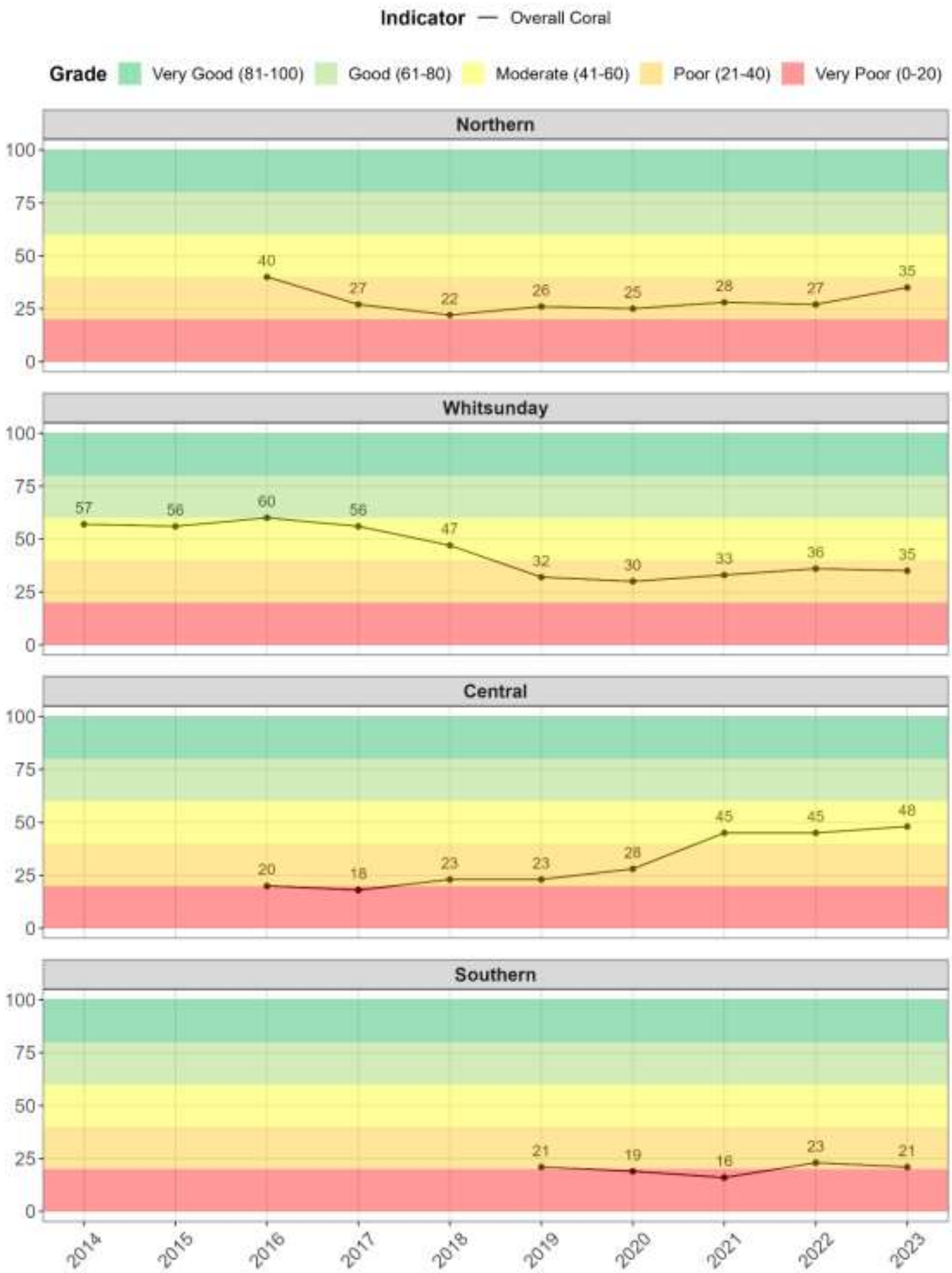

Figure 55. Inshore overall coral index scores and grades for the 2024 Report Card (2022-23 data) compared to the historic record. Scores in the Northern Zone before 2020 have been adjusted due to changes in reef aggregation level.

4.2.2 Offshore Marine Zone

The Offshore Zone was less impacted by TC Debbie in 2017 and since then most reefs have shown improvement in coral cover.

Notes on data interpretation for Report Card results

LTMP program redesign: In 2020, AIMS revised its monitoring program and decommissioned several of the southern reefs previously reported in the Offshore Zone. The improvement in coral score compared to previous reporting reflects ongoing recovery of most reefs but has also been influenced by the change in the AIMS sampling design, as historic scores have been back-calculated to include only those reefs currently monitored.

Results (Table 37, Figure 56, Figure 57, and Appendix 8.4.2)**:**

Key Messages:

1) Overall scores for the Offshore Zone were at their highest in the past 10 years of monitoring. Scores were driven by on-going 'very good' grades for juvenile coral densities and 'moderate' but increasing grades for coral cover.

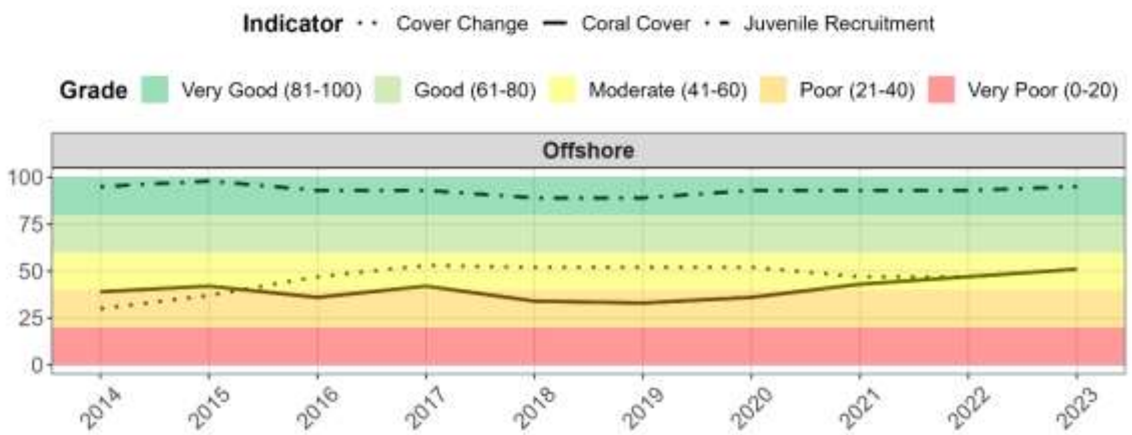

Figure 56. Offshore coral indicator scores and grades for the 2024 Report Card (2022-23 data) compared to the historic record. Offshore coral scores have been back-calculated before 2022 to account for the decommission of several sites.

Juvenile coral density was 'very good' at every monitored reef in the Offshore Zone except Penrith Island ('moderate'). This score suggests that recent environmental conditions have not imposed substantive limitations to hard coral recruitment, indicating ongoing resilience of coral communities in this zone. The lower score for juvenile coral density at Penrith Island may be influenced by the reef's spatial remoteness (MWI HR2RP, 2024) resulting in reduced larval supply relative to the more offshore reefs (A. Thompson, pers. comm. 14/04/21).

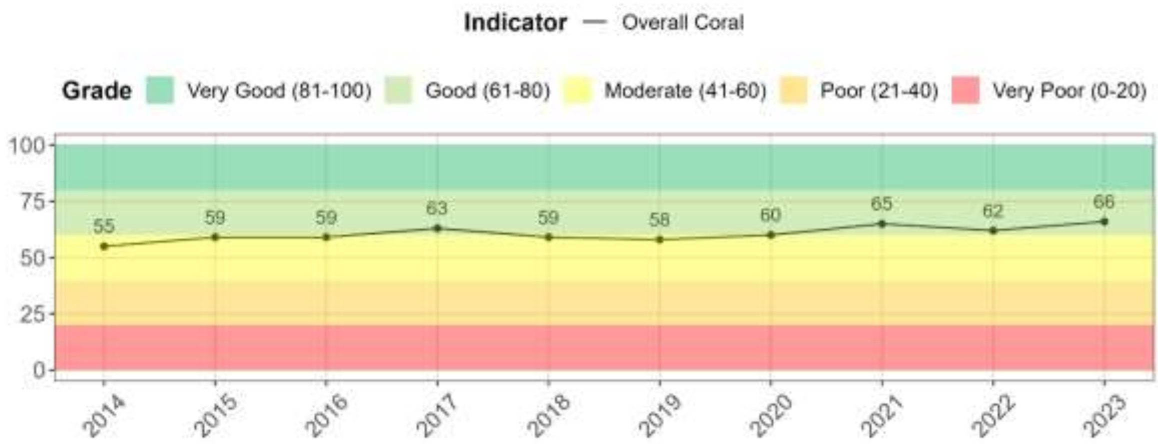

Figure 57. Offshore overall coral index scores and grades for the 2024 Report Card (2022-23 data) compared to the historic record. Scores have been back-calculated before 2022 to account for several sites decommissioned since 2021-22.

4.2.3 Confidence

Confidence in scores is 'high' for inshore coral indicators and 'moderate' for offshore coral indicators (Table 37).

Table 37. Confidence associated with coral index results in marine zones for the 2024 Report Card. Confidence criteria are scored 1–3 and then weighted by the value identified in parentheses. Final scores (4.5–13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1 to 5 (very low–very high), which indicates the final confidence level. Unless otherwise specified, confidence in results is the same across marine zones where relevant.

	Indicator	Maturity of Methodology (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured Error (x0.71)	Final Score	Rank
Inshore	Cover	3	3	2	3	2	10.8	4
	Change	3	3	2	3	2	10.8	4
	Juvenile	3	3	2	3	2	10.8	4
	Macroalgae	3	3	2	3	2	10.8	4
	Composition	3	3	2	3	2	10.8	4
	Inshore Coral Index						**10.8**	**4**
Offshore	Cover	3	3	1	3	2	8.8	3
	Change	3	3	1	3	2	8.8	3
	Juvenile	3	3	1	3	2	8.8	3
	Offshore Coral Index						**8.8**	**3**

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 Seagrass Index

Seagrass data for the 2024 Report Card (2022-23 data) were sourced from either the AIMS MMP, the Queensland Ports Seagrass Monitoring Program (QPSMP), or the Partnership-funded Southern Inshore Program (SIP) (Figure 58). The MMP measures abundance (percent cover) and resilience, while the QPSMP and SIP condition indicators are area, biomass, and species composition.

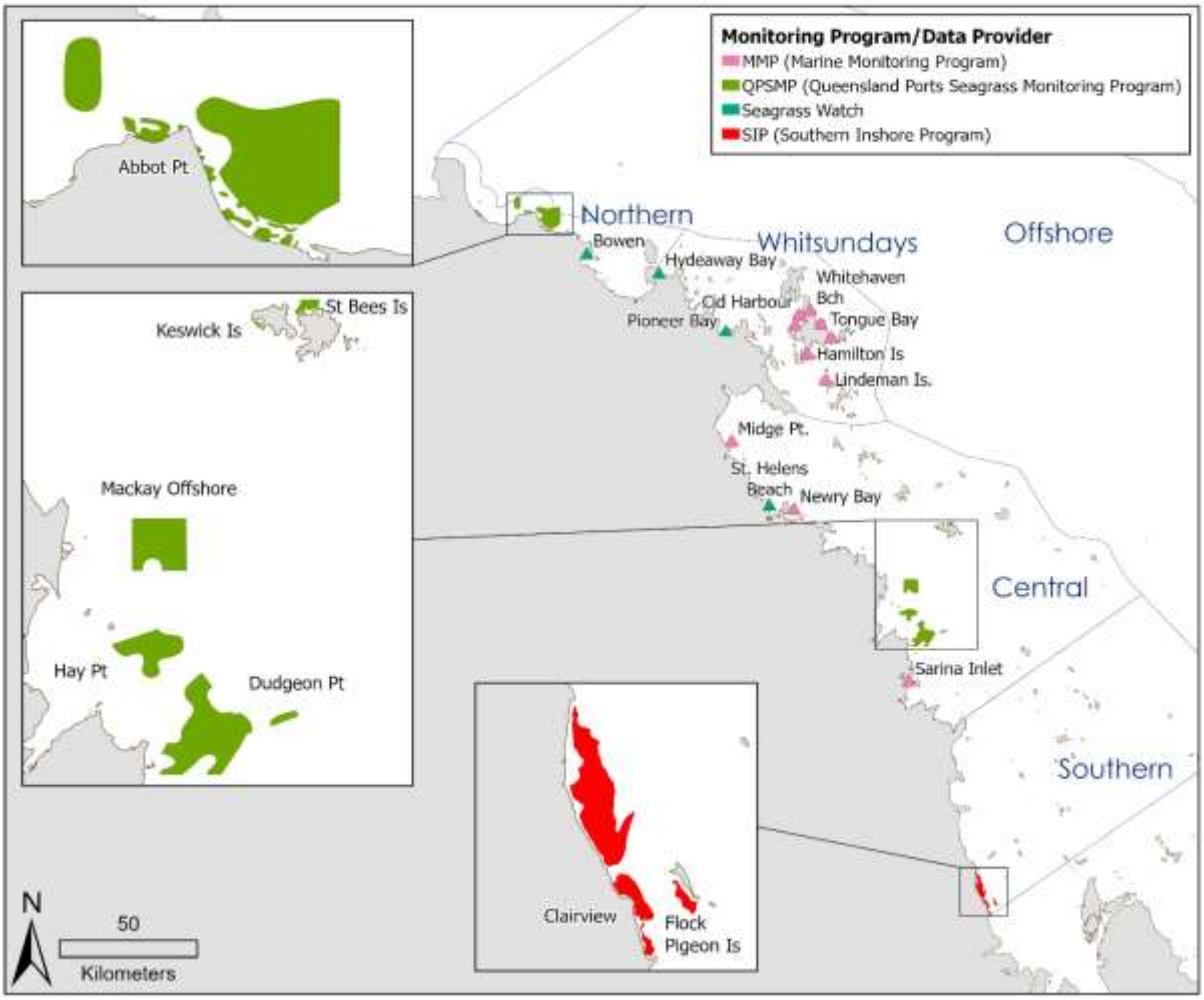

Figure 58. Seagrass monitoring sites for marine inshore zones. Colours represent each data provider with MMP data from JCU TropWater shown as pink, QPSMP data from NQBP as light green, Seagrass Watch citizen science data as teal, and Partnership-funded data from the SIP as red. Sites following the QPSMS methodology are shown as polygon extents of the meadow survey area, while sites following the MMP methodology are shown as a triangle point feature. Seagrass is not currently reported in the Offshore Zone.

Notes on data interpretation for Report Card results

Natural Variability: The first five years of monitoring in the Southern Inshore have demonstrated that seagrass meadows can be highly dynamic in terms of spatial and temporal variability even without major climatic or anthropogenic impacts. This is due in part to high levels of herbivory which influence the location of biomass hotspots (Rasheed et al., 2022).

Results (Table 38, Figure 59, and Appendix 8.4.3.)**:**

Table 38. Results for seagrass indicators for inshore zones for the 2024 Report Card (2022-23 data). Indicators are based on data collected from the Marine Monitoring Program (MMP) or North Queensland Bulk Port's (NQBP) Queensland Ports Seagrass Monitoring Program (QPSMP). The seagrass index is derived via calculation rather than average of site/meadow scores, which can be found in Appendix 8.4.3.

2024 Report Card (2022-23 data)						
Zones	**MMP**		**NQBP**			**Seagrass Index^**
	Abundance	**Resilience**	**Biomass**	**Area**	**Species Comp.**	
Northern	75		79	86	84	**73**
Whitsunday	28	29				**30**
Central	66	85	82	68	97	**67**
Southern			70	92	84	**70**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

^Refer to Appendix 8.4.3 for individual site scores used to calculate the seagrass index. Each meadow/site score is defined as the lowest grade/score of the three indicators within that meadow where this is driven by biomass or area. Where species composition is the lowest score, it contributed 50% of the overall meadow score, with the next lowest indicator (area or biomass) contributed the remaining 50%.

Key Messages:

1) Recovery after impacts from TC Debbie in 2017 appear stable in the Northern Zone, with all condition indicators remaining 'good' or above.

2) Seagrass grades in the Whitsunday Zone have been poor for four consecutive years, however improvement was seen at Pioneer Bay coastal meadow ('poor' to 'good'). Despite generally moderate environmental conditions, the seagrass index in the Whitsunday Zone has not been improving consistently due to a range of environmental pressures (McKenzie et al., 2023).

3) Score decline in the Whitsunday Zone was influenced by the reintroduction of four new subtidal monitoring sites, two at Whitehaven Beach and two at Cid Harbour. All were graded 'poor' or lower.

4) Although overall scores improved in the Central Zone, three meadows (Dudgeon Pt, St Bees Island, and Keswick Island) declined in Area (from 'very good' to 'moderate'). The cause of these declines was not identified as environmental conditions were favourable for seagrass growth.

5) Meadows in the Southern Zone continued to have a high level of utilisation by dugongs with dugong feeding trails recorded in the two inshore meadows as well as the presence of numerous green turtles during the survey.

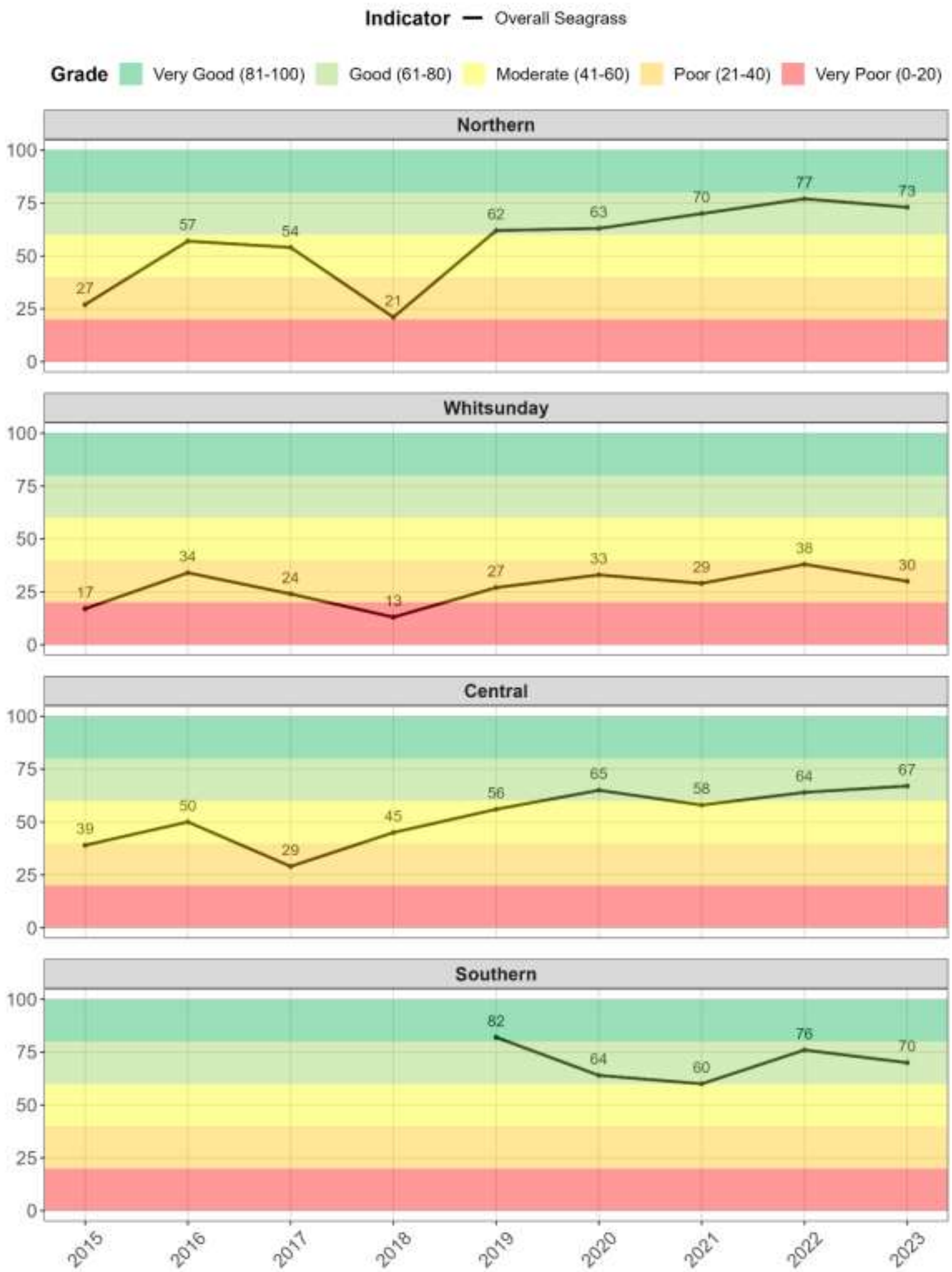

Figure 59. Results for seagrass index for inshore zones for the 2024 Report Card (2022-23 data), compared to historic scores. Indicators are based on data collected from the Marine Monitoring Program (MMP) or North Queensland Bulk Port's (NQBP) Queensland Ports Seagrass Monitoring Program (QPSMP). Scores prior to 2019-20 may differ slightly from past reporting as they have been back-calculated to exclude sites that have since been decommissioned. Scores prior to 2018-19 have not been back-calculated with the MMP Resilience metric and are therefore not directly comparable to current scores.

4.3.1 Confidence

Confidence ranks for seagrass condition indicators associated with both the MMP and QPSMP were equal, resulting in 'moderate' confidence in the overall seagrass index (Table 39).

Table 39. Confidence associated with seagrass index results in inshore zones. Confidence criteria are scored 1–3 and then weighted by the value identified in parentheses. Final scores (4.5–13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1 to 5 (very low–very high), which indicates the final confidence level.

Indicator	Maturity of Methodology (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured Error (x0.71)	Final Score	Rank
Abundance	3	3	1	3	2	8.8	3
Resilience	2	3	1	3	2	8.4	3
Biomass	3	3	1	3	2	8.8	3
Area	3	3	1	3	2	8.8	3
Species Composition	3	3	1	3	2	8.8	3
Seagrass Index						**8.7**	**3**
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 Fish Index

There is currently no score for marine fish in the Report Card. Identification of appropriate indicators and methodology development is currently under investigation in inshore and offshore zones. The suitability of citizen science and/or engagement of recreational fishers was investigated by Regional Report Card Partnerships, however, was ultimately found unsuitable due to the complexities of merging datasets with differing methods, and representativeness (spatial and temporal) that was not sufficient for Report Card indicator development. See full report online (Vinall, 2023).[33]

4.5 Overall Marine Zone Condition

Results (Table 40, Figure 60):

Table 40. Overall inshore and offshore marine scores and grades for the 2024 Report Card (2022-23 data). Overall grade for Offshore Zone cannot be calculated due to minimum index requirements.

2024 Report Card						
Marine Zones	**Water Quality**	**Coral**	**Seagrass**	**Fish**	**Total Score and Grade**	
Northern	55	35	73		**54**	**C**
Whitsunday	58	35	30		**41**	**C**
Central	55	48	67		**56**	**C**
Southern	40	21	70		**43**	**C**
Offshore*		66				

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap
* The Offshore Zone cannot be given an overall grade as only the coral index was measured during the 2022–23 reporting cycle; however, coral scores remain for reference.

Key Messages:

1) The **Whitsunday Zone** improved from 'poor' to 'moderate', largely due to the addition of marine inshore pesticide monitoring. Although sample results demonstrate that pesticides reach the reef ecosystems (with potential spikes in concentrations that pose high risks to aquatic species), dilution in the marine environment is such that the annual risk to marine species is currently 'very low'.

2) **Overall**, condition grades for inshore zones in the 2024 Report Card (2022-23 data) were 'moderate' in all inshore zones.

While scores remained 'moderate' in the **Northern Zone**, score decline was influenced by decline in all indices, primarily water quality, where both nutrients and chl-*a* indicators declined to 'poor' (from 'good' and 'moderate' respectively). However, it is important to note that the Northern Zone does not assess NOx, which influenced improved nutrients scores in other zones. In the **Central Zone** scores improved in all indices, however overall score remained 'moderate'. The Partnership-funded **Southern Inshore Program** is now well-established, with all indices now assessed across multiple years. The addition of condition assessment for seagrass meadows in the Report Card is particularly relevant for dugong protection in the region (Coles et al., 2002; Van De Wetering et al., 2021).

[33] https://healthyriverstoreef.org.au/projects/reef-fish-citizen-science-data-assessment/

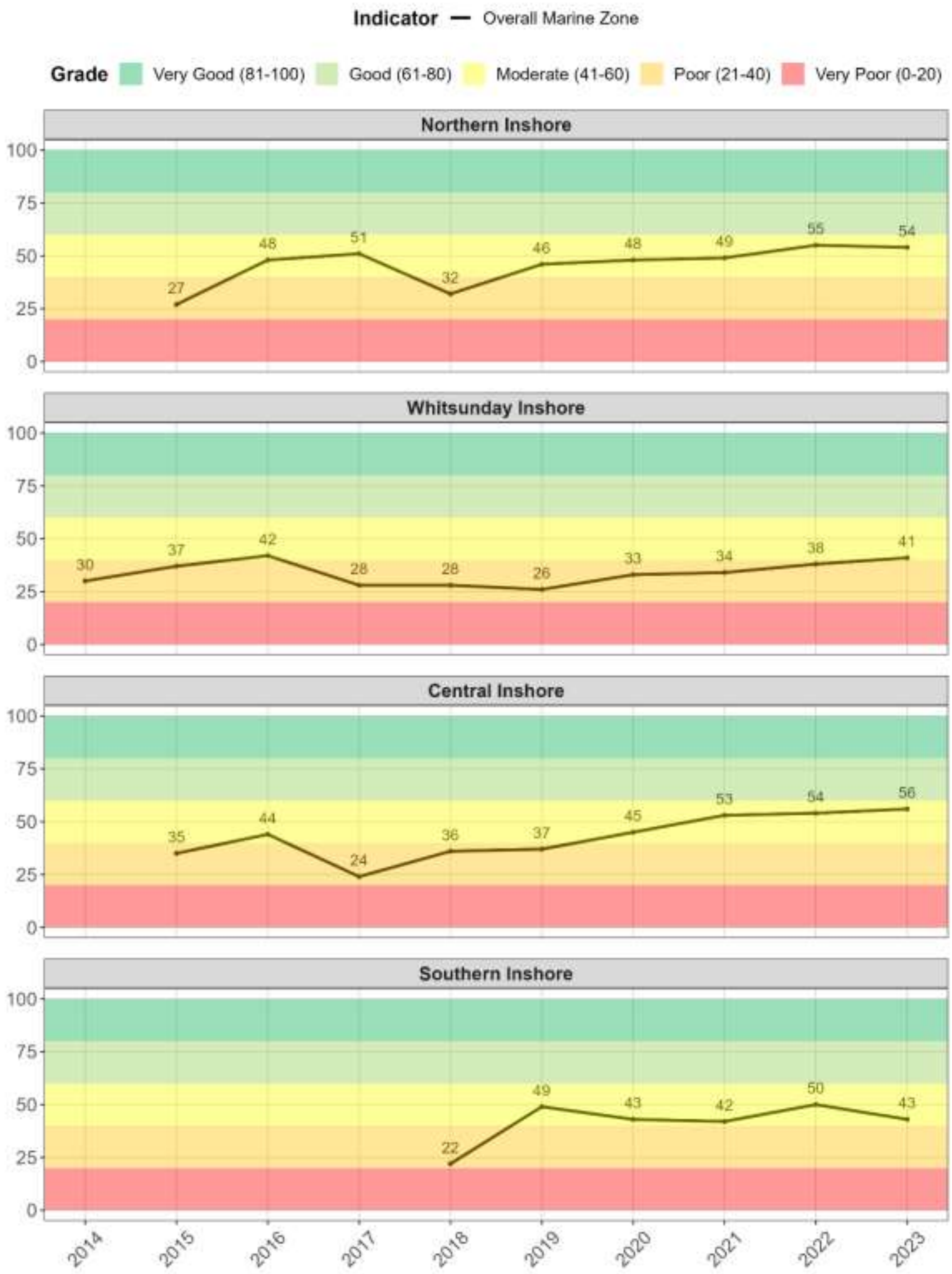

Figure 60. Overall inshore marine scores for the 2024 Report Card (2022-23 data) compared to the historic record. Historic scores may differ slightly from past reporting as they have been back-calculated to reflect changes in sites and/or methods for marine indices.

5 Urban Water Stewardship Framework

The Urban Water Stewardship Framework (UWSF) is a tool for assessing and reporting on the level of practice applied by local government and industry to manage sediment and nutrient loads, including erosion during the construction phase (categorised as developing urban), stormwater run-off during the post-construction phase (established urban), and sewage wastewater treatment plant releases (point source). UWSF assessments are implemented every two years via a facilitated workshop and consensus opinion rating process (DESI, 2020). Results below represent the most recent data available, from the second round of assessments, undertaken in 2022-23.[34]

Results (Figure 61, Table 41, Table 42, Table 43):

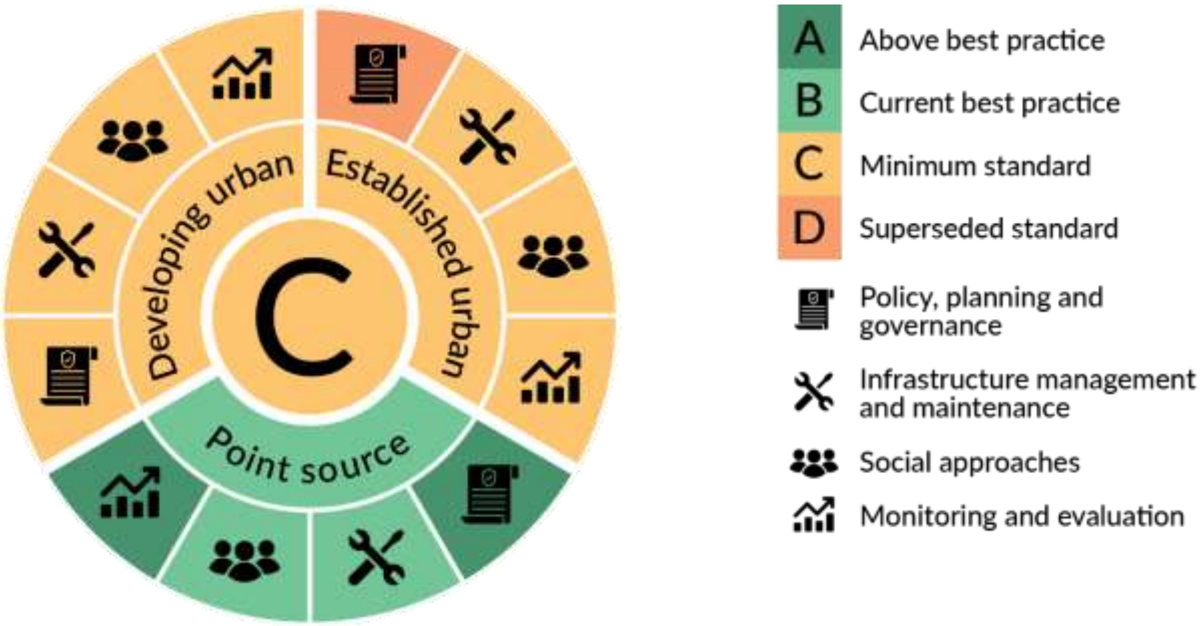

Figure 61. UWSF indicator categories (outer ring), indicators (middle ring), and overall index grade (inner ring) that contribute to the overall score. The indicator categories (clockwise) for each indicator are 'policy, planning, and governance' symbolised by a scroll, 'infrastructure, management, and maintenance' symbolised by tools, 'social approaches' symbolised by people, and 'monitoring and evaluation' symbolised by a graph.

Key Messages:

1) The overall urban water management practice level for the MWI region was rated as C, which equates to a level of practice that meets minimum industry standards and a moderate level of risk to water quality.
2) Although scores for Developing Urban and Established Urban components of the framework improved since the previous reporting cycle, both remained at minimum industry standard (C/Moderate risk).

[34] https://healthyriverstoreef.org.au/report-card/stewardship/

3) Regionally, the poorest-scoring indicators related to policy, planning, and governance for the Established Urban categories. This indicates that improved erosion and sediment control (ESC) and Stormwater Planning in our region could significantly reduce the risk to water quality.

5.1 Developing Urban

The Developing Urban (DU) component refers to urban areas under development for residential, commercial, or industrial purposes, which are frequently associated with the mobilisation of soils.

Table 41. Developing Urban (DU) scores and grades for the 2024 Report Card (2022-23 data). Regional Councils have been de-identified for privacy purposes. RC = Regional Council.

Management Activity Group (MAG)		Regional Council Score			Regional Mean Score
		RC 1	RC 2	RC 3	
DU 1	Policy, planning, and governance (Urban Stormwater Management & ESC policy)	9.3	10.0	9.0	9.4
DU 2	Policy, planning, and governance (development assessment and approvals)	11.8	13.3	11.0	12.0
DU 3	Policy, planning, and governance (Site-based and ESC plans)	0.0	11.5	6.0	5.8
DU 4	Infrastructure management & maintenance (Site-based USM and ESC)	8.0	13.5	6.0	9.2
DU 5	Social approaches (Collaboration, partnerships, capacity building, and learning)	9.5	12.0	8.0	9.8
DU 6	Monitoring, evaluation, reporting & improvement	11.0	9.5	0.0	6.8

UWSF scoring range: ■ Superseded (High risk) = <5.0 | ■ Minimum Standard (Moderate risk) = 5.0 – 12.4 | ■ Current Best Practice (Moderate-low risk) = 12.5 – 17.4 | ■ Innovative and/or Aspirational (Lowest risk) = >17.5

DU 3 (Policy, Planning, and Governing for site-based and ESC plans), and DU 6 (monitoring, evaluation, reporting & improvement) were the poorest-scoring elements in the Developing Urban component.

There is a potential opportunity for more comprehensive erosion control planning across the MWI Region, including improved alignment with water sensitive urban design (WSUD) principles and International Erosion Control Association (IECA) guidelines in the planning stage of developments to meet water quality objectives of the development approvals process.

5.2 Established Urban

The Established Urban (EU) component refers to activities related to managing stormwater runoff and protecting catchment aspects, such as natural wetlands and riparian zones, in established urban areas.

Table 42. Established Urban (EU) scores and grades for the 2024 Report Card (2022-23 data). Regional Councils have been de-identified for privacy purposes. RC = Regional Council.

Management Activity Group (MAG)		Regional Council Score			Regional Mean Score
		RC 1	RC 2	RC 3	
EU 1	Policy, planning, and governance (Catchment Management)	4.0	8.0	4.0	5.3
EU 2	Policy, planning, and governance (Stormwater Management Plan)	4.5	5.0	1.0	3.5
EU 3	Infrastructure management and maintenance (Stormwater network)	4.0	7.0	5.0	5.3
EU 4	Social approaches (Collaboration, partnerships, capacity building, and learning)	9.3	12.3	8.8	10.1
EU 5	Monitoring, evaluation, reporting, and improvement	0.0	11.5	10.0	7.2
UWSF scoring range: ■ Superseded (High risk) = <5.0 | ■ Minimum Standard (Moderate risk) = 5.0 – 12.4 | ■ Current Best Practice (Moderate-low risk) = 12.5 – 17.4 | ■ Innovative and/or Aspirational (Lowest risk) = >17.5					

Ratings of minimum standard or lower for the Established Urban indicator category indicate room for improvement across post-development activities. Examples include the installation, maintenance, and retrofit of treatment devices within catchments, catchment protection and rehabilitation, managing and maintaining stormwater treatment assets, and urban water monitoring that integrates with broader catchment scale monitoring and helps identify local or catchment-based solutions.

Policy, planning, and governance for Stormwater Management Plans (EU 2) was rated lowest scoring at the regional level. This suggests a need to develop and implement stormwater treatment asset management plans, and for improvement in the way riparian vegetation and wetlands are mapped, assessed, and protected.

5.3 Point Source

Under the UWSF, point sources (PS) are considered to relate to wastewater treatment facilities and connected sewer networks operated by councils.

Table 43. Point Source (PS) scores and grades for Management Activity Groups for the Point Source indicator category for the 2024 Report Card (2022-23 data). Regional Councils have been de-identified for privacy purposes. RC = Regional Council.

Management Activity Group (MAG)		Regional Council Score			Regional Mean Score
		RC 1	RC 2	RC 3	
PS 1	Policy, planning, and governance (sewage wastewater management)	11.0	20.0	20.0	17.0
PS 2	Infrastructure management and maintenance (Sewerage network)	14.0	15.0	17.0	15.3
PS 3	Infrastructure management and maintenance (new STP and upgrades)	13.0	18.0	15.0	15.3
PS 4	Social approaches (Collaboration, partnerships, capacity building, and learning)	15.0	19.0	18.0	17.3
PS 5	Monitoring, evaluation, reporting, and improvement	15.0	20.0	17.0	17.3
UWSF scoring range: ■ Superseded (High risk) <5.0 | ■ Minimum Standard (Moderate risk) 5.0 – 12.4 | ■ Current Best Practice (Moderate-low risk) 12.5 – 17.4 | ■ Innovative and/or Aspirational (Lowest risk) >17.5					

The highest scores for point source MAGs were regarding management practices associated with activities in social approaches and monitoring and evaluation. Point Source elements are advanced and indicative of a high level of stewardship.

The highest regional score for point source was attributed to management activities relating to monitoring, evaluation, reporting, and improvement. This indicates that Sewage Treatment Plant receiving water monitoring is done well, incorporated into wider catchment monitoring, and results and reviewed and used to inform management decisions across all aspects of the planning cycle.

5.4 Confidence

Overall confidence for the Urban Water Stewardship indicator was ‘poor’ (Table 44).

Table 44. Confidence associated with Urban Water Stewardship results for the 2024 Report Card. Confidence criteria are scored 1 to 3 and then weighted by the value identified in parentheses as per the UWSF implementation manual (DESI, 2020). Final scores (6–18) are additive across weighted confidence criteria.

	Maturity of methodology (x0.4)	Validation (x0.7)	Representativeness (x4.0)	Directness (x0.7)	Measured error (x0.7)	Final	Rank
UWSF	2	1	2	1	1	**11**	**2**
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 Cultural Heritage

Cultural heritage surveys in the Mackay-Whitsunday-Isaac region are reported by the Partnership every three years, with results included in the 2015, 2018 and 2021 Report Cards. The aim of the assessments is to monitor the state of culturally important places and highlight areas requiring maintenance and preservation.

The most recent cultural heritage scores (2020-21 data) are based on assessments of 17 sites from four zones: Islands of the Whitsundays, Proserpine and Airlie Beach, St Lawrence, and Lake Elphinstone and Mt Britton) (Figure 62). The assessments took place on the traditional country of Yuwibara, Juru, Ngaro, Gia, Koinmerburra, Barada and Widi peoples in October 2020. Further information about the indicators and grades are available in our Cultural Heritage Executive Summary.[35]

Figure 62. Cultural Heritage zones assessed in the 2020-21 surveys. Islands of the Whitsundays (4 sites), Airle Beach & Proserpine (4 sites), Lake Elphinstone & Mt Britton (7 sites), St Lawrence (2 sites).

[35] https://healthyriverstoreef.org.au/wp-content/uploads/2022/07/hr2rp-cultural-heritage-exec-summary-2021.pdf

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8 Appendices

8.1 Climate

8.1.1 Don Basin

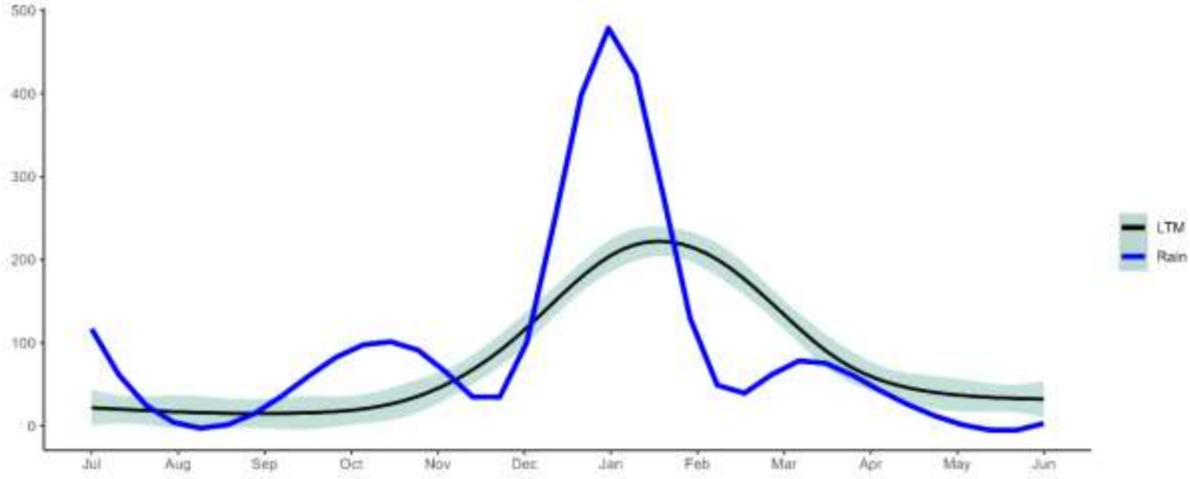

Figure 63. Current financial year (monthly) rainfall (blue line) compared to the long term mean (black line) for each month in the Don Basin. Month on the x axis, rainfall (mm) on the y-axis. Source: Australian Water Outlook

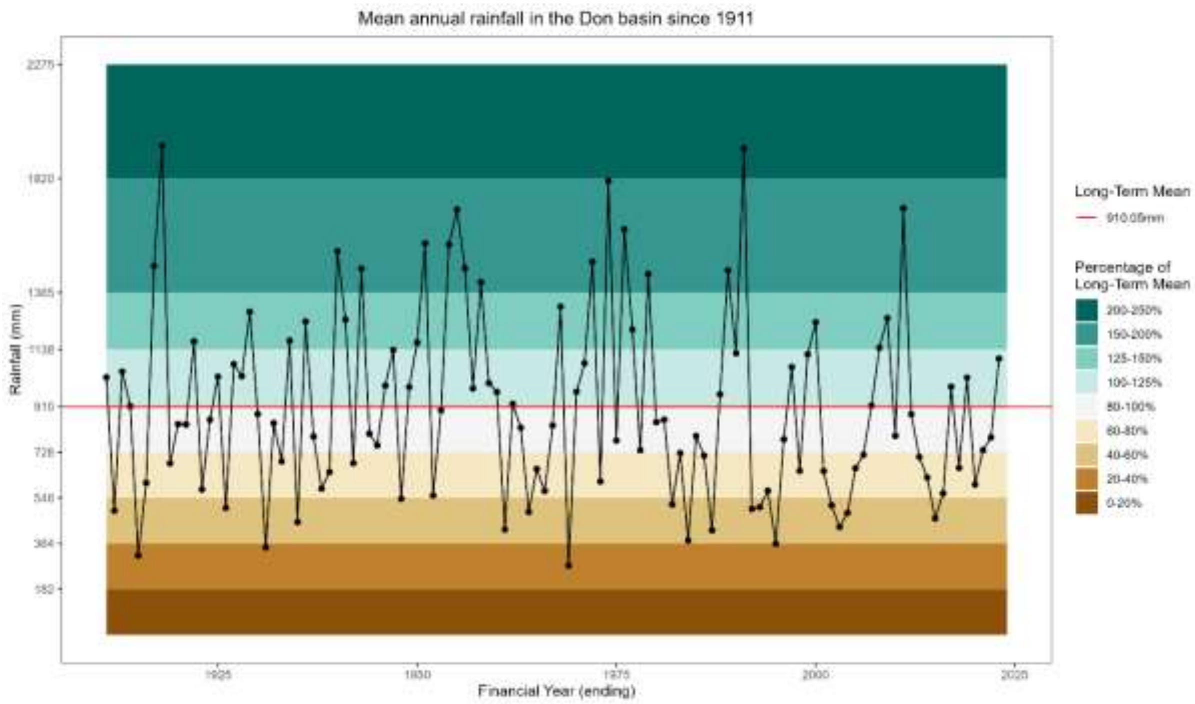

Figure 64. Annual rainfall totals for the Don Basin. Financial year on the x-axis, annual rainfall (mm) on the y-axis. Long-term mean (910 mm) red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2022-23). Long-term annual temperature data sourced from BoM and calculated using results from 1911–2023. Source: Australian Water Outlook.

8.1.2 Proserpine Basin

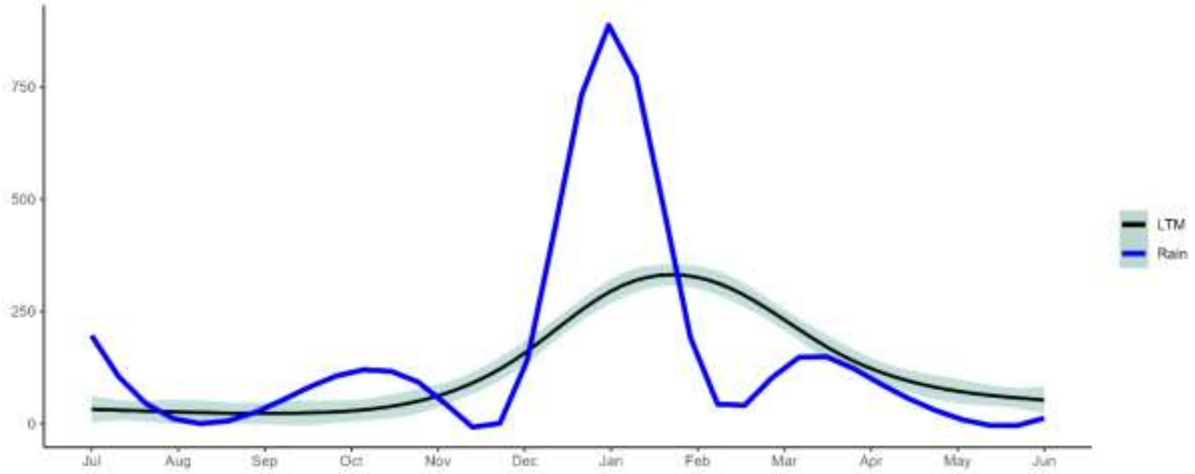

Figure 65. Current financial year (monthly) rainfall (blue line) compared to the long term mean (black line) for each month in the Proserpine Basin. Month on the x axis, rainfall (mm) on the y-axis. Source: Australian Water Outlook

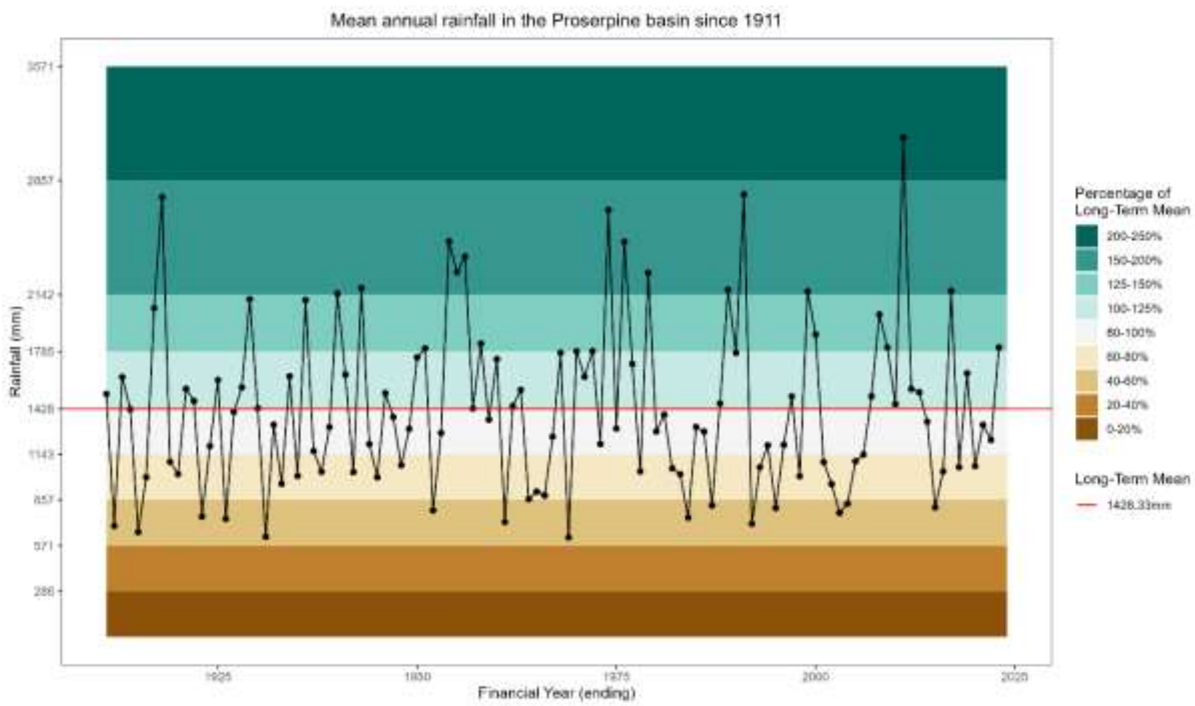

Figure 66. Annual rainfall totals for the Proserpine Basin. Financial year on the x-axis, annual rainfall (mm) on the y-axis. Long-term mean (1428 mm) red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2022-23). Long-term annual temperature data sourced from BoM and calculated using results from 1911–2023. Source: Australian Water Outlook

8.1.3 O'Connell Basin

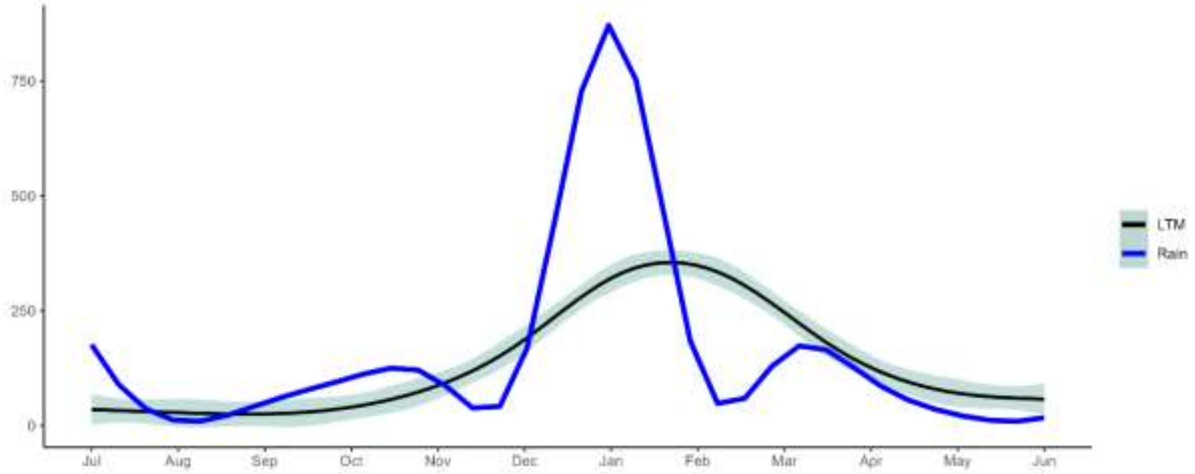

Figure 67. Current financial year (monthly) rainfall (blue line) compared to the long term mean (black line) for each month in the O'Connell Basin. Month on the x axis, rainfall (mm) on the y-axis. Source: Australian Water Outlook

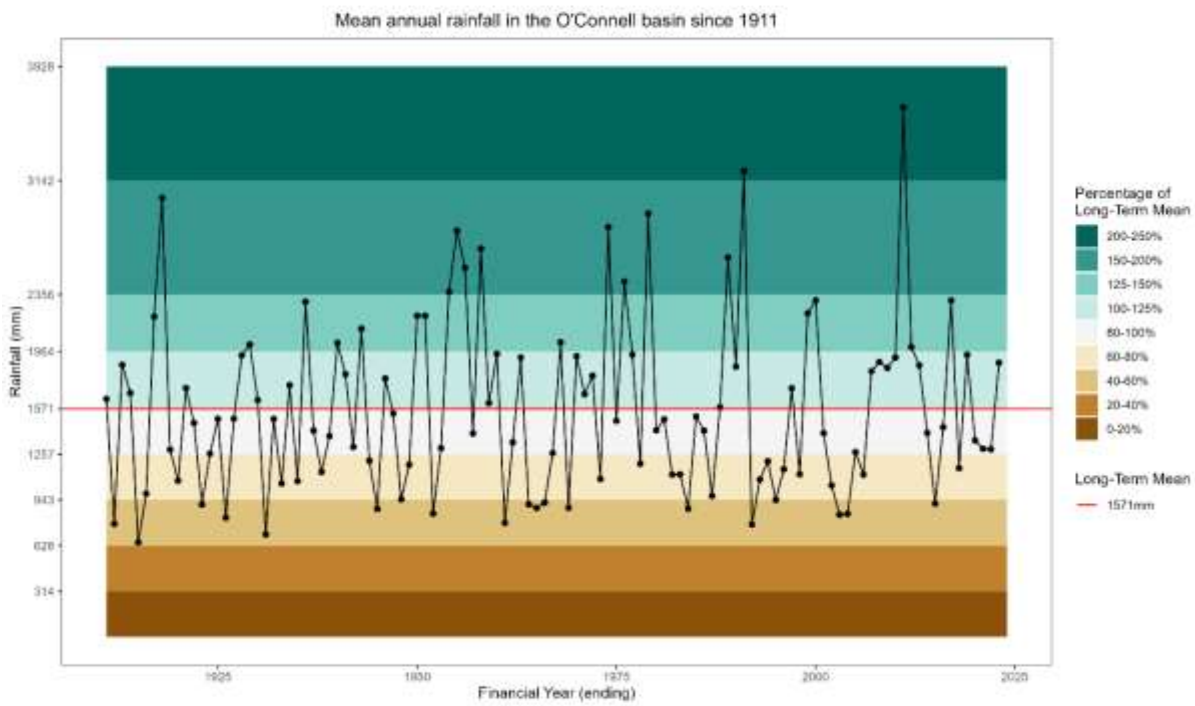

Figure 68. Annual rainfall totals for the O'Connell Basin. Financial year on the x-axis, annual rainfall (mm) on the y-axis. Long-term mean (1571 mm) red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2022-23). Long-term annual temperature data sourced from BoM and calculated using results from 1911–2023. Source: Australian Water Outlook

8.1.4 Pioneer Basin

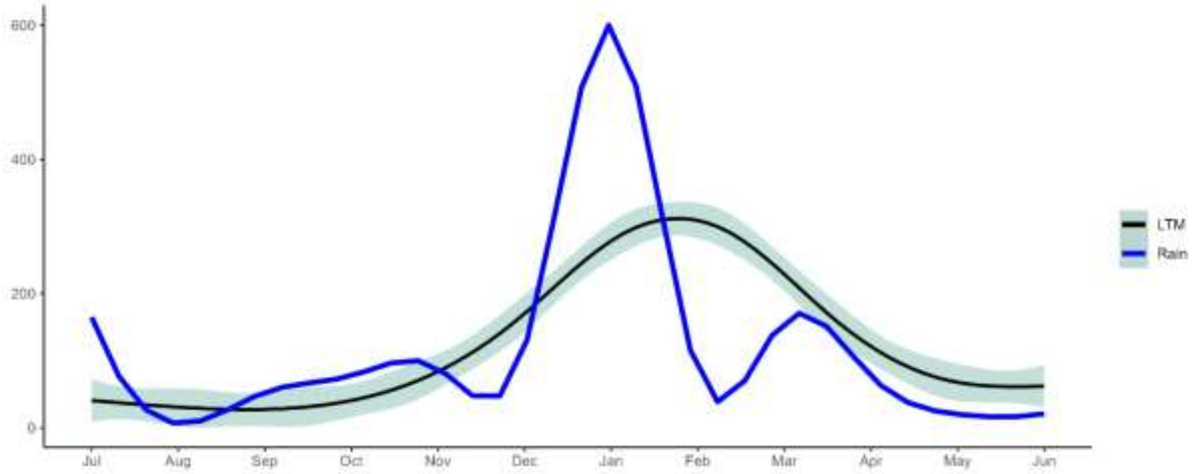

Figure 69. Current financial year (monthly) rainfall (blue line) compared to the long term mean (black line) for each month in the Pioneer Basin. Month on the x axis, rainfall (mm) on the y-axis. Source: Australian Water Outlook

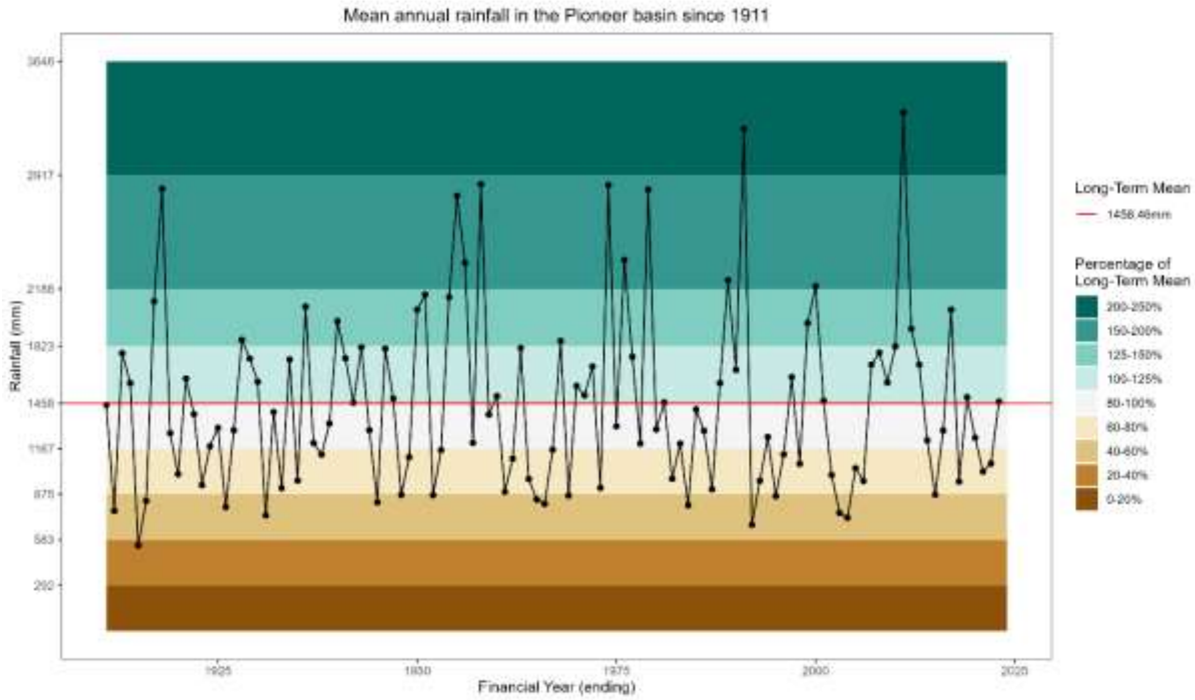

Figure 70. Annual rainfall totals for the Pioneer Basin. Financial year on the x-axis, annual rainfall (mm) on the y-axis. Long-term mean (1458 mm) red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2022-23). Long-term annual temperature data sourced from BoM and calculated using results from 1911–2023. Source: Australian Water Outlook

8.1.5 Plane Basin

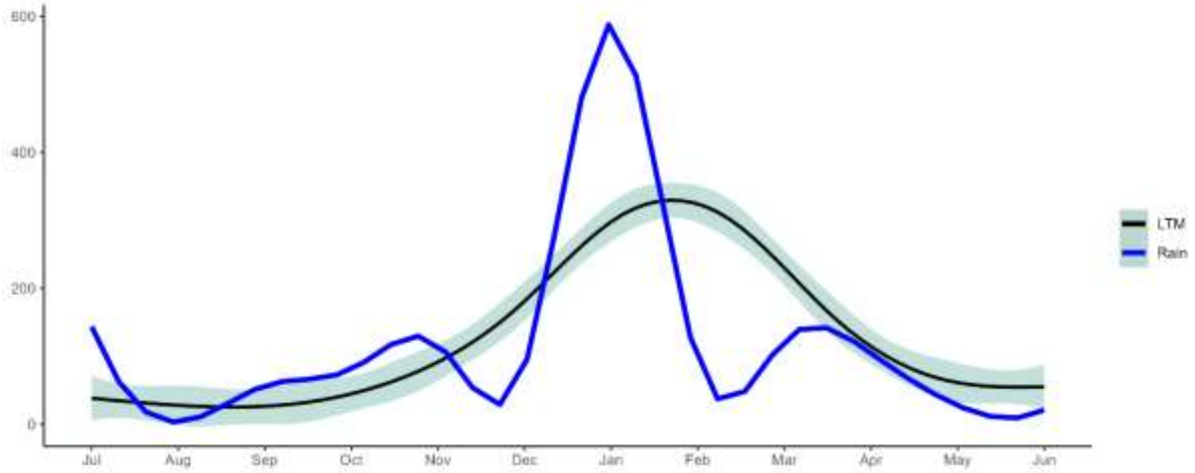

Figure 71. Current financial year (monthly) rainfall (blue line) compared to the long term mean (black line) for each month in the Pioneerl Basin. Month on the x axis, rainfall (mm) on the y-axis. Source: Australian Water Outlook

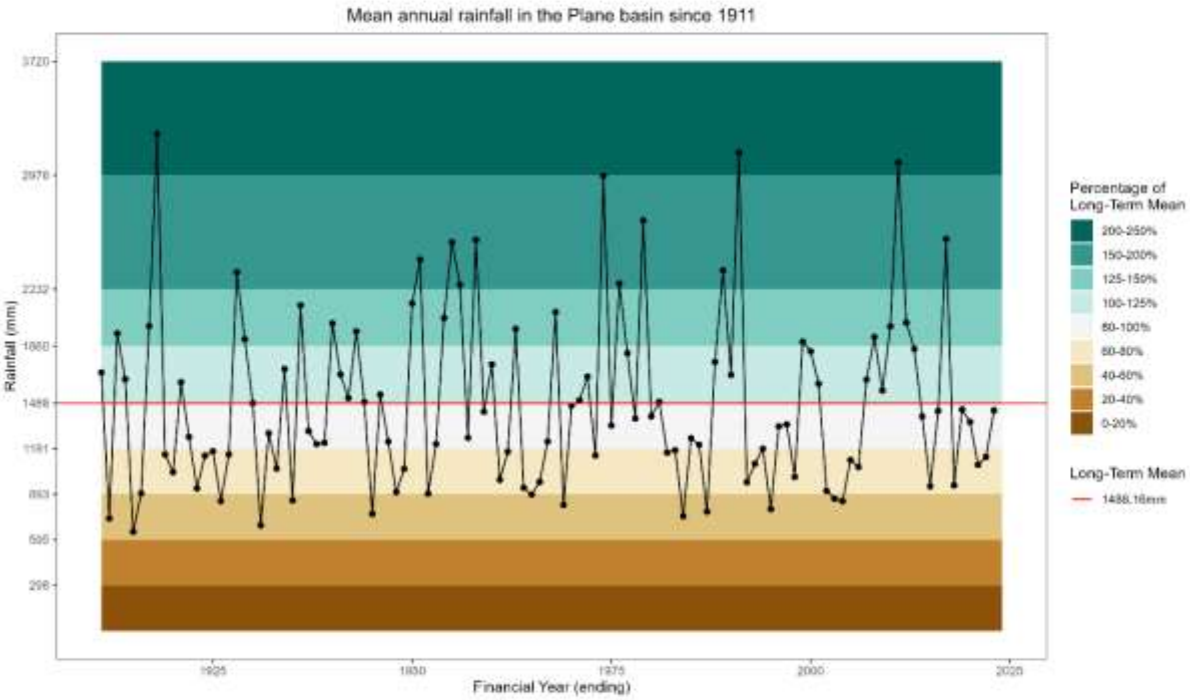

Figure 72. Annual rainfall totals for the Plane Basin. Financial year on the x-axis, annual rainfall (mm) on the y-axis. Long-term mean (1488 mm) red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2022-23). Long-term annual temperature data sourced from BoM and calculated using results from 1911–2023. Source: Australian Water Outlook

8.1.6 Sea Surface Temperature

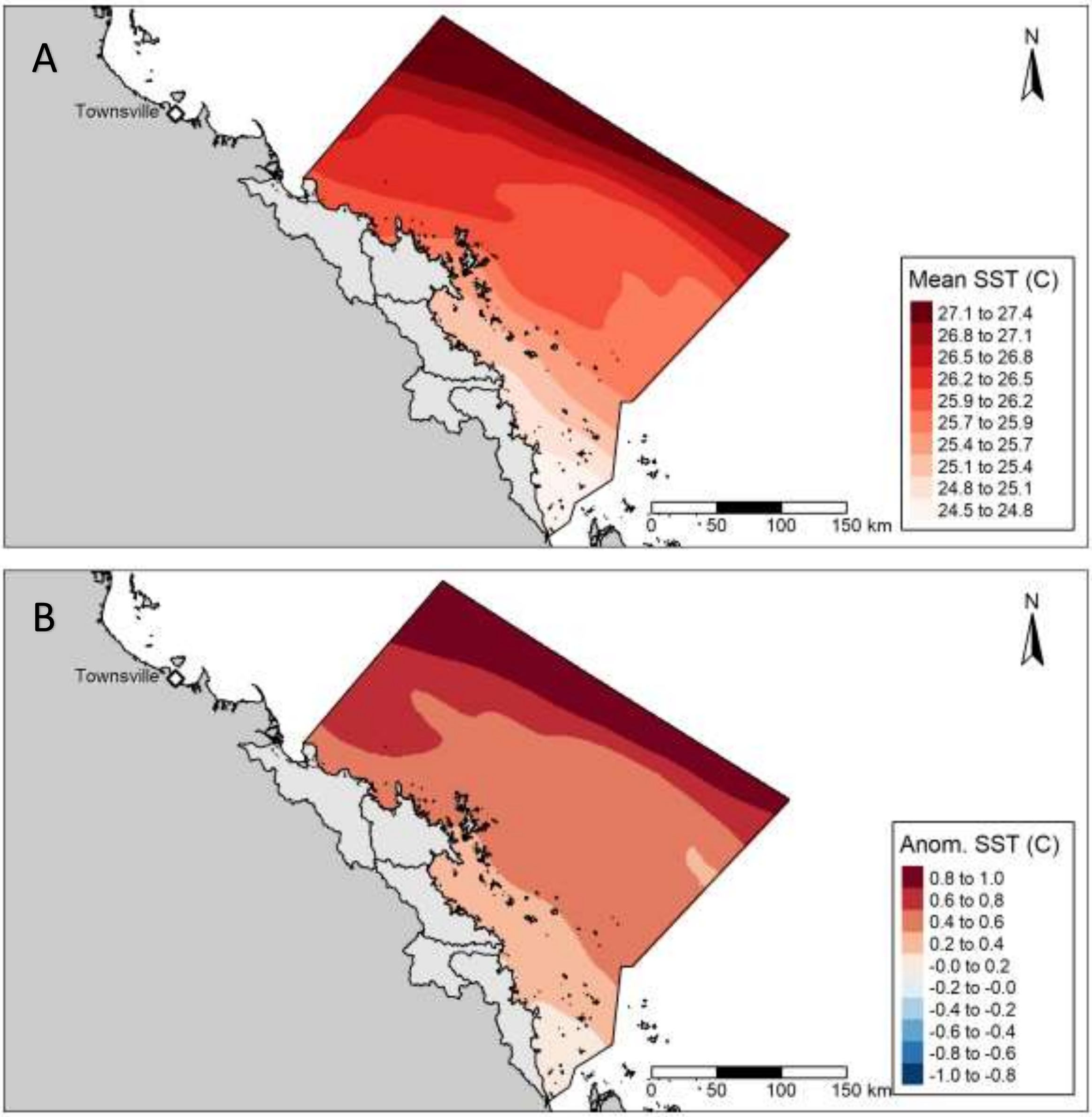

Figure 73. Sea surface temperature (SST) in Mackay-Whitsunday-Isaac. A) SST values were derived by taking the mean of monthly averages calculated across spatial grid sub-sets of each basin. B) Temperature anomaly in the MWI region in 2022-23, calculated as the difference (C) from a long-term mean (calculated from the most recent 30-yr block (1991-2020). Data source: National Oceanic and Atmospheric Association (NOAA)

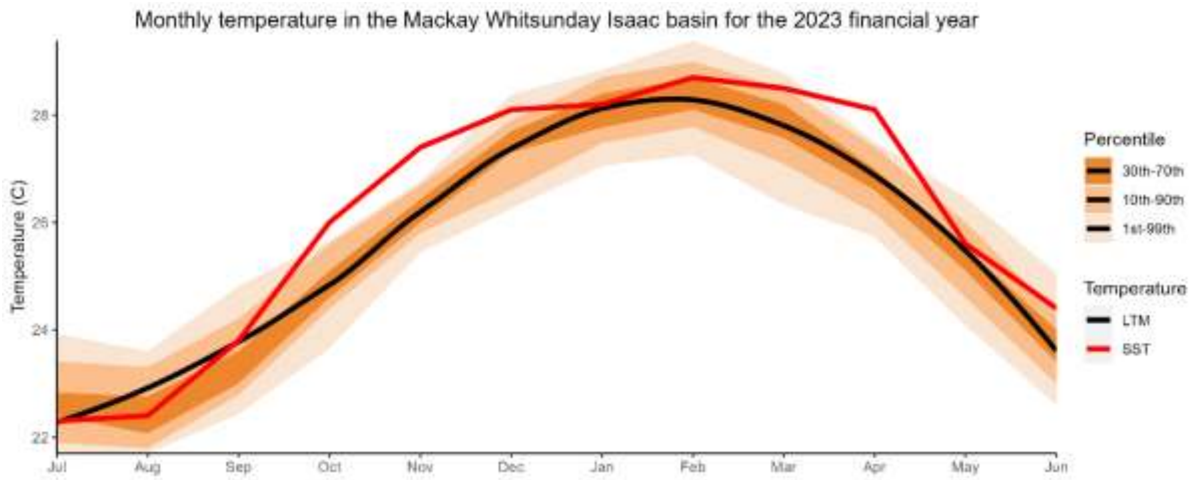

Figure 74. Annual sea surface temperature (SST). Monthly SST in Mackay-Whitsunday-Isaac in comparison to the long-term mean (calculated from 1991 to 2020). The red line indicates the temperature for the current financial year. The black line indicates the long-term temperature. The dark orange shading represents the 30th to 70th percentiles of the long-term mean, the medium orange shading represents the 10th to 90th percentiles of the long-term mean, and the light orange shading represents the 1st to 99th percentiles of the long-term mean. Current financial year (monthly) temperature (red line) compared to the long term mean (black line) for each month in the Mackay-Whitsunday-Isaac marine zones. Month on the x axis, temperature (C) on the y-axis. Source: NOAA

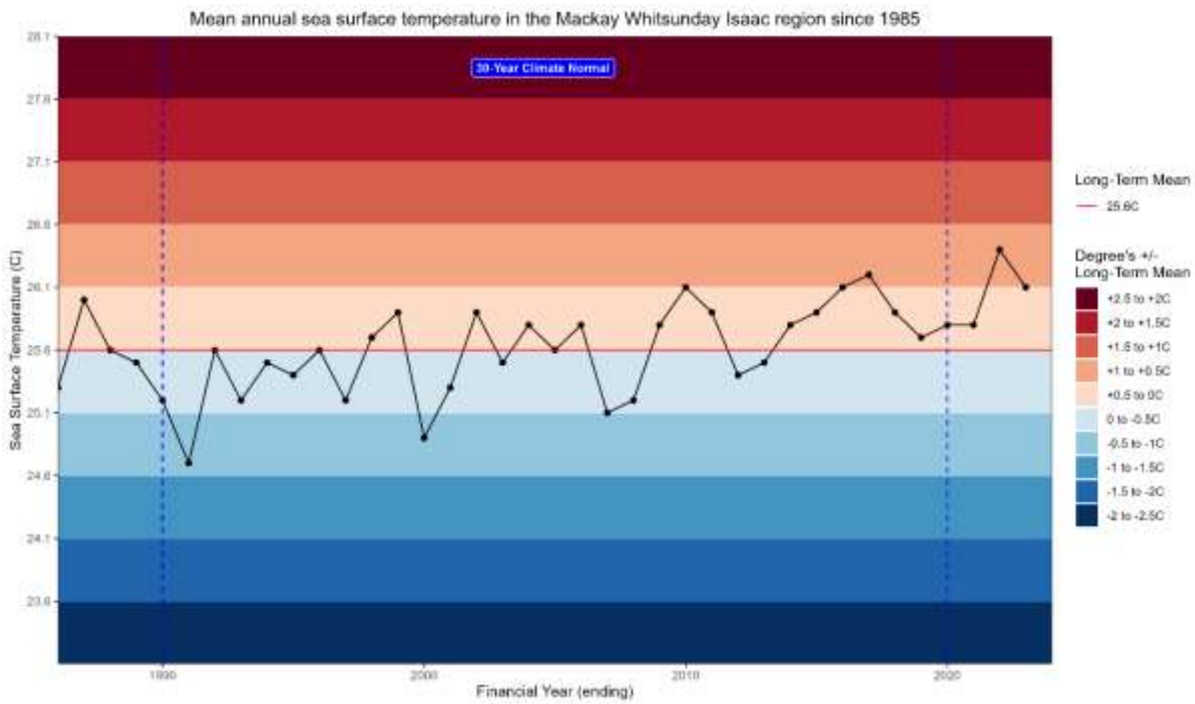

Figure 75. Long-term sea surface temperature (SST) totals for the Mackay-Whitsunday-Isaac region. Financial year on the x-axis, annual sea surface temperature (C) on the y-axis. Long-term mean (25 C) red horizontal line. Shaded background represents the percentage of the long-term mean (calculated from 1991-2020). Source: NOAA

8.2 Freshwater Basins

8.2.1 Basin Summary Stats and Boxplots

Table 45. Freshwater summary statistics for monitored water quality in the MWI basin reporting areas, from July 2021 to June 2022. Summary statistics are presented to three significant figures. Presented alongside summary statistics are relevant guideline values and the adopted statistic for comparison. Significant figures are shown to the same level as given in the relevant guideline value.

Site	Indicator	n	Mean	Minimum	25th %ile	Median	75th %ile	Maximum	Guidelines	
									Comparison Statistic	Guideline Values (mg/L)
Don River at Bowen	TSS	30	110.15	0.5	5.25	47	151.75	685	Median	5
	DIN	30	0.245333	0.022	0.07525	0.1445	0.36225	1.217	Median	0.03
	FRP	30	0.131833	0.013	0.067	0.1265	0.192	0.345	Median	0.045
Proserpine River at Glen Isla	TSS	41	167.365853	19	54	103	237	714	Median	5
	DIN	41	0.233585	0.004	0.096	0.217	0.307	1.008	Median	0.03
	FRP	41	0.105731	0.013	0.088	0.109	0.119	0.255	Median	0.025
O'Connell River at Caravan Park	TSS	57	78.157894	2	7	31	80	924	Median	2
	DIN	57	0.226464	0.0015	0.045	0.107	0.228	2.648	Median	0.03
	FRP	57	0.098535	0.0005	0.014	0.033	0.096	1.11	Median	0.006
O'Connell River at Stafford's Crossing	TSS	71	99.429577	0.5	6.5	49	139	728	Median	2
	DIN	71	0.089718	0.003	0.038	0.061	0.12	0.309	Median	0.03
	FRP	71	0.026922535	0.0005	0.013	0.026	0.0335	0.098	Median	0.006
Pioneer River at Dumbleton Weir	TSS	49	37.867346	0.5	2	10	28	690	Median	5
	DIN	49	0.165826	0.002	0.054	0.16	0.229	0.679	Median	0.008
	FRP	49	0.040857	0.001	0.017	0.035	0.064	0.131	Median	0.005
Plane Creek at Sucrogen Weir	TSS	54	38.231481	0.5	6	21.5	30	336	Median	3
	DIN	54	0.140203	0.0015	0.03825	0.101	0.24275	0.487	Median	0.008
	FRP	54	0.122055	0.001	0.035	0.1075	0.16675	0.395	Median	0.008
Sandy Creek at Homebush	TSS	65	72.715384	0.5	16	42	80	552	Median	5
	DIN	65	0.583815	0.019	0.249	0.38	0.688	2.22	Median	0.03
	FRP	65	0.161661	0.024	0.131	0.174	0.208	0.275	Median	0.015

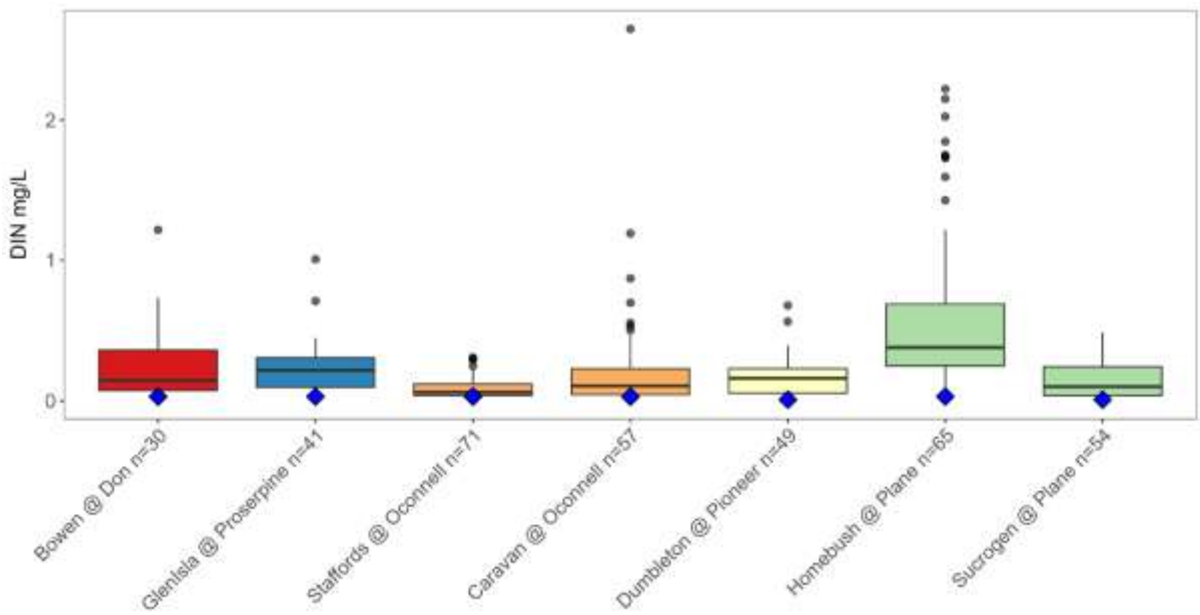

Figure 76. DIN Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median DIN concentrations in the MWI basins. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Basins are represented by colour.

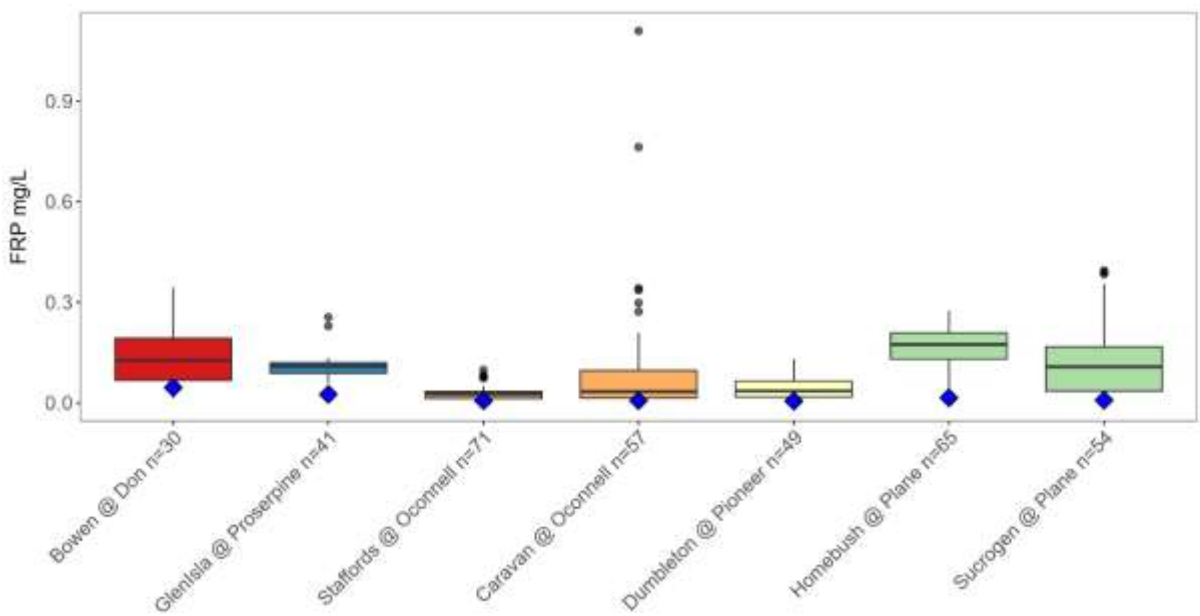

Figure 77. FRP Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median FRP concentrations in the MWI basins. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Basins are represented by colour.

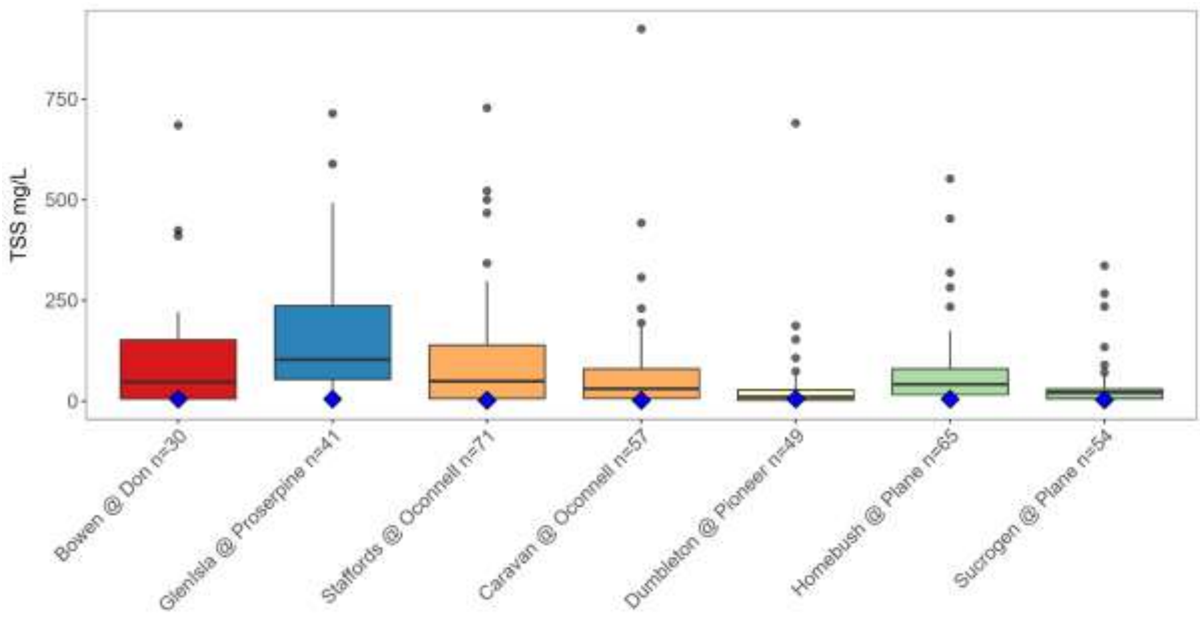

Figure 78. TSS Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median TSS concentrations in the MWI basins. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Basins are represented by colour.

8.2.2 Freshwater Flow Indicator Tool Scores and Hydrographs

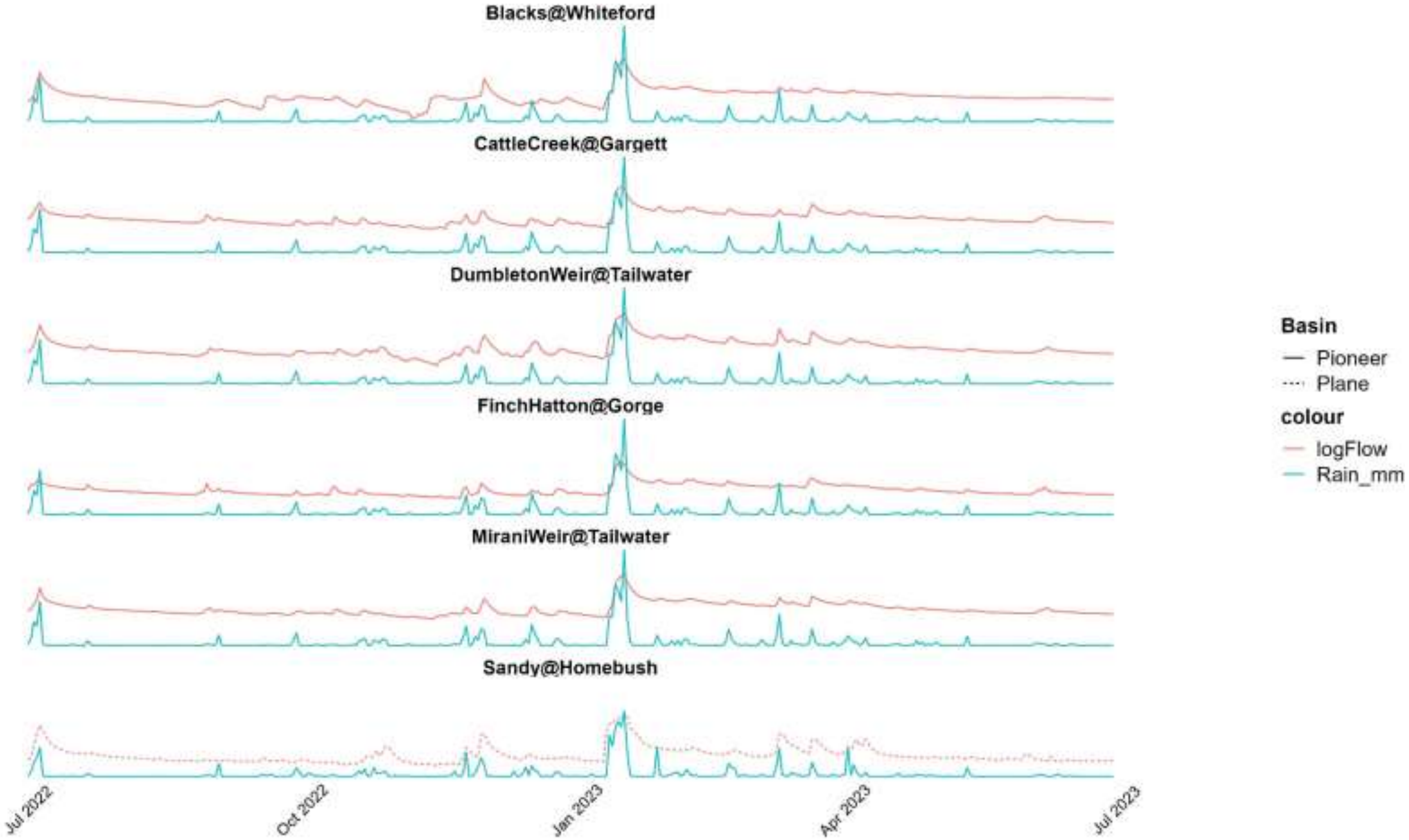

Figure 79. Hydrographs for gauging stations in the Pioneer and Plane basins. Observed discharge (ml/day) is plotted on a log scale against rainfall (mm) over the 2022–23 reporting year.

Table 46. Flow measure scores and summary scores for freshwater flow across the MWI Region, weighted by catchment area for the 2022–23 reporting year. Flow measures are scored between 1 to 5 and the 30th percentile is used as a summary score. Scores are then converted from a 1–5 scale to the standardised 0–100 for weighted aggregation. Climate type is based on annual rainfall across the basin.

Site	Gauging Station #	MDF: %Benchmark	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 Site Score	Gauge Catchment Area (km^2)	Adjusted Catchment Area (km^2)	Proportion (based on using gauged catchment area)	Standardised score x proportion	Aggregated Basin Score	Climate Type
Pioneer Basin																			**71**	**Average**
CattleCk@Gargett	125004B	1.2	4	4	5	5	5	5	4	5	5	5	4.7	75	326	326	0.1	11		
BlacksCk@Whitefords	125005A	0.6	5	5	5	5	5	5	5	3	1	5	5	80	509	702	0.3	25.2		
FinchHattonCk@GorgeRd	125006A	1.27	5	5	5	5	5	4	1	5	5	5	5	80	35	35	0.02	1.3		
PioneerR@MiraniWeirTW	125007A	0.9	4	4	5	5	5	5	5	1	4	5	4	61	1211	885	0.4	24.3		
PioneerR@DumbletonWeirTW	125016A	0.8	5	5	5	5	5	4	5	1	5	5	5	80	1488	277	0.1	10		
Plane Basin																			**61**	**Average**
SandyCreek@Homebush	126001A	1.09	5	5	4	4	1	5	3	4	5	5	4	61	326	326	1.00	61		

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

8.2.3 Assessing Multiple Sites per Catchment and Individual Indicators

Based on the recommendation provided by the TWG in March 2019, data collected from multiple independent monitoring sites were aggregated using a weighted average based on the relative catchment area upstream of each sampling site (MWI HR2RP, 2024). In the MWI Region this occurs in both the O'Connell and the Plane River catchments. Results for each sub-catchment are shown below for O'Connell Basin (Figure 80) and Plane Basin (Figure 81).

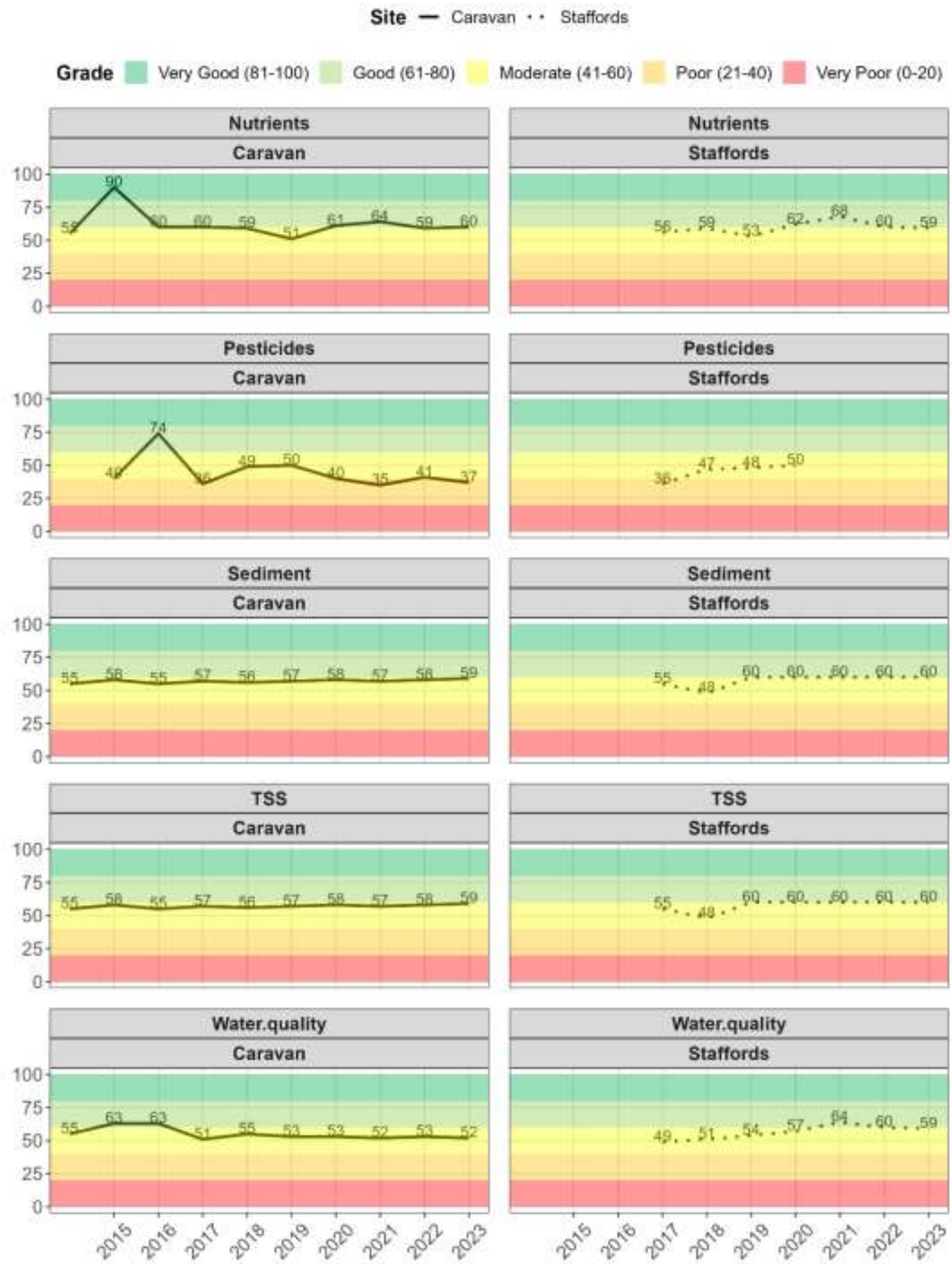

Figure 80. O'Connell Basin site results for water quality indicator categories for the 2024 Report Card (2022-23 data) compared to the historic record, with Stafford's Crossing represented by a dash-dot line and Caravan Park represented by a dotted line.

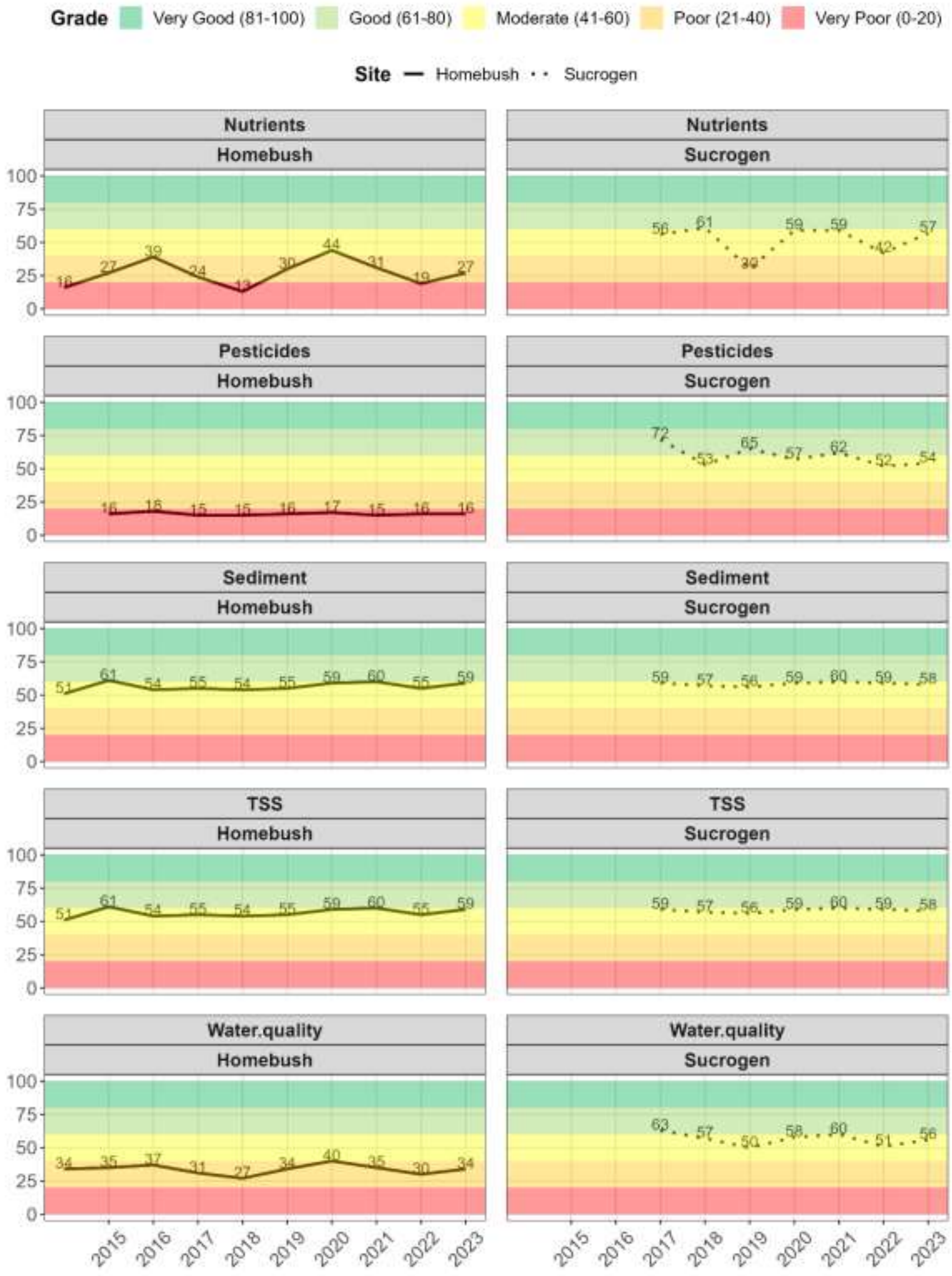

Figure 81. Plane Basin site results for water quality indicator categories for the 2021 22 Report Card compared to the historic record, with Plane River Sucrogen Weir represented by a dash-dot line and Sandy Creek Homebush represented by a dotted line.

8.3 Estuarine Waterways

8.3.1 Estuary Summary Stats and Boxplots

Table 47. Estuary summary statistics for monitored water quality in the MWI estuary reporting areas from July 2021 to June 2022. Summary statistics are presented alongside guideline values, which represented the adopted statistic for comparison. In the estuaries, the median concentration value should be compared against the applicable water quality guideline. Significant figures are shown to the same level as given in the relevant guideline value.

Site	Indicator	n	Mean	Minimum	25th %ile	Median	75th %ile	Maximum	Guidelines	
									Comparison Statistic	Guideline Values
Gregory River	Chl-*a*	22	3.653	1.212	2.182	2.837	4.661	9.733	Median	2 µg/L
	DIN	22	0.017	0.002	0.004	0.011	0.023	0.085	Median	0.018 mg/L
	FRP	22	0.014	0.003	0.008	0.011	0.017	0.062	Median	0.03 mg/L
	Turbidity	22	7.442	1.8	2.972	4.285	9.957	30.89	Median	10 mg/L
	DO	22	74.738	56	70.675	75.8	79.825	87.2	Median	70-105 %
O'Connell River	Chl-*a*	11	4.059	1.684	2.691	3.869	4.601	7.888	Median	2 µg/L
	DIN	12	0.057	0.001	0.012	0.023	0.088	0.183	Median	0.018 mg/L
	FRP	12	0.018	0.0005	0.002	0.009	0.028	0.062	Median	0.03 mg/L
	Turbidity	11	8.927	3	3.95	6.03	11.14	28.45	Median	10 mg/L
	DO	11	103.581	73.8	99.2	105.4	110.85	120.7	Median	70-105 %
St Helens Creek	Chl-*a*	12	4.398	1.257	1.701	4.7954	5.582	8.950	Median	2 µg/L
	DIN	12	0.083	0.042	0.054	0.065	0.092	0.202	Median	0.018 mg/L
	FRP	12	0.013	0.006	0.009	0.0105	0.016	0.025	Median	0.03 mg/L

Site	Indicator	n	Mean	Minimum	25th %ile	Median	75th %ile	Maximum	Guidelines	
									Comparison Statistic	Guideline Values
	Turbidity	24	16.352	6.71	8.755	10.8	13.887	77.66	Median	10 mg/L
	DO	24	86.812	72.4	81.625	85.5	92.375	102.6	Median	70-105 %
Murray Creek	Chl-*a*	24	4.430	1.158	2.353	4.789	5.994	9.101	Median	2 µg/L
	DIN	24	0.149	0.01	0.053	0.150	0.194	0.57	Median	0.018 mg/L
	FRP	24	0.032	0.015	0.022	0.032	0.042	0.063	Median	0.03 mg/L
	Turbidity	36	23.653	2	4.822	9.815	21.245	185.18	Median	10 mg/L
	DO	36	83.894	44.7	79.1	83.85	88.375	113.4	Median	70-105 %
Vines Creek	Chl-*a*	12	3.935	1.29	2.302	3.369	4.586	9.018	Median	2 µg/L
	DIN	12	0.302	0.098	0.146	0.333	0.412	0.59	Median	0.018 mg/L
	FRP	12	0.041	0.007	0.011	0.015	0.023	0.21	Median	0.03 mg/L
	Turbidity	12	11.014	2.11	3.327	5	9.192	55.38	Median	10 mg/L
	DO	12	77.933	42.8	71.2	81.35	85.725	94.2	Median	70-105 %
Sandy Creek	Chl-*a*	24	3.748	1.431	2.270	3.463	5.224	7.53	Median	5 µg/L
	DIN	24	0.339	0.002	0.008	0.153	0.496	1.2	Median	0.018 mg/L
	FRP	24	0.067	0.012	0.025	0.058	0.083	0.21	Median	0.06 mg/L
	Turbidity	24	26.726	2.92	9.317	14.695	30.057	185.09	Median	NA
	DO	24	87.770	66.4	78.375	87.95	96.35	108.8	Median	70-105%

Site	Indicator	n	Mean	Minimum	25th %ile	Median	75th %ile	Maximum	Guidelines	
									Comparison Statistic	Guideline Values
Plane Creek	Chl-*a*	24	5.029	1.583	2.958	3.906	5.647	17.368	Median	5 µg/L
	DIN	24	0.038	0.002	0.004	0.017	0.062	0.142	Median	0.018 mg/L
	FRP	24	0.030	0.004	0.008	0.024	0.051	0.09	Median	0.06 mg/L
	Turbidity	24	11.119	1.6	4.395	5.69	7.787	98.73	Median	NA
	DO	24	94.362	76.3	87.925	92	98.35	119.2	Median	70-105%
Rocky Dam Creek	Chl-*a*	22	6.842	2.108	4.983	6.419	8.066	16.157	Median	5 µg/L
	DIN	22	0.195	0.04	0.140	0.170	0.228	0.431	Median	0.018 mg/L
	FRP	22	0.039	0.02	0.0312	0.039	0.044	0.068	Median	0.06 mg/L
	Turbidity	22	75.684	7.79	46.427	57.18	98.477	200.52	Median	NA
	DO	22	86.413	72	80.575	86.55	88.725	126	Median	70-105%
Carmila Creek	Chl-*a*	24	5.613	0.926	3.916	6.278	7.687	8.718	Median	5 µg/L
	DIN	12	0.077	0.002	0.004	0.059	0.095	0.28	Median	0.018 mg/L
	FRP	12	0.035	0.007	0.025	0.036	0.047	0.066	Median	0.06 mg/L
	Turbidity	24	29.285	6.57	9.565	13.83	24.98	126.48	Median	NA
	DO	24	98.237	63.2	91.3	98.3	108.05	125.7	Median	70-105%

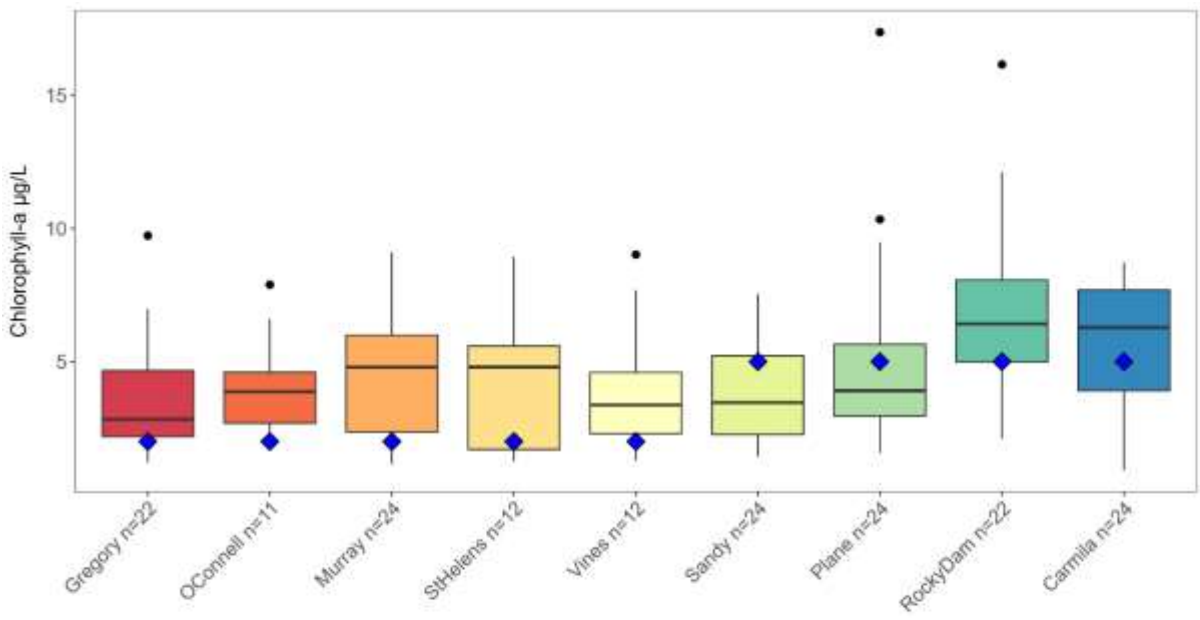

Figure 82. Chl-*a* Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median Chlorophyll-*a* concentrations in the MWI estuaries. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per estuary is shown with the x axis labels.

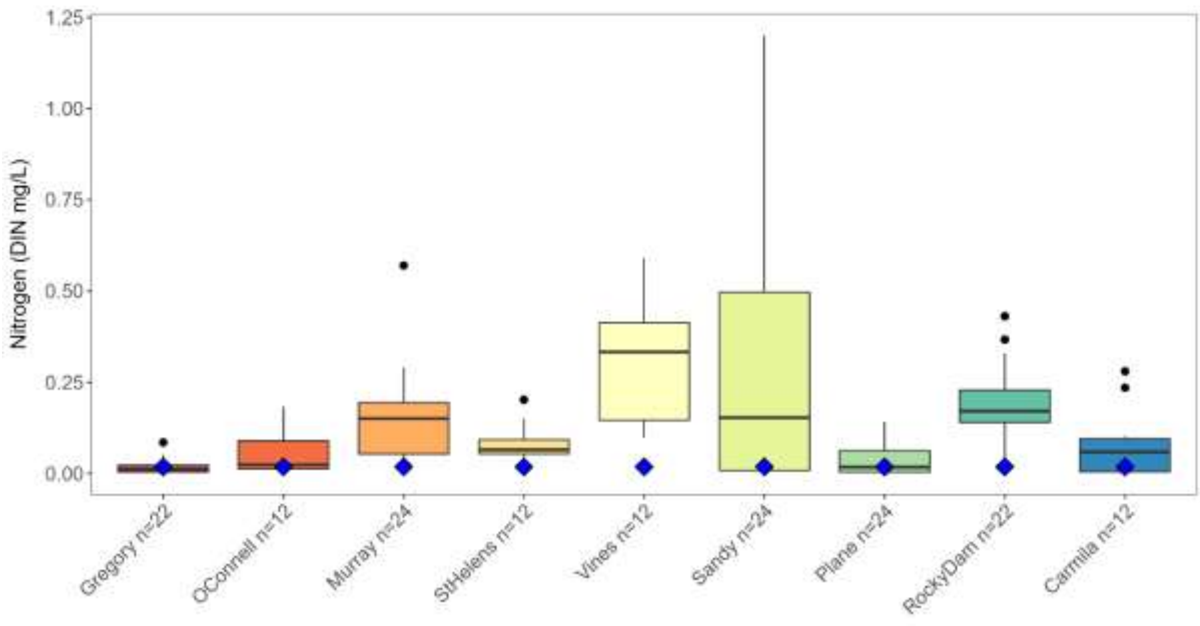

Figure 83. DIN Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median DIN concentrations in the MWI estuaries. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per estuary is shown with the x axis labels.

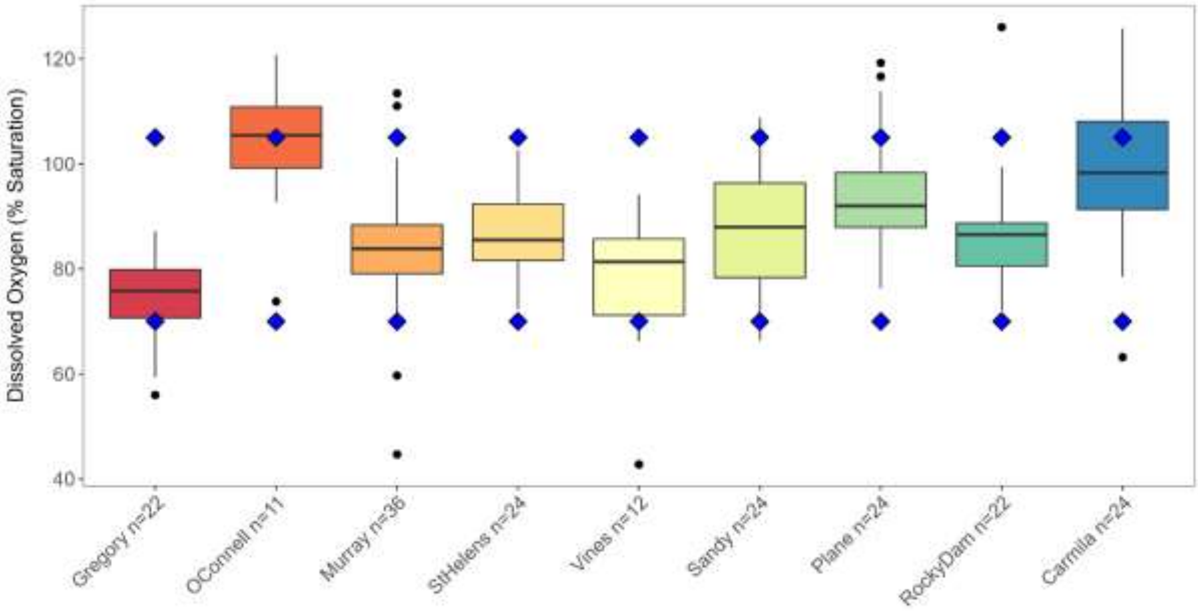

Figure 84. DO Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median Dissolved Oxygen (DO) concentrations in the MWI estuaries. Guideline values are represented by a blue diamond, and both lower and upper DO guideline values are presented. Outliers (>1.5 x IQR) are represented as black points. Sample size per estuary is shown with the x axis labels.

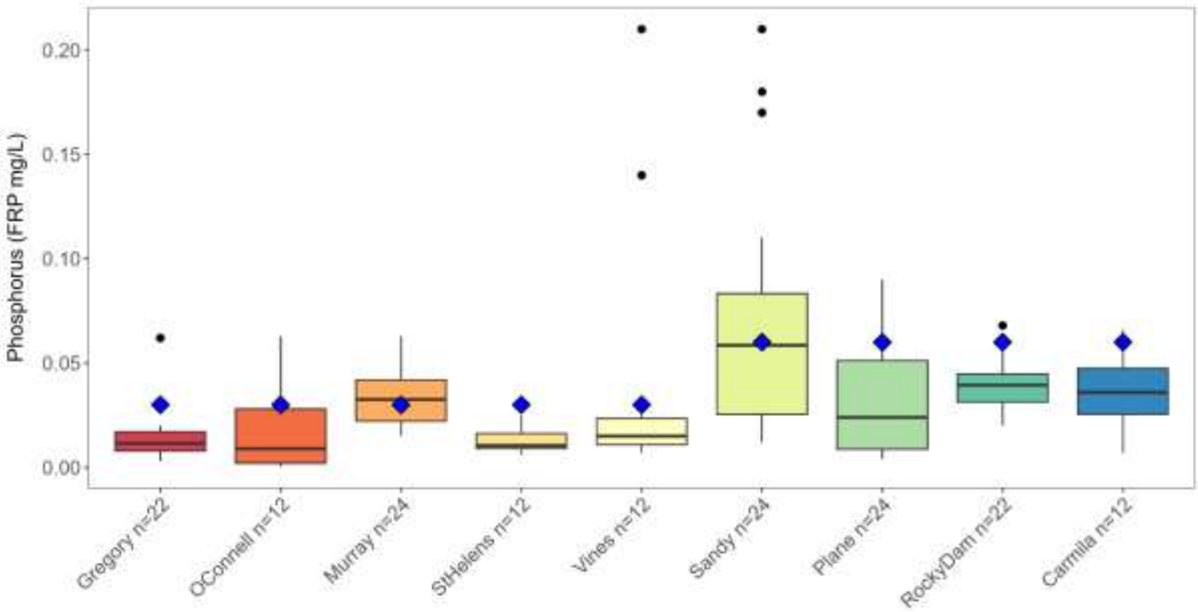

Figure 85. FRP Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median FRP concentrations in the MWI estuaries. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per estuary is shown with the x axis labels.

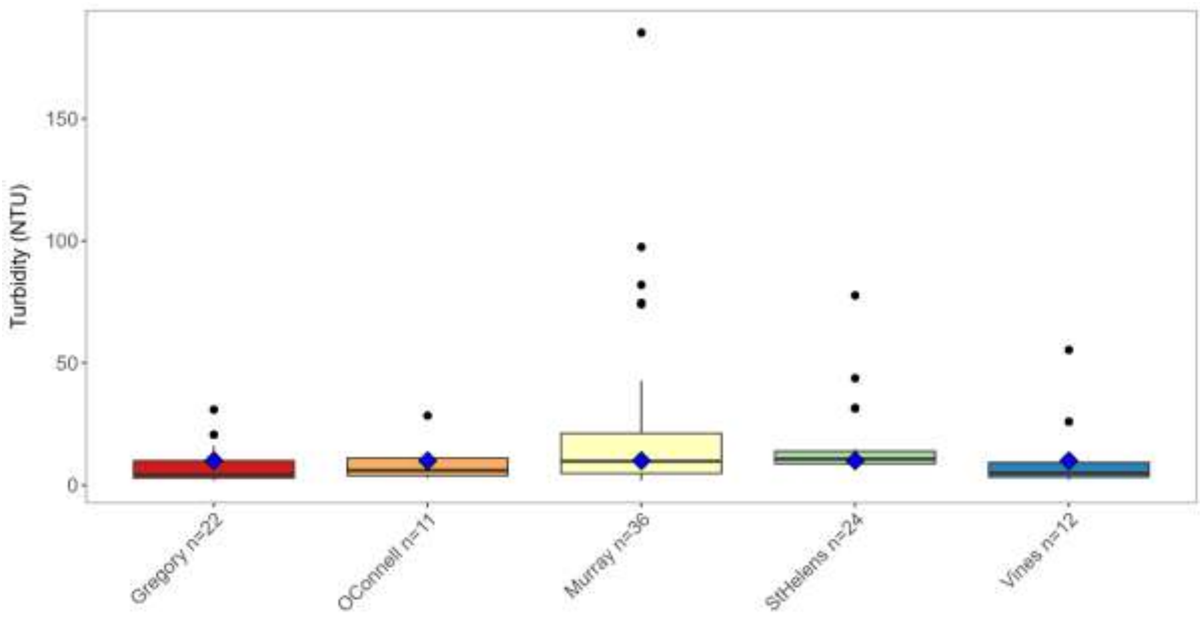

Figure 86. NTU Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median NTU in the MWI estuaries. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per estuary is shown with the x axis labels.

8.4 Marine Environments

The scores and graphs presented below are for the inshore and offshore zones for the 2024 Report Card (2022-23 data). Boxplots are presented for inshore water quality indicators and summary statistics are tabulated for individual sites. Site-level scores are also presented where applicable.

8.4.1 Marine Water Quality

8.4.1.1 Indicator Boxplots

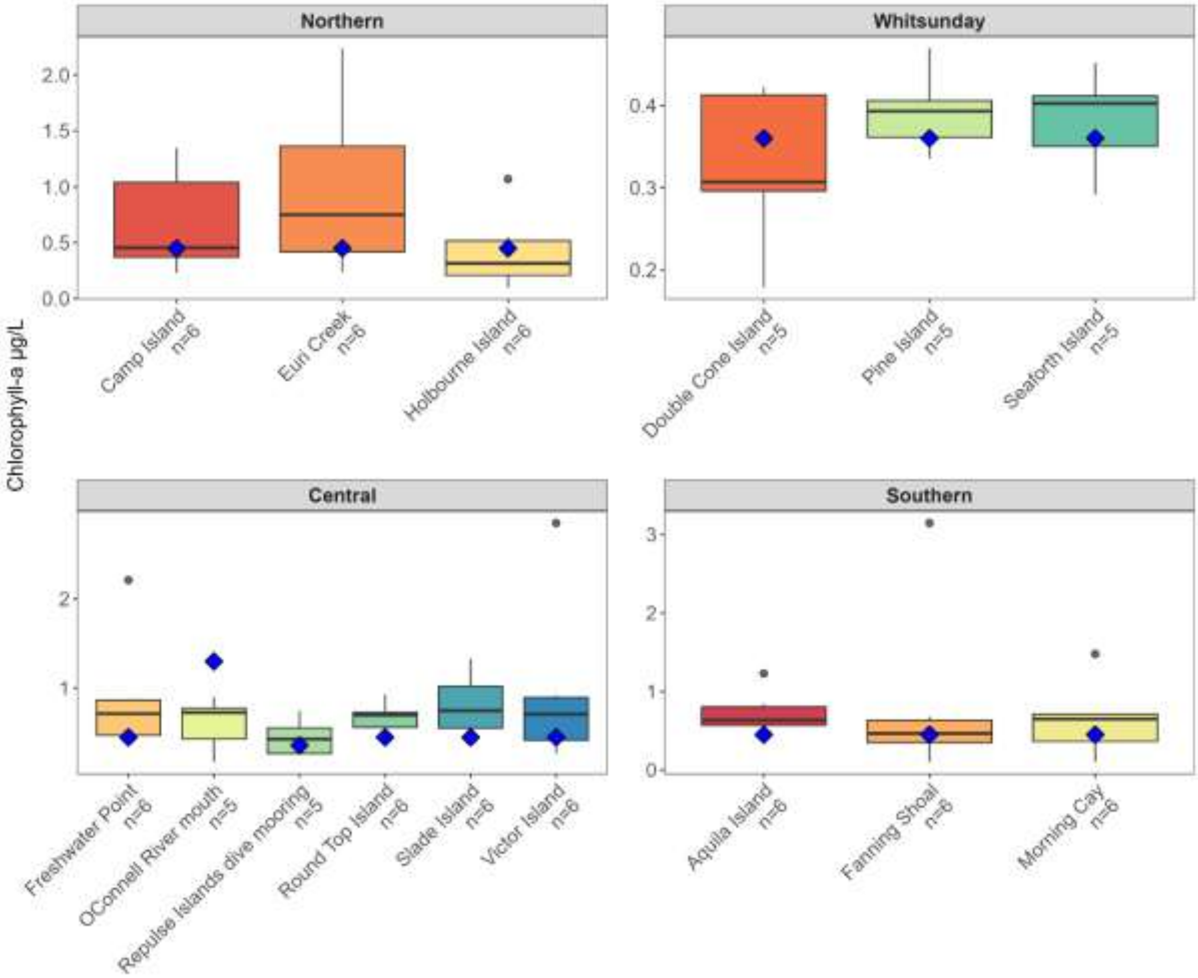

Figure 87. Chl-*a* box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of Chlorophyll-*a* concentrations in the MWI inshore zones and sampling sites. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per site is shown with the x axis labels. Note the free scale on the y axis.

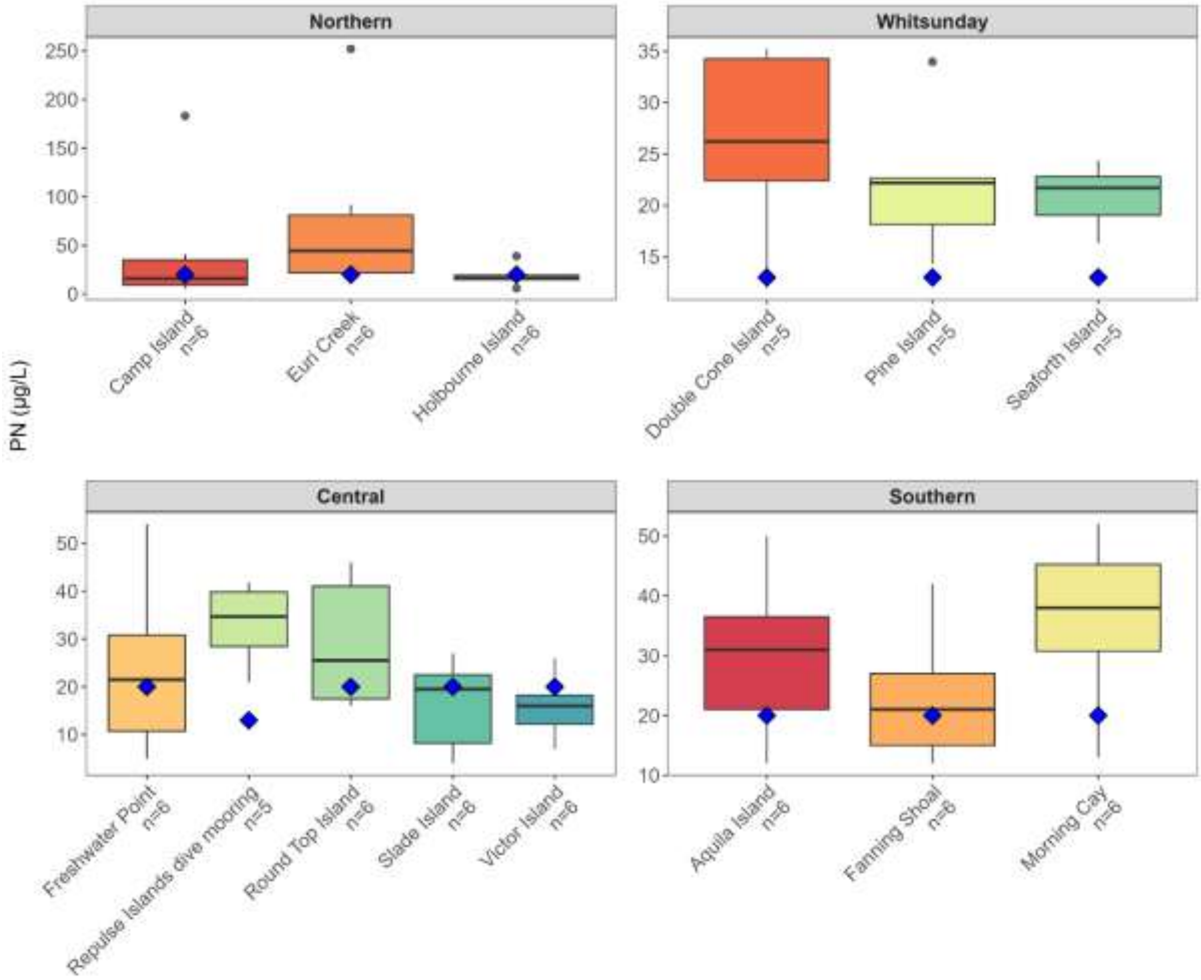

Figure 88. PN Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of PN concentrations in the MWI inshore zones and sampling sites. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per site is shown with the x axis labels. Note the free scale on the y axis.

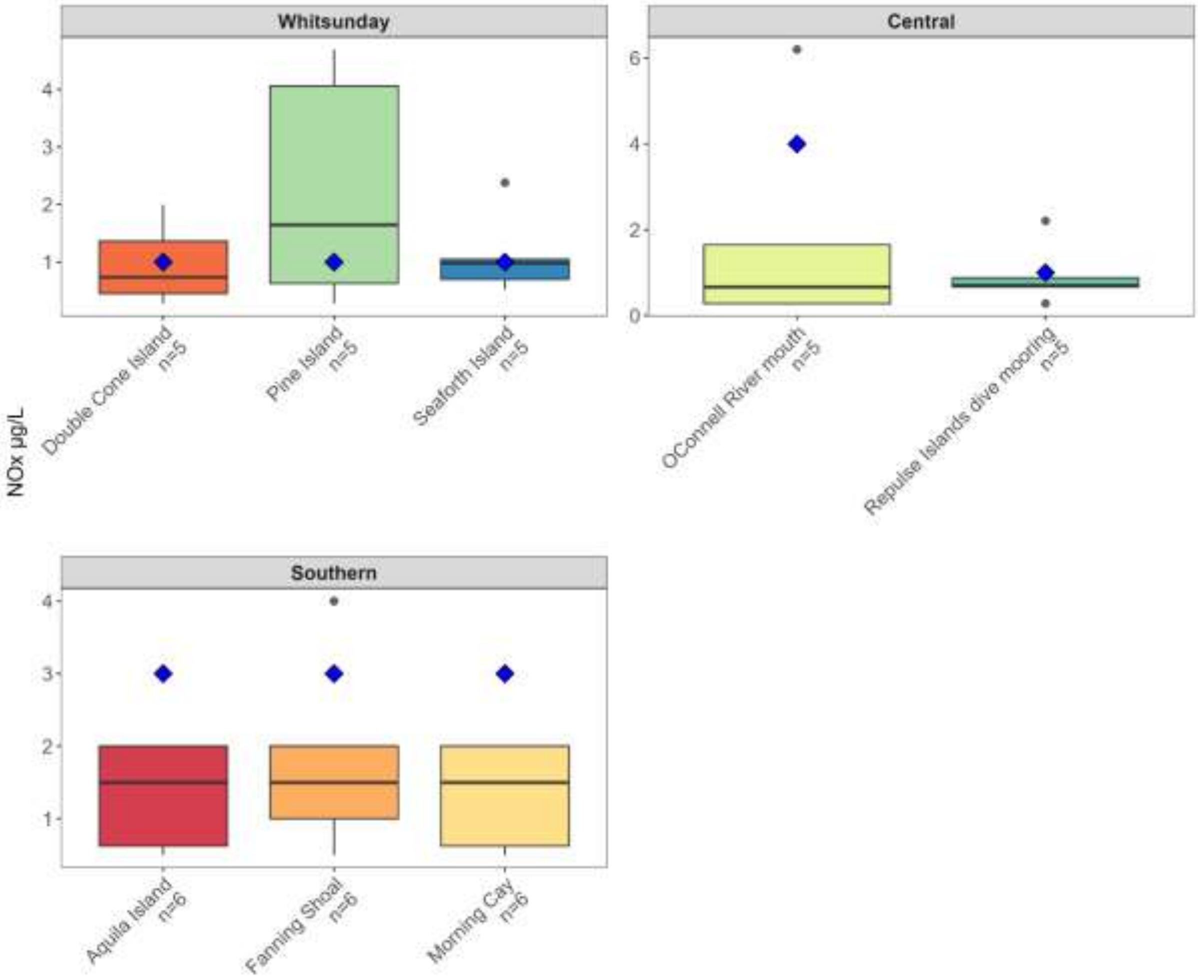

Figure 89. NOx Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of NOx concentrations in the MWI inshore zones and sampling sites. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per site is shown with the x axis labels. Note the free scale on the y axis.

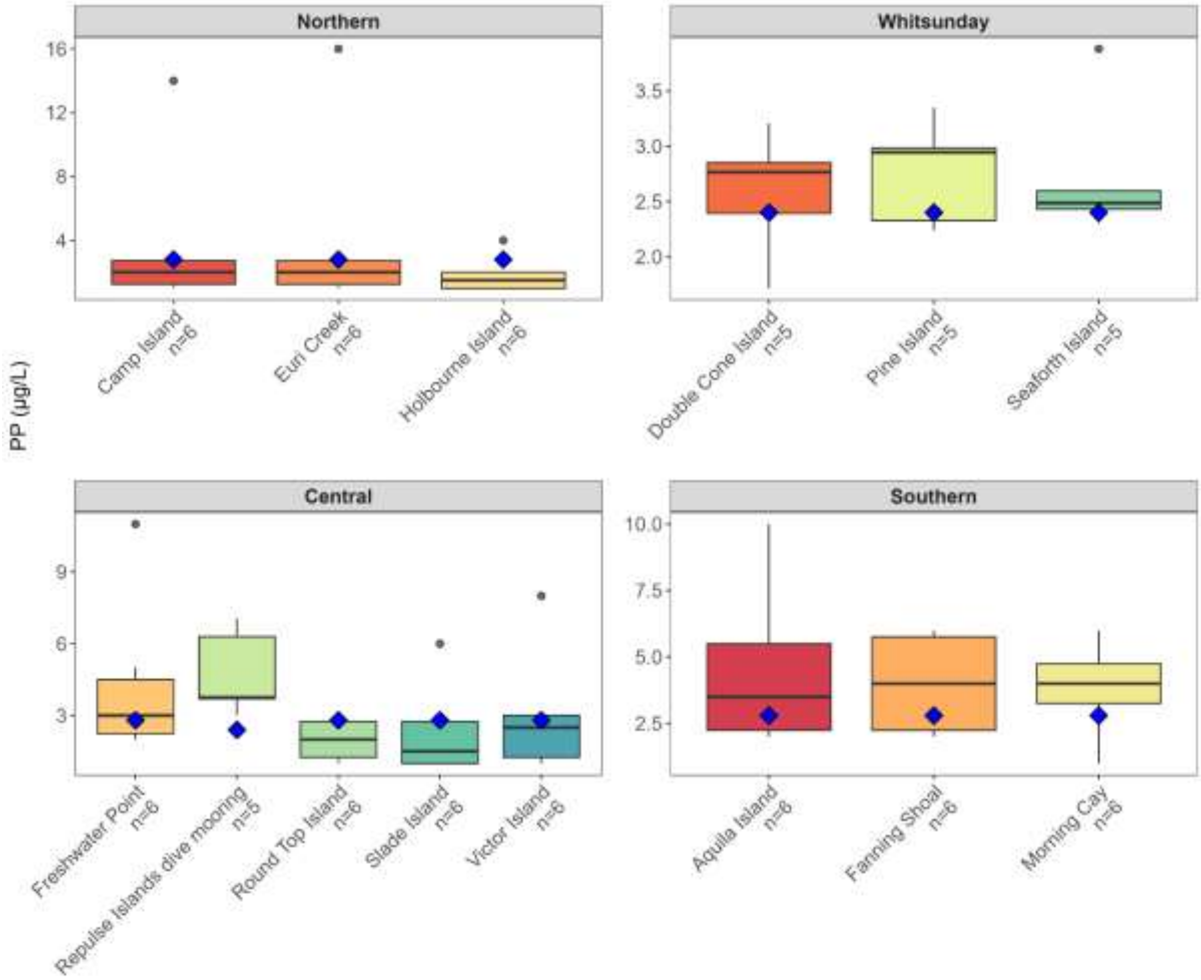

Figure 90. PP Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of PP concentrations in the MWI inshore zones and sampling sites. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per site is shown with the x axis labels. Note the free scale on the y axis.

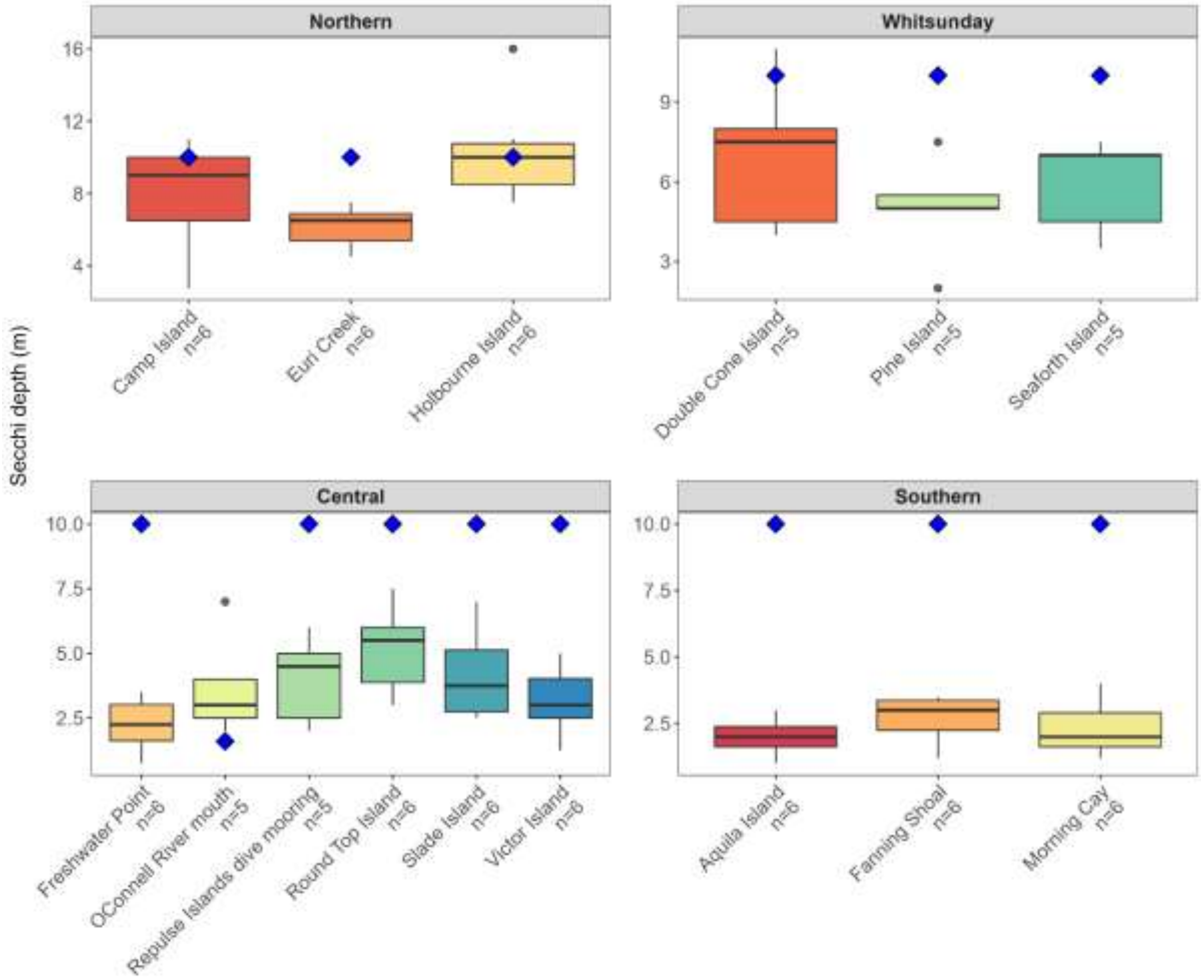

Figure 91. Secchi Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of Secchi depth (m) in the MWI inshore zones and sampling sites. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per site is shown with the x axis labels. Note the free scale on the y axis.

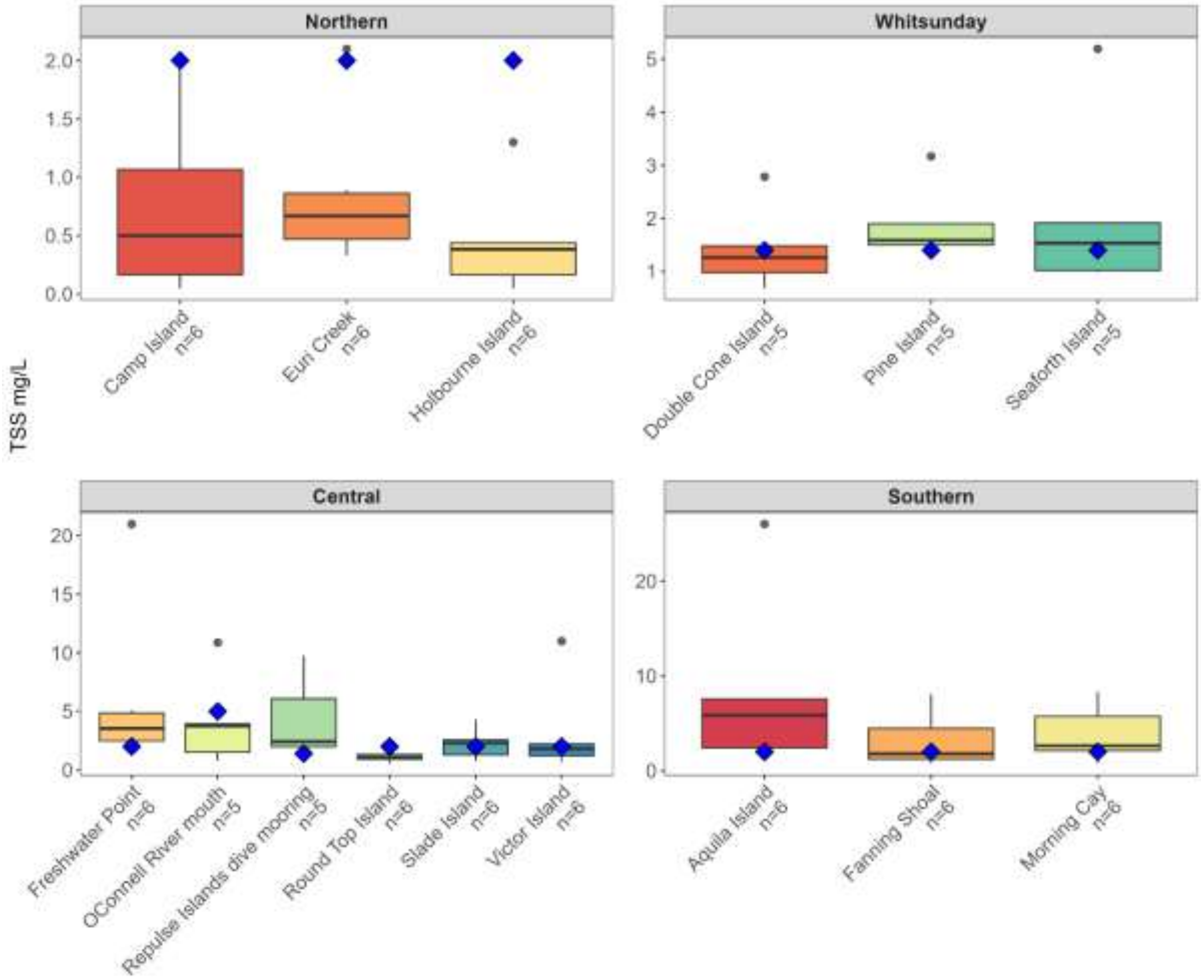

Figure 92. TSS Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of TSS concentrations in the MWI inshore zones and sampling sites. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per site is shown with the x axis labels. Note the free scale on the y axis.

8.4.1.2 Northern Inshore Zone

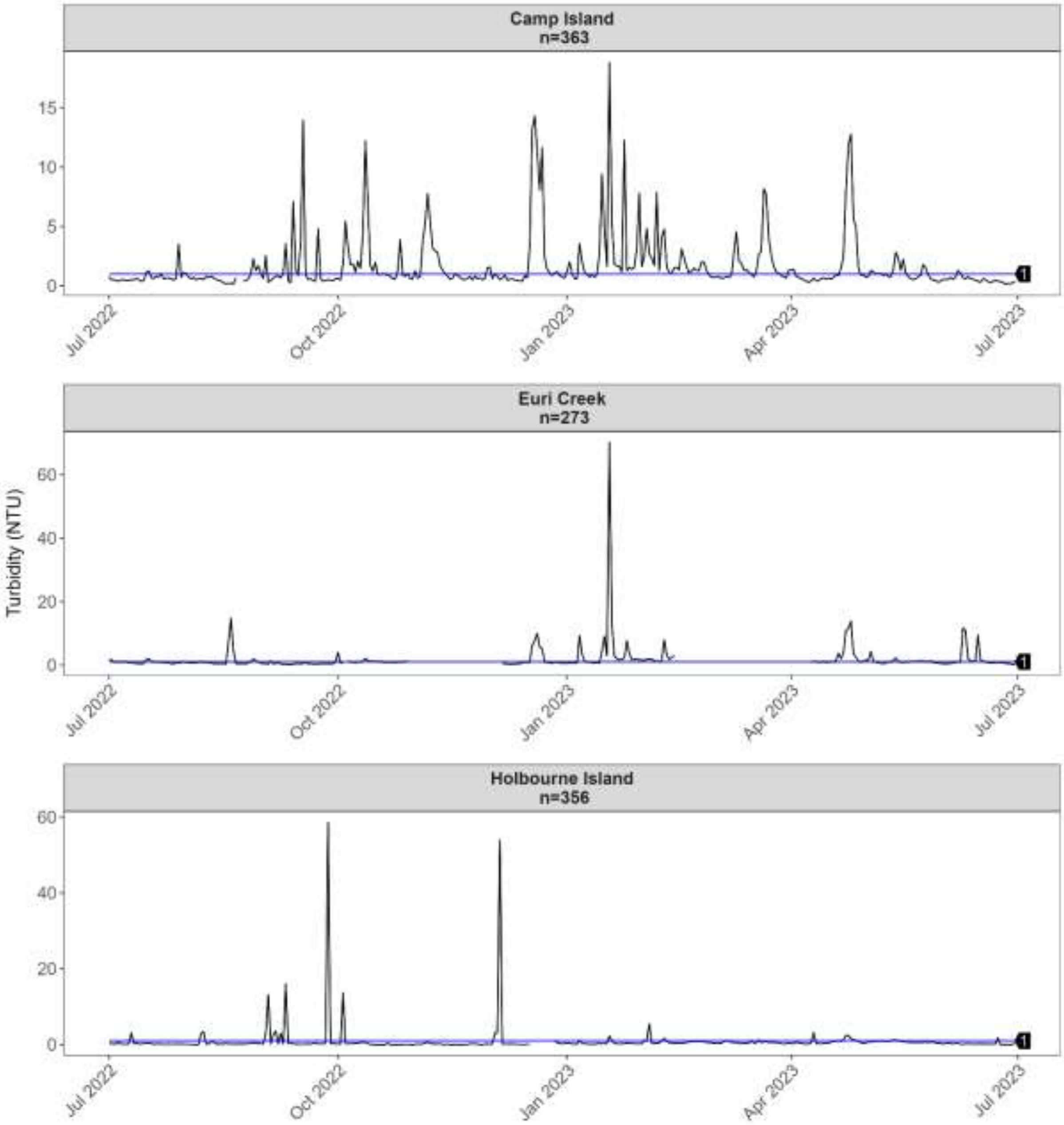

Figure 93. Northern Zone Linegraphs representing daily mean turbidity (NTU) at the sampling sites in the NQBP Abbot Point monitoring program in.. Missing data removed due to spikes and/or fouling. Guideline value represented by a blue line. Note the free scales on the y-axis. Sample size is described in title and relates to the number of daily mean turbidity values in the reporting year.

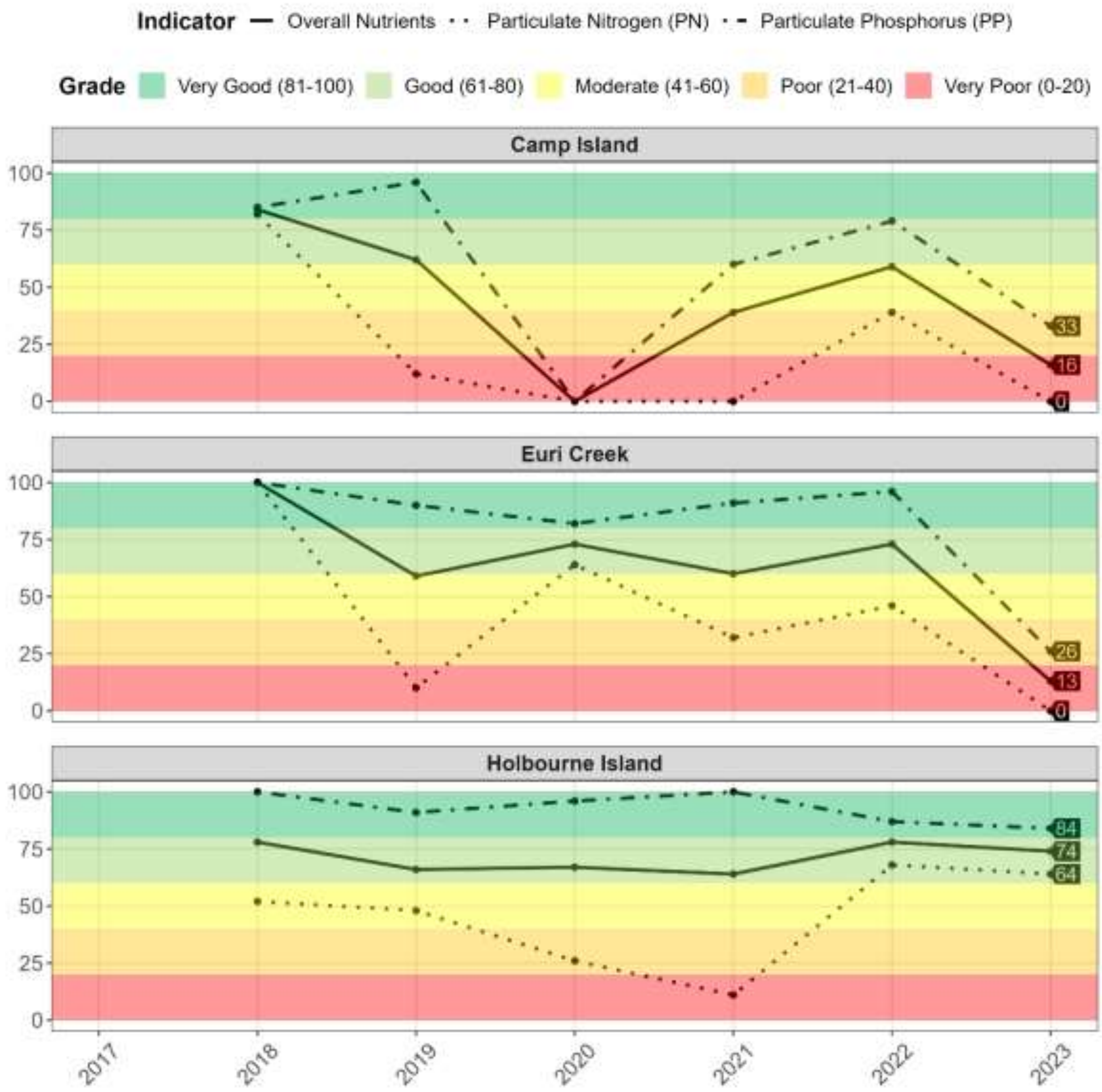

Figure 94. Northern Zone site level nutrients scores, current reporting compared to the historic record. The annotated solid black line (overall nutrients) is an average of the other indicators.

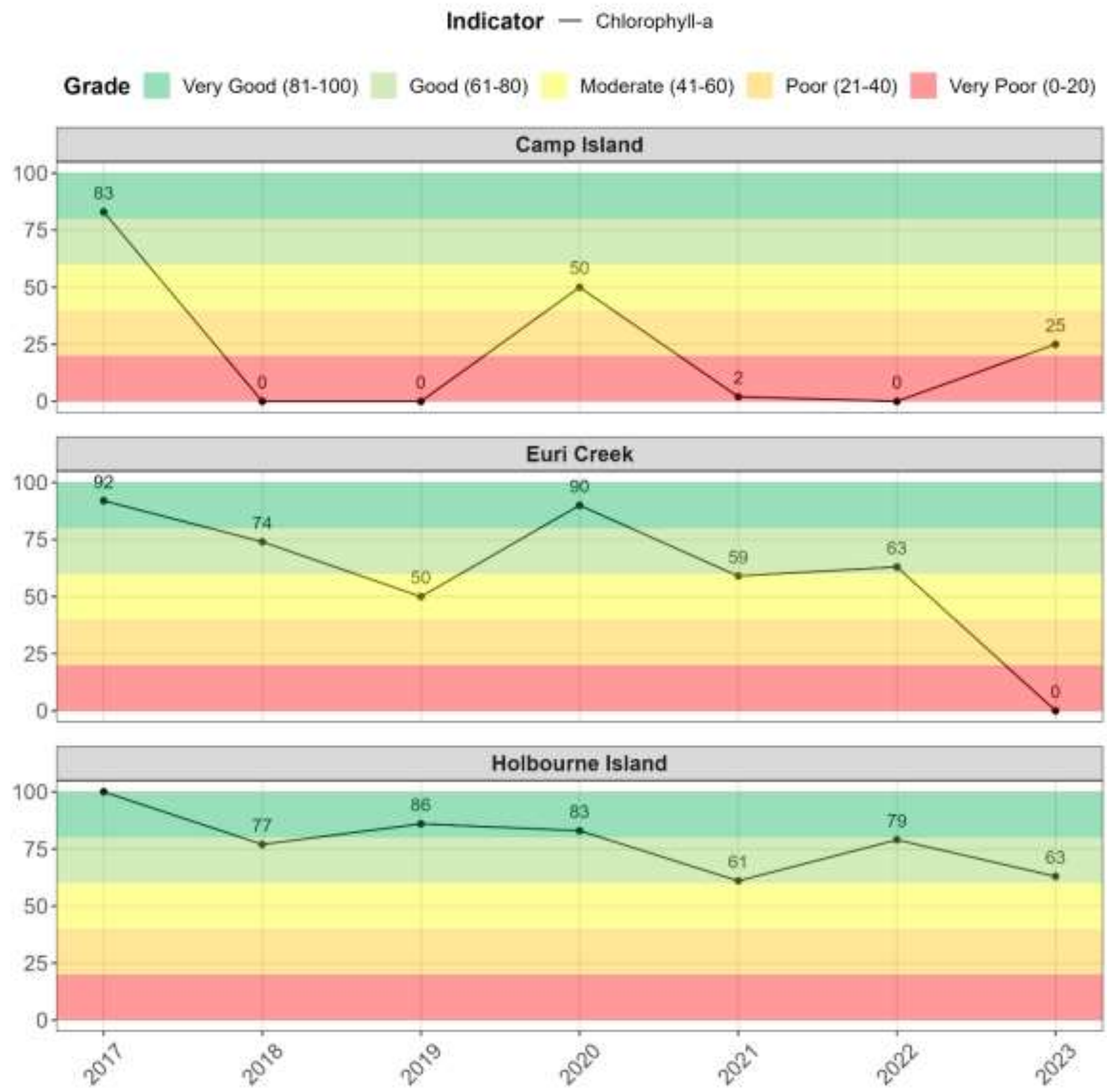

Figure 95. Northern Zone site level Chlorophyll-*a* scores, current reporting compared to the historic record.

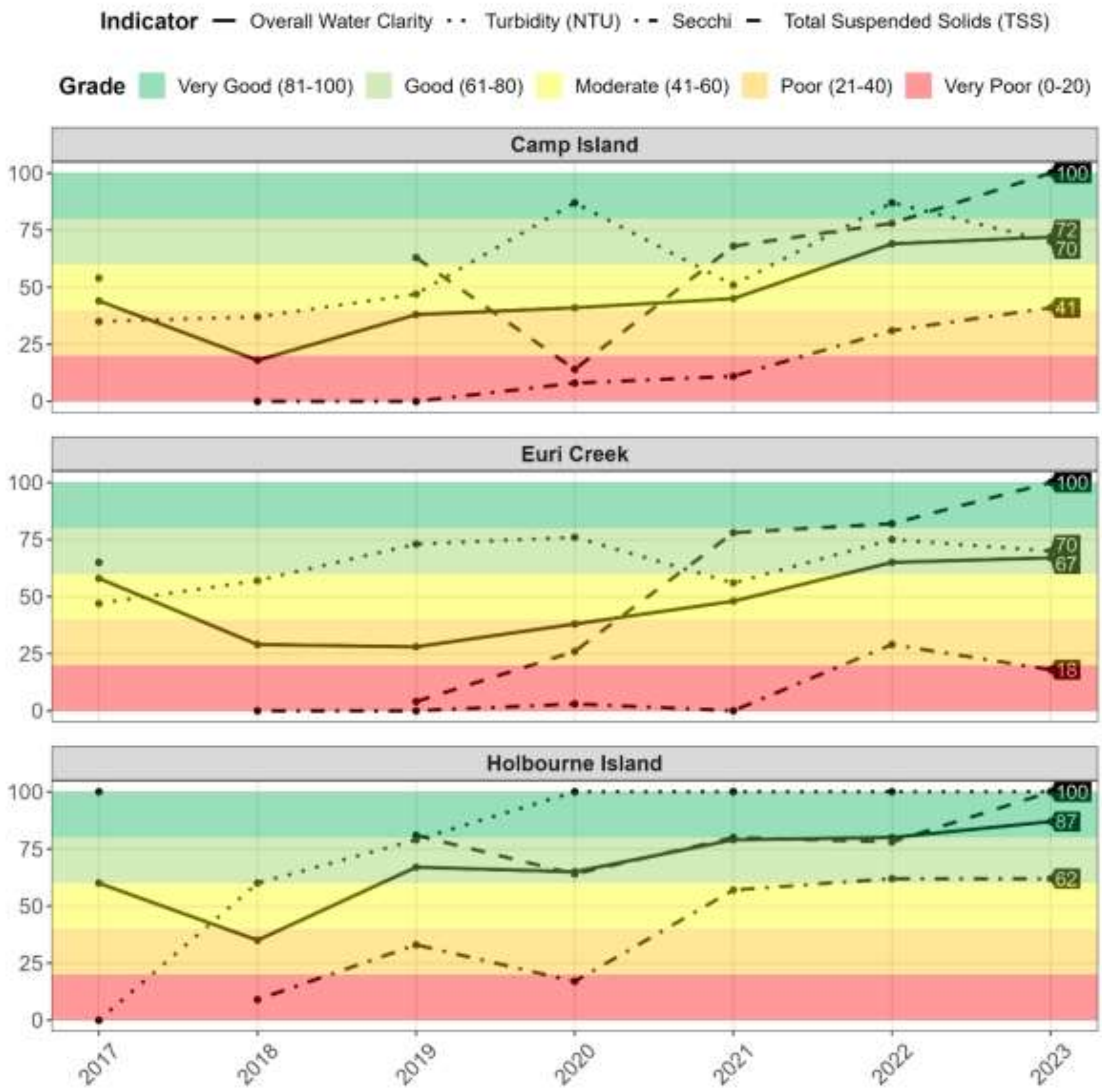

Figure 96. Northern Zone site level water clarity scores, current reporting compared to the historic record. The annotated solid black line (overall nutrients) is an average of the other indicators.

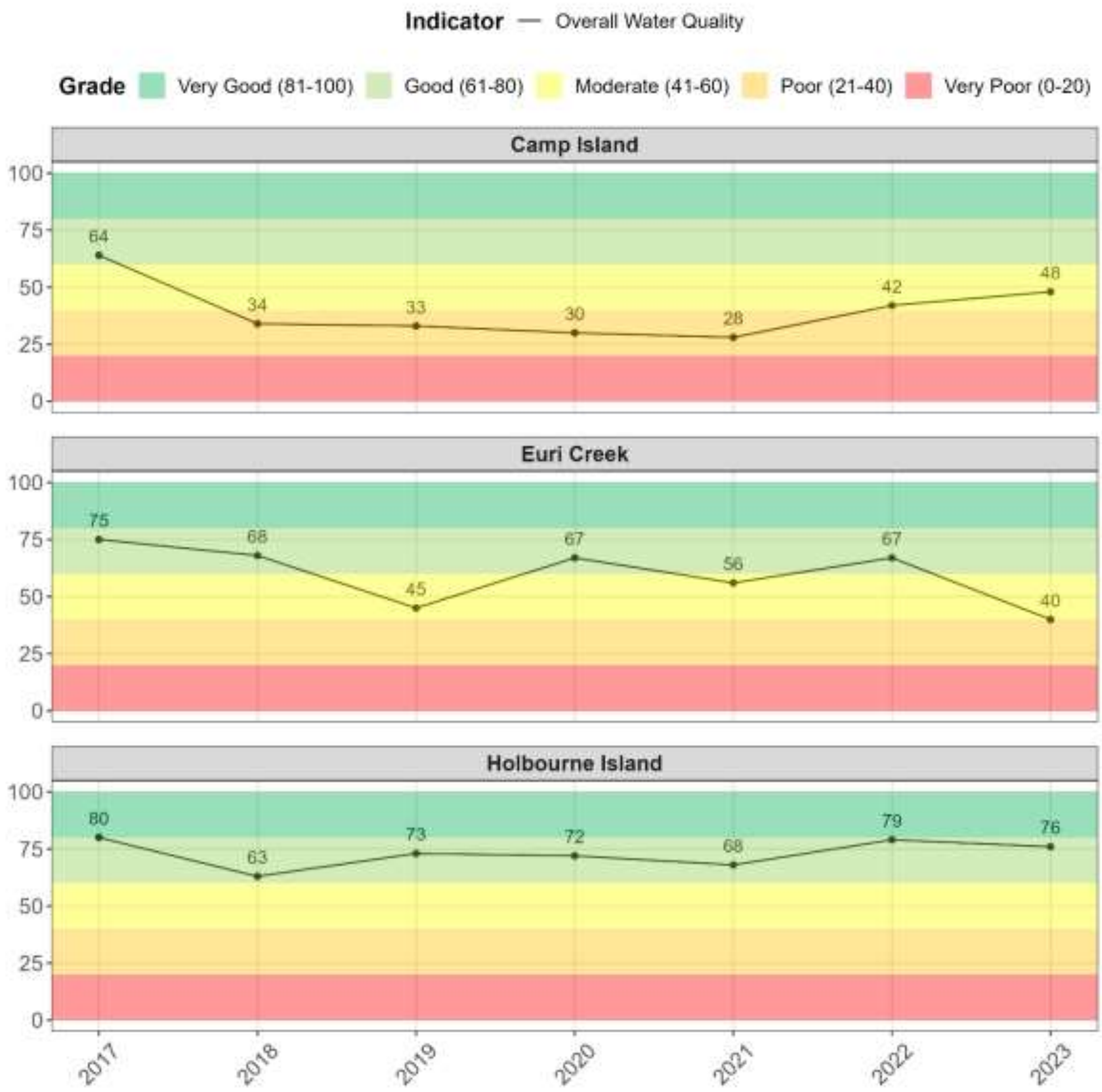

Figure 97. Northern Zone site level overall water quality scores, current reporting compared to the historic record.

Table 48. Northern Inshore Zone summary statistics for water quality indicators from July 2022 to June 2023. Presented alongside statistics that were compared to guideline values. For all indicators except secchi, to meet the guideline, the relevant statistic must be lower compared to the guideline (secchi must be higher than the guideline). Significant figures are shown to the same level as given in the relevant guideline value.

Site	Indicator	n	Mean	Minimum	25th %tile	Median	75th %tile	Maximum	Guidelines	
									Comparison Statistic	Guideline Value
AP_AMB1 (Euri Ck)	PN (µg/L)	6	77.17	14	22	44.5	81.25	252	Mean	20
	PP (µg/L)	6	4.16	1	1.25	2	2.75	16	Mean	2.8
	Chl-*a* (µg/L)	6	0.97	0.24	0.42	0.75	1.36	2.24	Mean	0.45
	TSS (mg/L)	6	0.85	0.33	0.47	0.67	0.86	2.1	Mean	2
	Secchi (m)	6	6.16	4.5	5.37	6.5	6.87	7.5	Mean	10
	Turb (NTU)	273*	1.83	0.14	0.56	0.84	1.29	70.13	Median	1
AP_AMB4 (Camp Is.)	PN (µg/L)	6	44.83	6	9	16	35	183	Mean	20
	PP (µg/L)	6	3.83	1	1.25	2	2.75	14	Mean	2.8
	Chl-*a* (µg/L)	6	0.68	0.23	0.37	0.45	1.04	1.35	Mean	0.45
	TSS (mg/L)	6	0.73	0.05	0.16	0.5	1.06	2	Mean	2
	Secchi (m)	6	7.96	2.75	6.5	9	10	11	Mean	10
	Turb (NTU)	363*	1.7	0.11	0.58	0.84	1.53	18.83	Median	1
AP_AMB5 (Holbourne Is.)	PN (µg/L)	6	18.83	16.5	6	15	19.5	39	Mean	20
	PP (µg/L)	6	1.83	1	1	1.5	2	4	Mean	2.8
	Chl-*a* (µg/L)	6	0.42	0.1	0.21	0.31	0.51	1.07	Mean	0.45
	TSS (mg/L)	6	0.44	0.05	0.16	0.38	0.44	1.3	Mean	2
	Secchi (m)	6	10.41	7.5	8.5	10	10.75	16	Mean	10
	Turb (NTU)	356*	0.89	0	0.13	0.27	0.54	58.62	Median	1

*While turbidity loggers were deployed for the entire 2022-23 reporting period, sample size is based on daily averages from validated data recovered from this period. Some data points were lost due to device malfunction or damage.

8.4.1.3 Whitsunday Inshore Zone

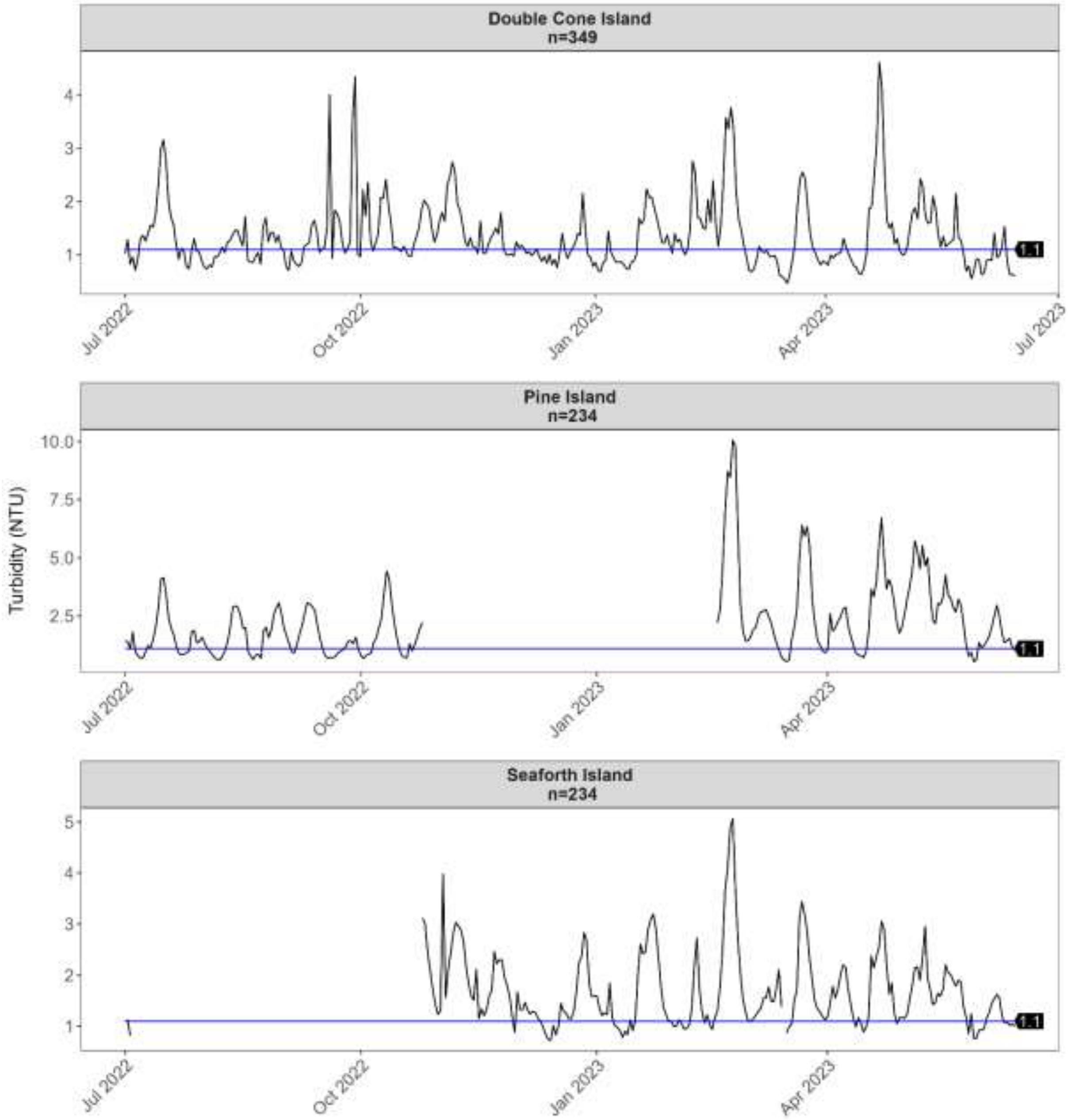

Figure 98. Whitsunday Zone Linegraphs representing daily mean turbidity (NTU) at the sampling sites in the MMP monitoring program in the current reporting year. Missing data removed due to spikes and/or fouling. Guideline value represented by a blue line. Note the free scales on the y-axis. Sample size is described in title and relates to the number of daily mean turbidity values in the reporting year.

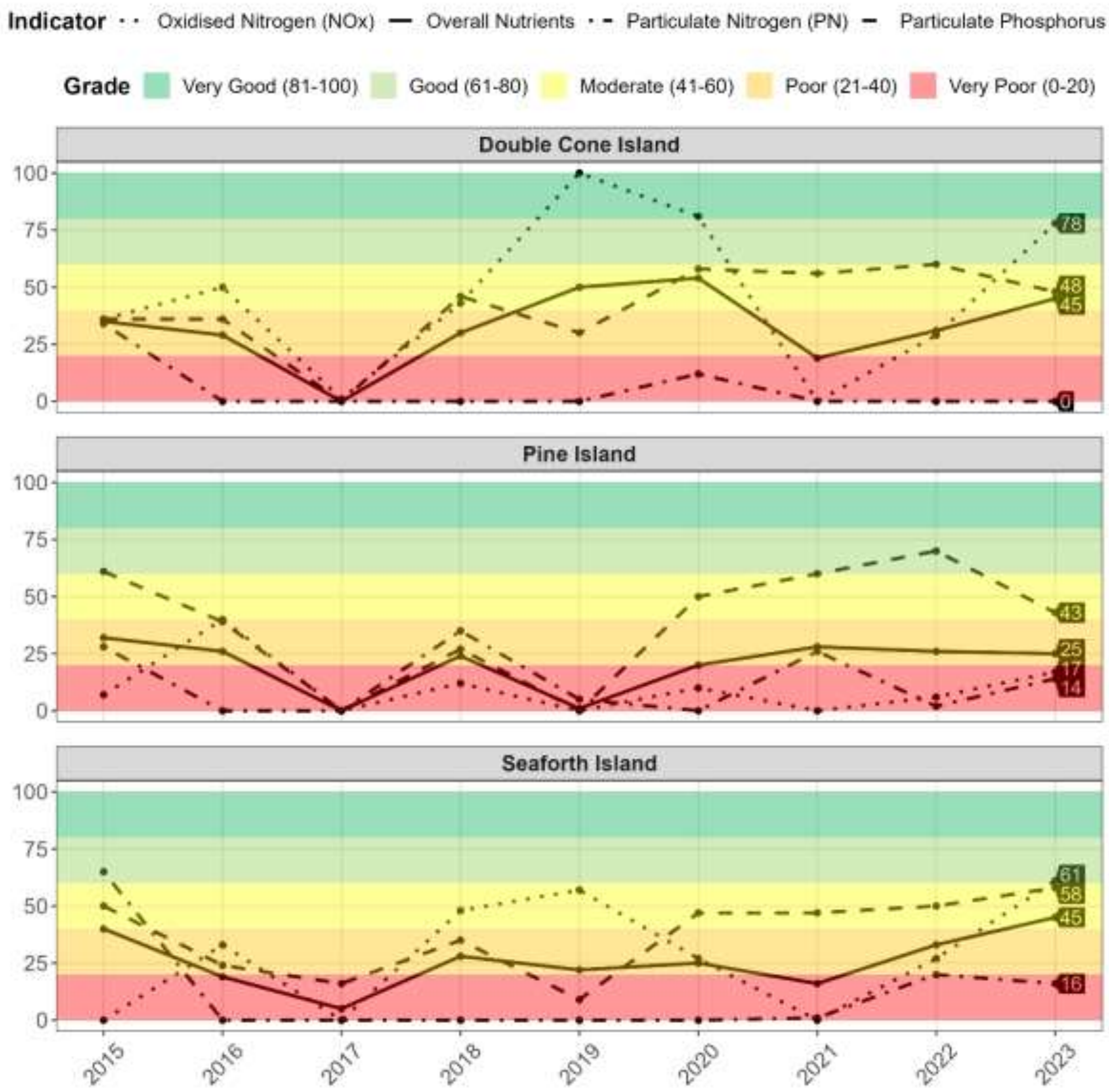

Figure 99. Whitsunday Zone site level nutrients scores, current reporting compared to the historic record. The annotated solid black line (overall nutrients) is an average of the other indicators.

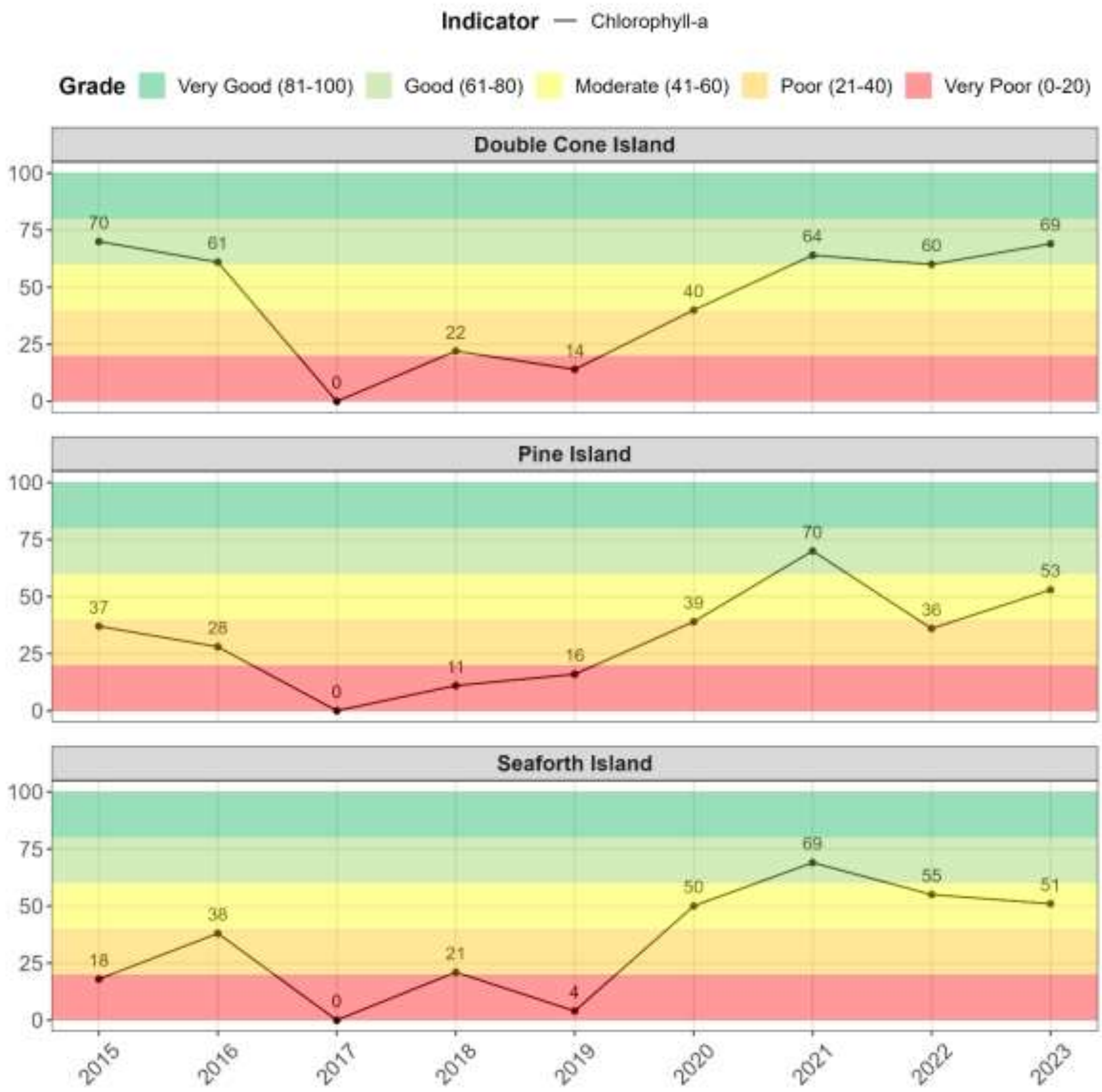

Figure 100. Whitsunday Zone site level chl-*a* scores, current reporting compared to the historic record.

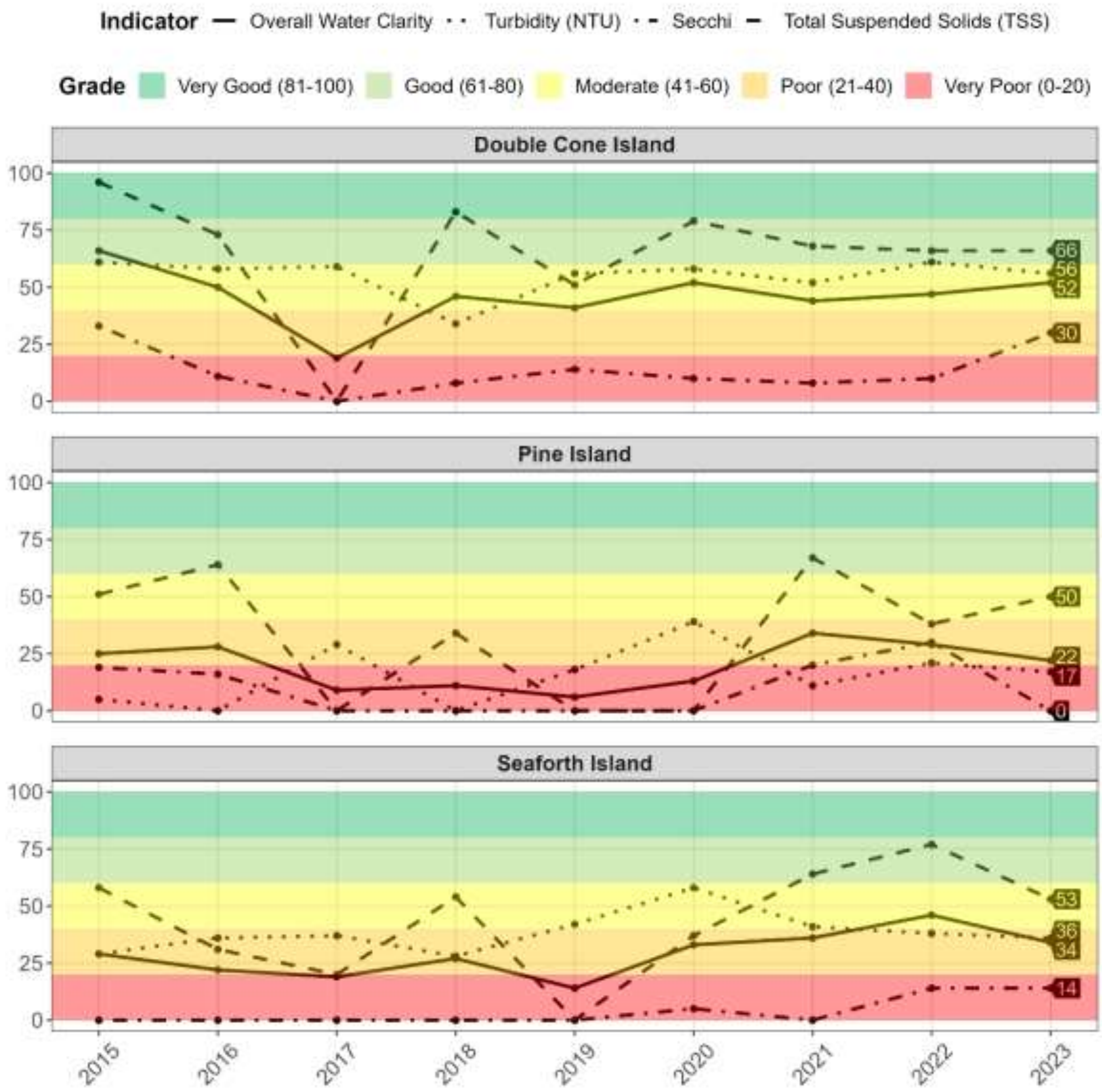

Figure 101. Whitsunday Zone site level water clarity scores, current reporting compared to the historic record. The solid black line (overall nutrients) is an average of the other indicators.

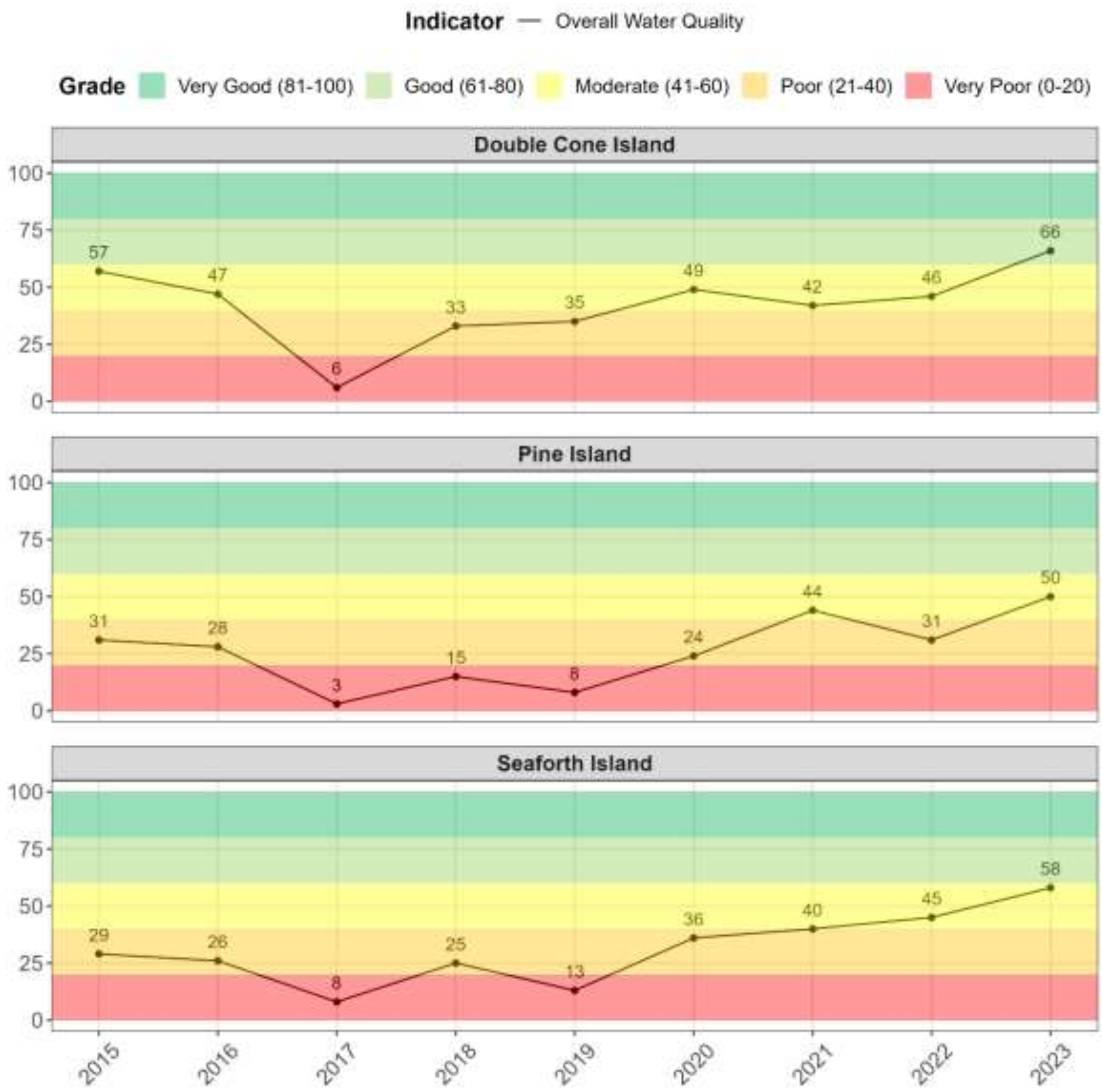

Figure 102. Whitsunday Zone site level overall water quality scores, current reporting compared to the historic record.

Table 49. Whitsunday Inshore Zone summary statistics for water quality indicators in the Whitsunday Zone sites from July 2022 to June 2023. Presented alongside statistics are guideline values, including the statistic that was compared to the guideline. For all indicators except secchi, to meet the guideline the relevant statistic must be lower compared to the guideline (secchi must be higher than the guideline). Significant figures are shown to the same level as given in the relevant guideline value.

Site	Indicator	n	Mean	Minimum	25th %tile	Median	75th %tile	Maximum	Guidelines	
									Comparison Statistic	Guideline Value
WHI1 (Double Cone Is.)	NOx (µg/L)	5	0.96	0.28	0.45	0.73	1.36	1.99	Median	1
	PN (µg/L)	5	26	11.95	22.4	26.2	34.26	35.21	Median	13
	PP (µg/L)	5	2.58	1.72	2.39	2.76	2.85	3.2	Median	2.4
	Chl-*a* (µg/L)	5	0.32	0.18	0.29	0.3	0.41	0.42	Median	0.36
	TSS (mg/L)	5	1.43	0.69	0.98	1.26	1.48	2.78	Median	1.4
	Secchi (m)	5	7	4	4.5	7.5	8	11	Mean	10
	Turb (NTU)	349*	1.35	0.46	0.96	1.16	1.57	4.62	Median	1.1
WHI4 (Pine Island)	NOx (µg/L)	5	2.26	0.28	0.63	1.64	4.06	4.69	Median	1
	PN (µg/L)	5	22.25	14.3	18.15	22.19	22.65	33.96	Median	13
	PP (µg/L)	5	2.76	2.24	2.32	2.94	2.98	3.35	Median	2.4
	Chl-*a* (µg/L)	5	0.39	0.34	0.36	0.39	0.4	0.46	Median	0.36
	TSS (mg/L)	5	1.88	1.29	1.49	1.59	1.9	3.17	Median	1.4
	Secchi (m)	5	5	2	5	5	5.5	7.5	Mean	10
	Turb (NTU)	234*	2.23	0.54	1.04	1.8	2.86	10.04	Median	1.1
WHI5 (Seaforth Island)	NOx (µg/L)	5	1.12	0.53	0.7	0.98	1.05	2.38	Median	1
	PN (µg/L)	5	20.85	16.35	19.05	21.7	22.8	24.35	Median	13
	PP (µg/L)	5	2.74	2.31	2.43	2.48	2.59	3.88	Median	2.4
	Chl-*a* (µg/L)	5	0.38	0.29	0.35	0.4	0.41	0.45	Median	0.36
	TSS (mg/L)	5	2.13	0.99	1.02	1.53	1.91	5.19	Median	1.4
	Secchi (m)	5	5.9	3.5	4.5	7	7	7.5	Mean	10
	Turb (NTU)	234*	1.67	0.73	1.15	1.46	2.07	5.06	Median	1.1

*While turbidity loggers were deployed for the entire 2022-23 reporting period, sample size is based on daily averages from validated data recovered from this period. Some data points were lost due to device malfunction or damage.

8.4.1.4 Central Zone

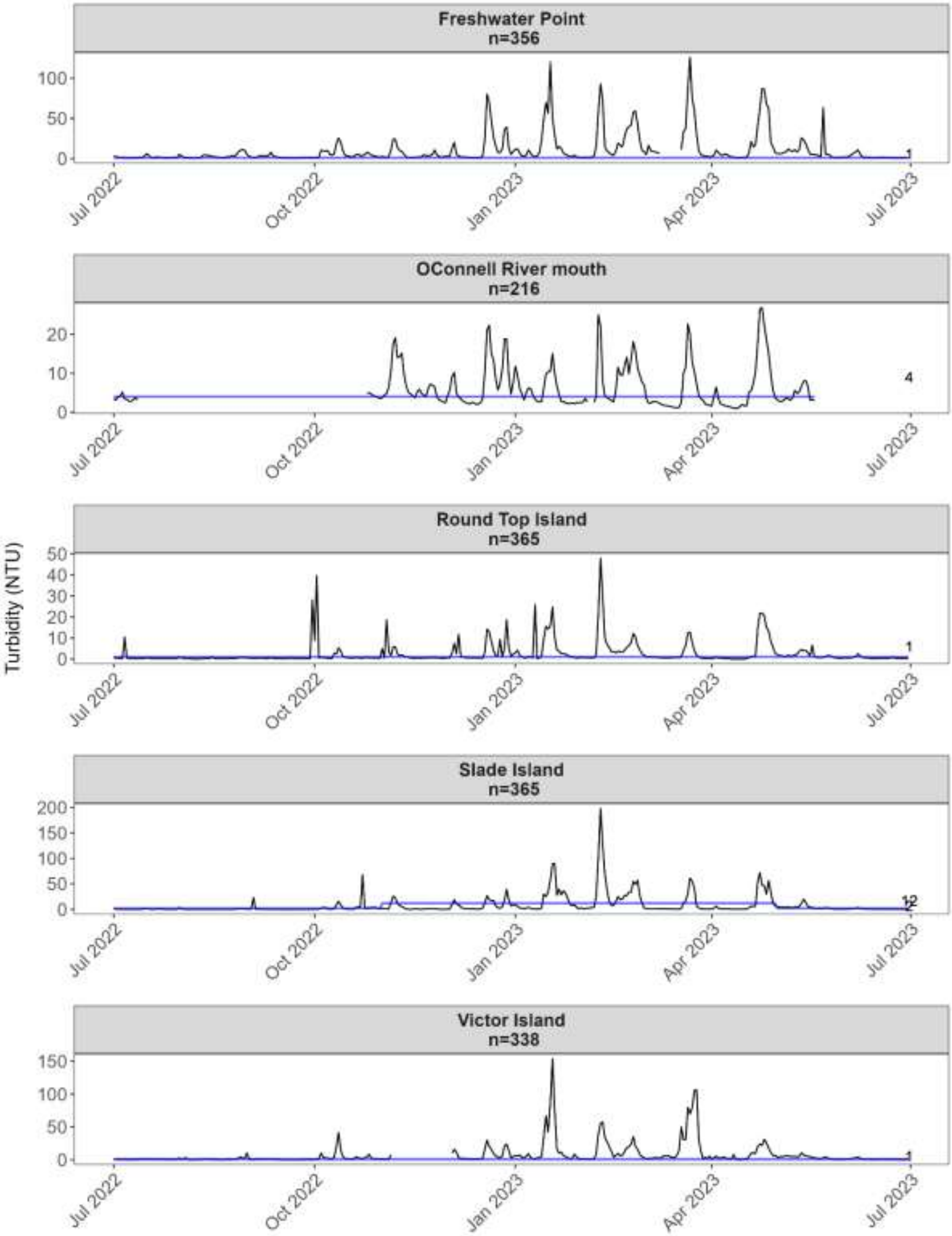

Figure 103. Central Zone linegraphs representing daily mean turbidity (NTU) at the sampling sites in the NQBP Hay Point monitoring program and AIMS MMP in current reporting. Missing data removed due to spikes and/or fouling. Guideline value represented by a blue line, note the wet season / dry season GVs for the Slade Island monitoring site. Sample size is described in title and relates to the number of daily mean turbidity values in the reporting year.

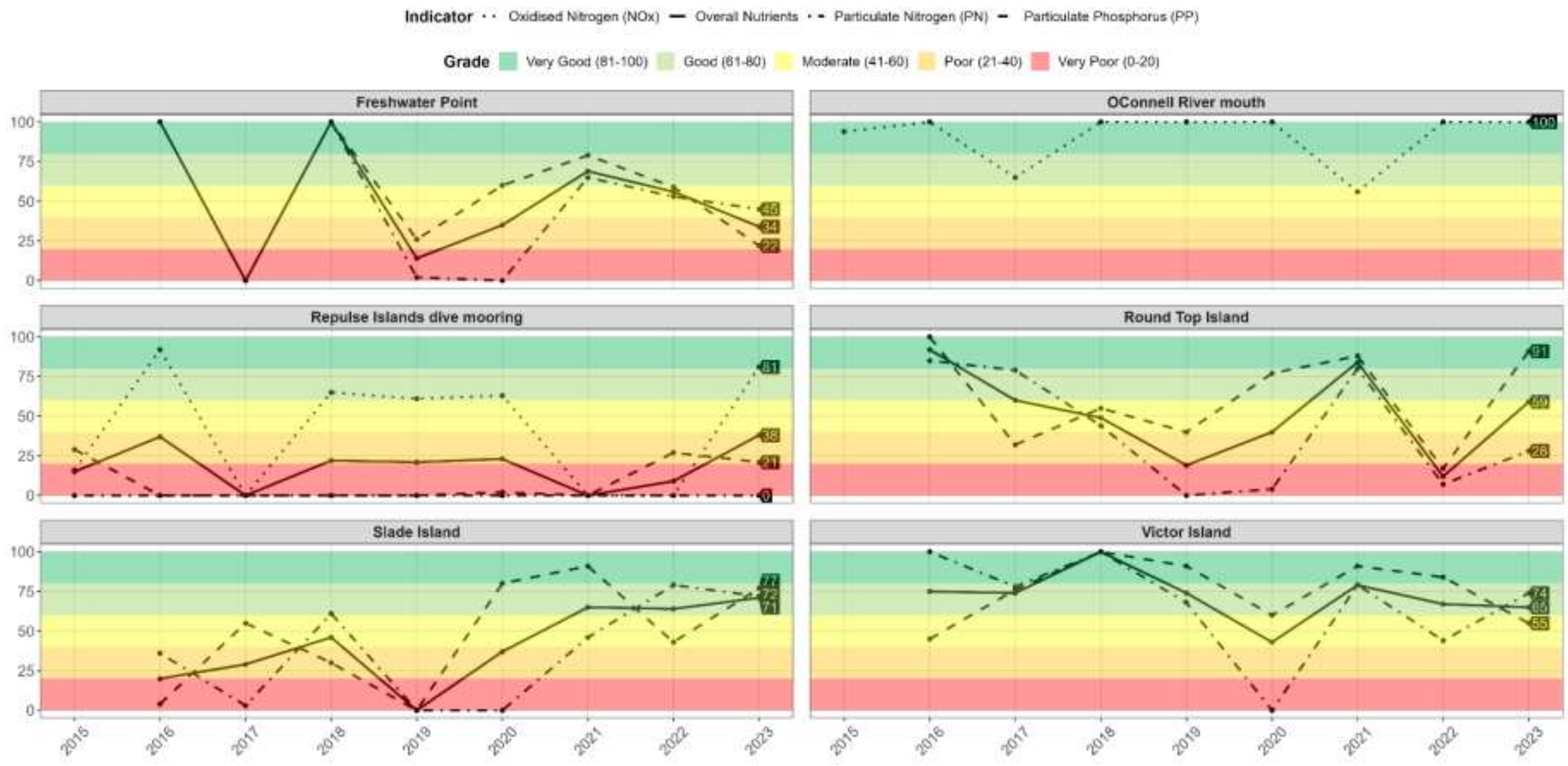

Figure 104. Central Zone site level nutrients scores, current reporting compared to the historic record. The annotated solid black line (overall nutrients) is an average of the other indicators. Scores for NOx at the NQBP monitoring sites cannot be calculated as there is no associated guideline value.

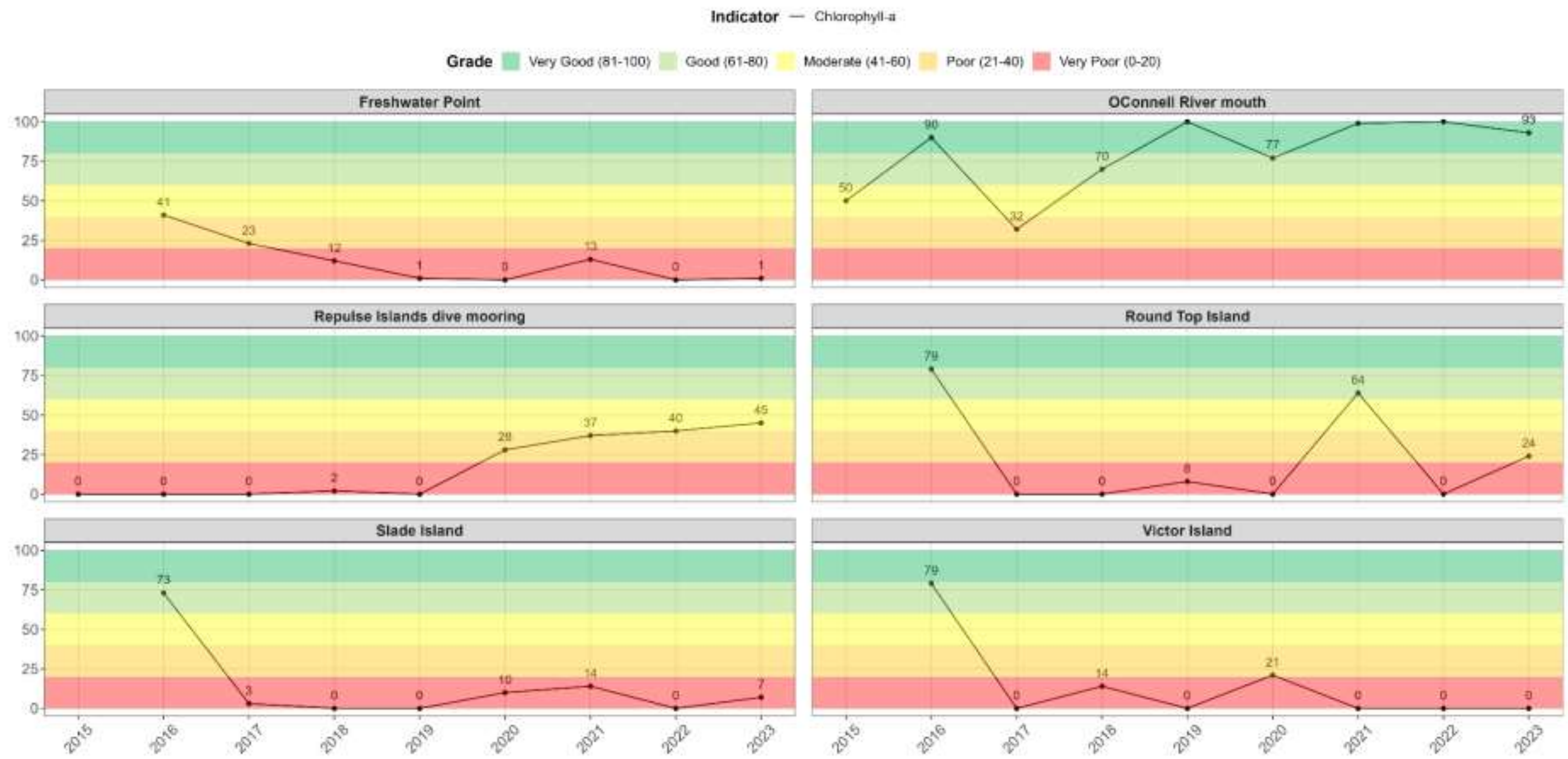

Figure 105. Central Zone site level Chlorophyll-*a* scores, current reporting compared to the historic record.

Figure 106. Central Zone site level water clarity scores, current reporting compared to the historic record. The annotated solid black line (overall clarity) is an average of the other indicators.

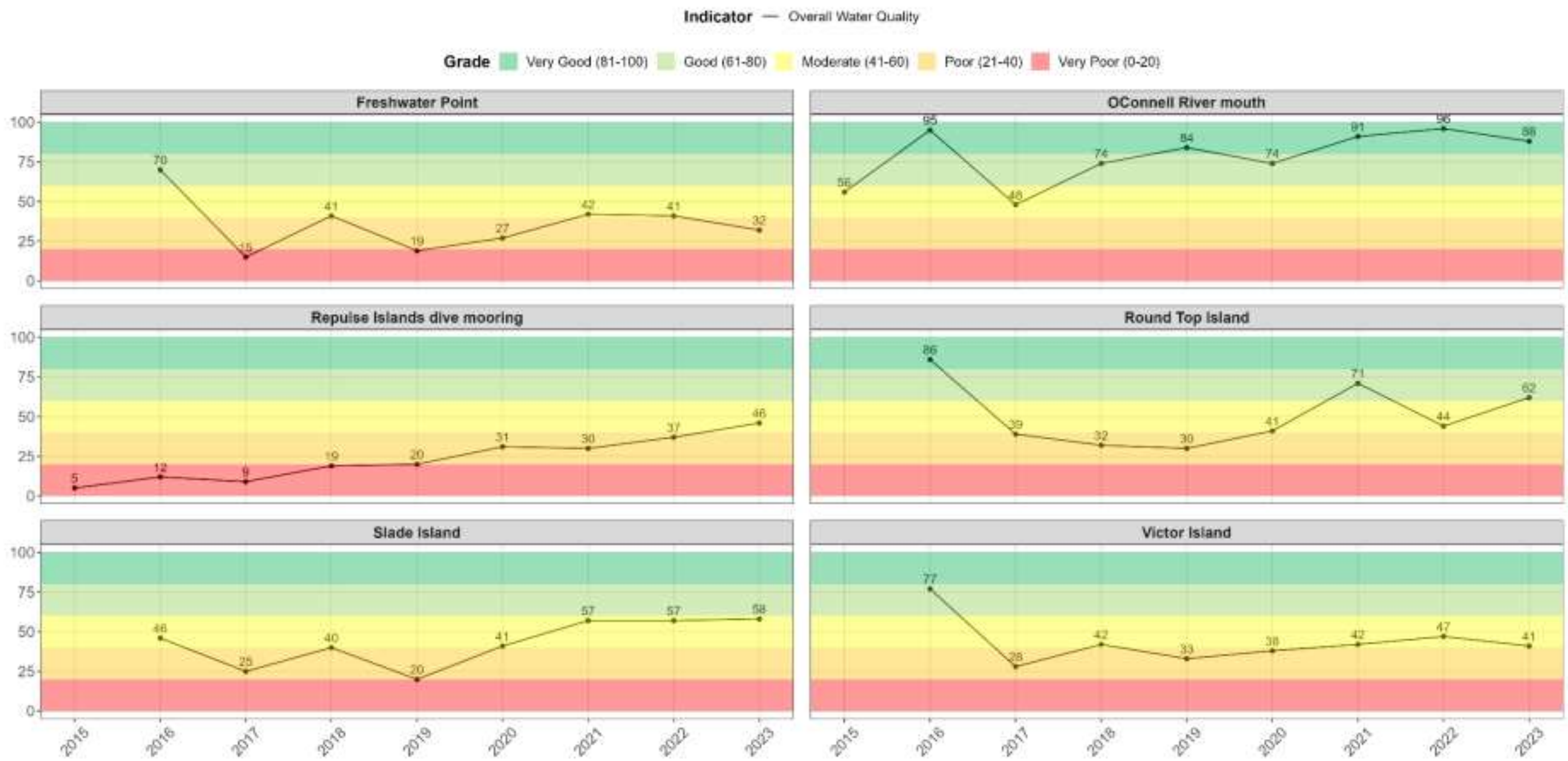

Figure 107. Central Zone site level overall water quality scores, current reporting compared to the historic record.

Table 50. Central Inshore Zone summary statistics for water quality indicators in the Central Zone sites from July 2022 to June 2023. Presented alongside statistics are guideline values, including the statistic that was compared to the guideline. For all indicators except secchi, to meet the guideline the relevant statistic must be lower compared to the guideline (secchi must be higher than the guideline). Significant figures are shown to the same level as given in the relevant guideline value.

Site	Indicator	n	Mean	Minimum	25th %ile	Median	75th %ile	Maximum	Guidelines	
									Comparison Statistic	Guideline Value
WHI6 (O'Connell River mouth)	NOx (µg/L)	5	1.81	0.28	0.28	0.66	1.64	6.19	Median	4
	Chl-*a* (µg/L)	5	0.6	0.17	0.43	0.72	0.77	0.9	Median	1.3
	TSS (mg/L)	5	4.17	0.81	1.51	3.74	3.93	10.87	Median	5
	Secchi (m)	5	3.7	2	2.5	3	4	7	Median	1.6
	Turb (NTU)	216	6.33	0.93	2.719	4.19	7.97	26.81	Median	4
WHI7 (Repulse Islands dive mooring)	NOx (µg/L)	5	0.94	0.28	0.66	0.7	0.87	2.2	Median	1
	PN (µg/L)	5	33.11	21.01	28.39	34.66	39.8	41.72	Median	13
	PP (µg/L)	5	4.76	3.02	3.7	3.75	6.29	7.06	Median	2.4
	Chl-*a* (µg/L)	5	0.45	0.26	0.26	0.43	0.55	0.74	Median	0.36
	TSS (mg/L)	5	4.44	1.97	1.99	2.41	6.09	9.74	Median	1.4
	Secchi (m)	5	4	2	2.5	4.5	5	6	Mean	10
MKY_AMB1 (FW Point)	PN (µg/L)	6	23.83	5	10.75	21.5	30.75	54	Mean	20
	PP (µg/L)	6	4.33	2	2.5	3	4.5	11	Mean	2.8
	Chl-*a* (µg/L)	6	0.88	0.37	0.47	0.71	0.86	2.21	Mean	0.45
	TSS (mg/L)	6	6.23	1.9	2.47	3.55	4.85	21	Mean	2
	Secchi (m)	6	2.24	0.75	1.62	2.25	3.02	3.5	Mean	10
	Turb (NTU)	356*	10.55	0.49	1.6	3.77	9.77	126.05	Median	<1
MKY_AMB3B (Round Top Is.)	PN (µg/L)	6	29	16	17.5	25.5	41	46	Mean	20
	PP (µg/L)	6	2	1	1.25	2	2.75	3	Mean	2.8
	Chl-*a* (µg/L)	6	0.68	0.5	0.56	0.7	0.73	0.93	Mean	0.45
	TSS (mg/L)	6	1.17	0.56	0.91	1.05	1.32	2.1	Mean	2
	Secchi (m)	6	5.16	3	3.87	5.5	6	7.5	Mean	10
	Turb (NTU)	365*	2.59	0.01	0.29	0.57	1.83	48.02	Median	<1
MKY_AMB5 (Slade Is.)	PN (µg/L)	6	16.33	4	8.25	19.5	22.5	27	Mean	20
	PP (µg/L)	6	2.33	1	1	1.5	2.75	6	Mean	2.8
	Chl-*a* (µg/L)	6	0.82	0.52	0.55	0.75	1.02	1.33	Mean	0.45
	TSS (mg/L)	6	2.21	0.78	1.3	2.3	2.55	4.3	Mean	2
	Secchi (m)	6	4.16	2.5	2.75	3.75	5.12	7	Mean	10
	Turb (NTU) Dry season	184*	1.88	0	0.06	0.27	1.64	67.61	Median	Dry = 2

	Turb (NTU) Wet season	181*	14.39	0.06	0.82	2.87	19.16	198.27	Median	Wet = 12
MKY_AMB10 (Victor Is.)	PN (µg/L)	6	15.83	7	12.25	16	18.25	26	Mean	20
	PP (µg/L)	6	3	1	1.25	2.5	3	8	Mean	2.8
	Chl-*a* (µg/L)	6	0.97	0.27	0.42	0.71	0.89	2.85	Mean	0.45
	TSS (mg/L)	6	3.11	0.67	1.22	1.8	2.22	11	Mean	2
	Secchi (m)	6	3.15	1.25	2.5	3	4.02	5	Mean	10
	Turb (NTU)	338*	7.73	0.2	0.71	2.2	6.04	153.81	Median	<1

*While turbidity loggers were deployed for the entire 2022-23 reporting period, sample size is based on daily averages from validated data recovered from this period. Some data points were lost due to unforeseen device malfunction or damage.

8.4.1.5 Southern Zone

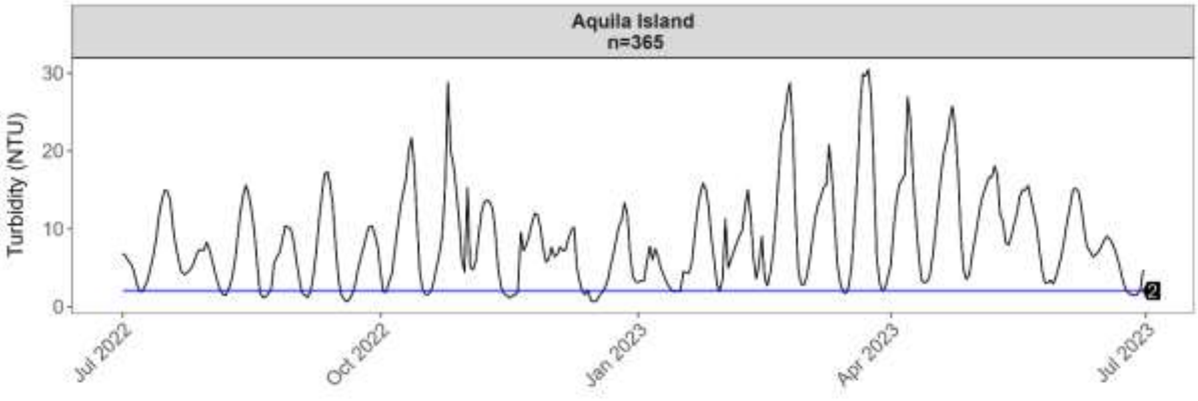

Figure 108. Southern Zone linegraphs representing daily mean turbidity (NTU) at the Aquila Island Southern Inshore monitoring program in current reporting. Missing data removed due to spikes and/or fouling. Guideline value represented by a blue line. Sample size is described in title and relates to the number of daily mean turbidity values recorded in the reporting year.

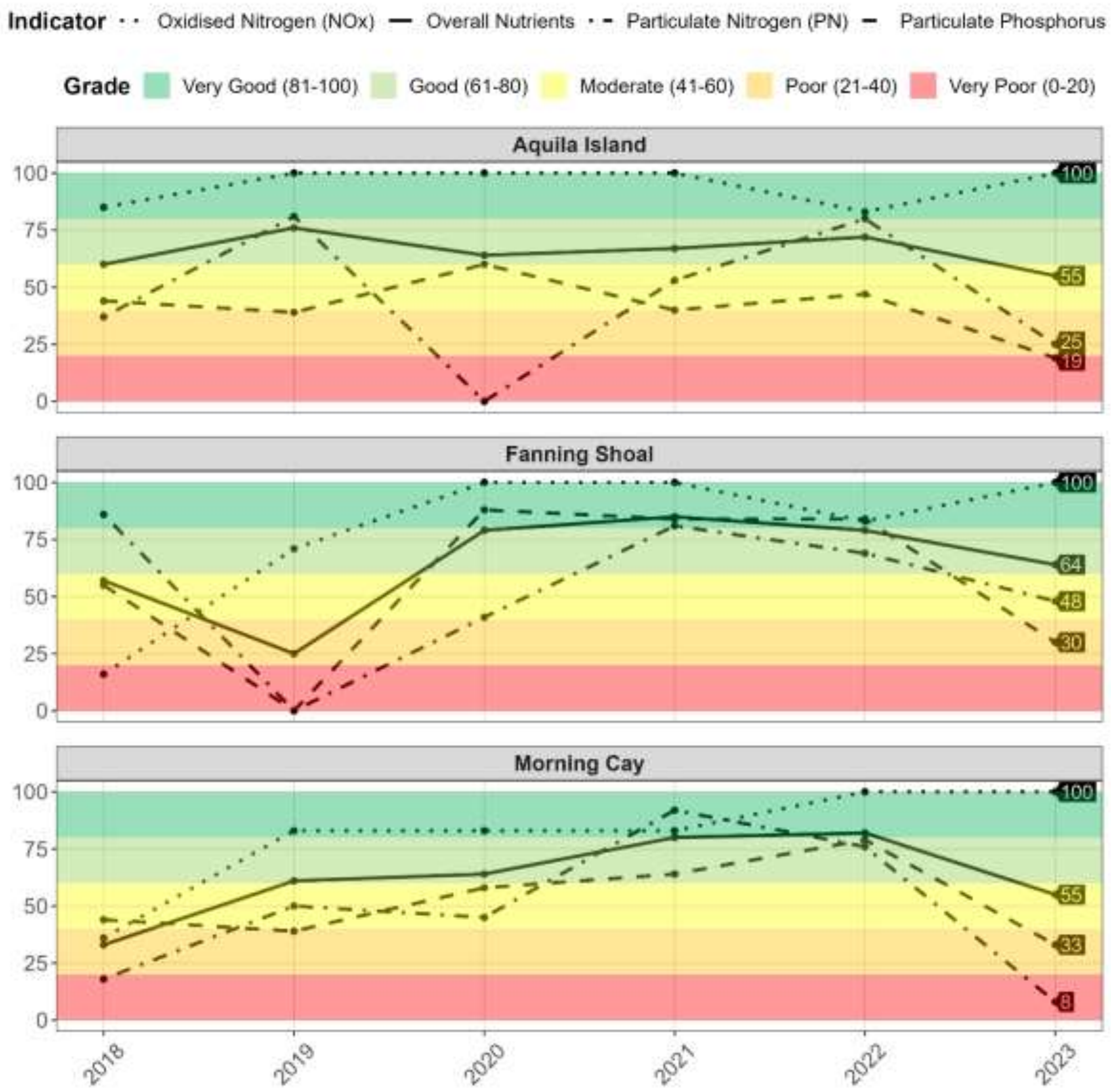

Figure 109. Southern Zone site level nutrients scores, current reporting compared to the historic record. The annotated solid black line (overall nutrients) is an average of the other indicators.

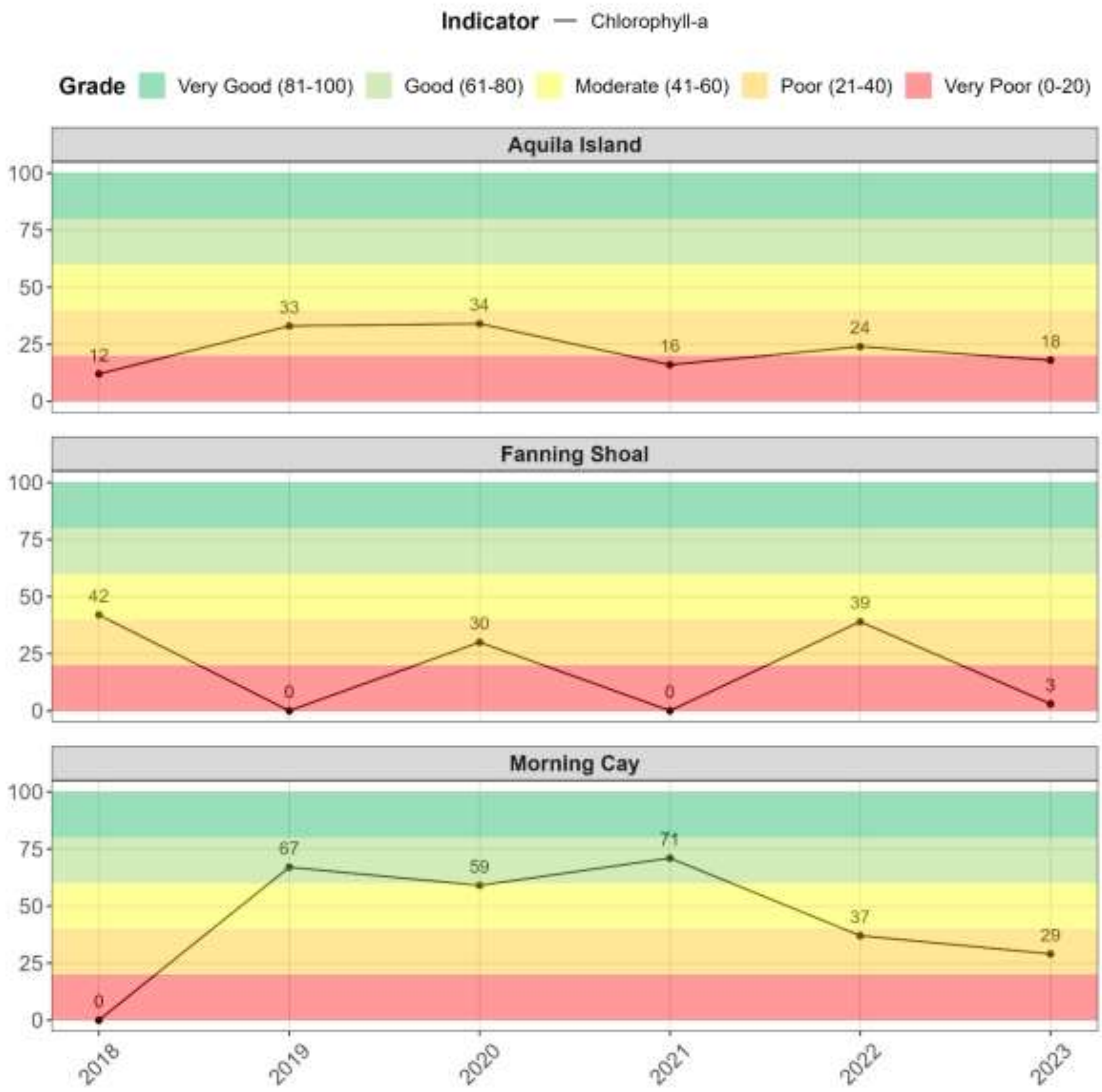

Figure 110. Southern Zone site level Chl-*a* scores, current reporting compared to the historic record.

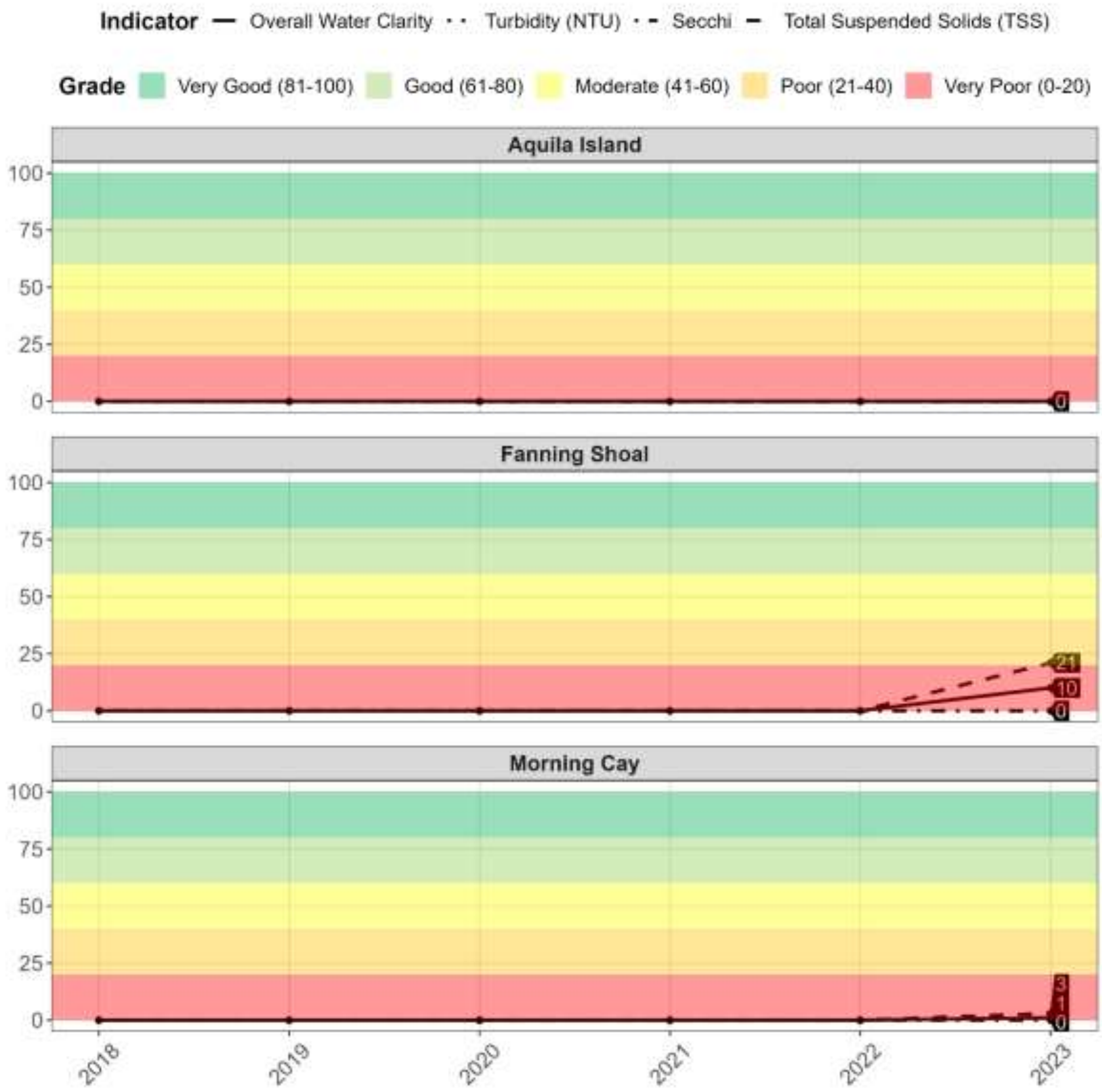

Figure 111. Southern Zone site level water clarity scores, current reporting compared to the historic record. The annotated solid black line (overall clarity) is an average of the other indicators.

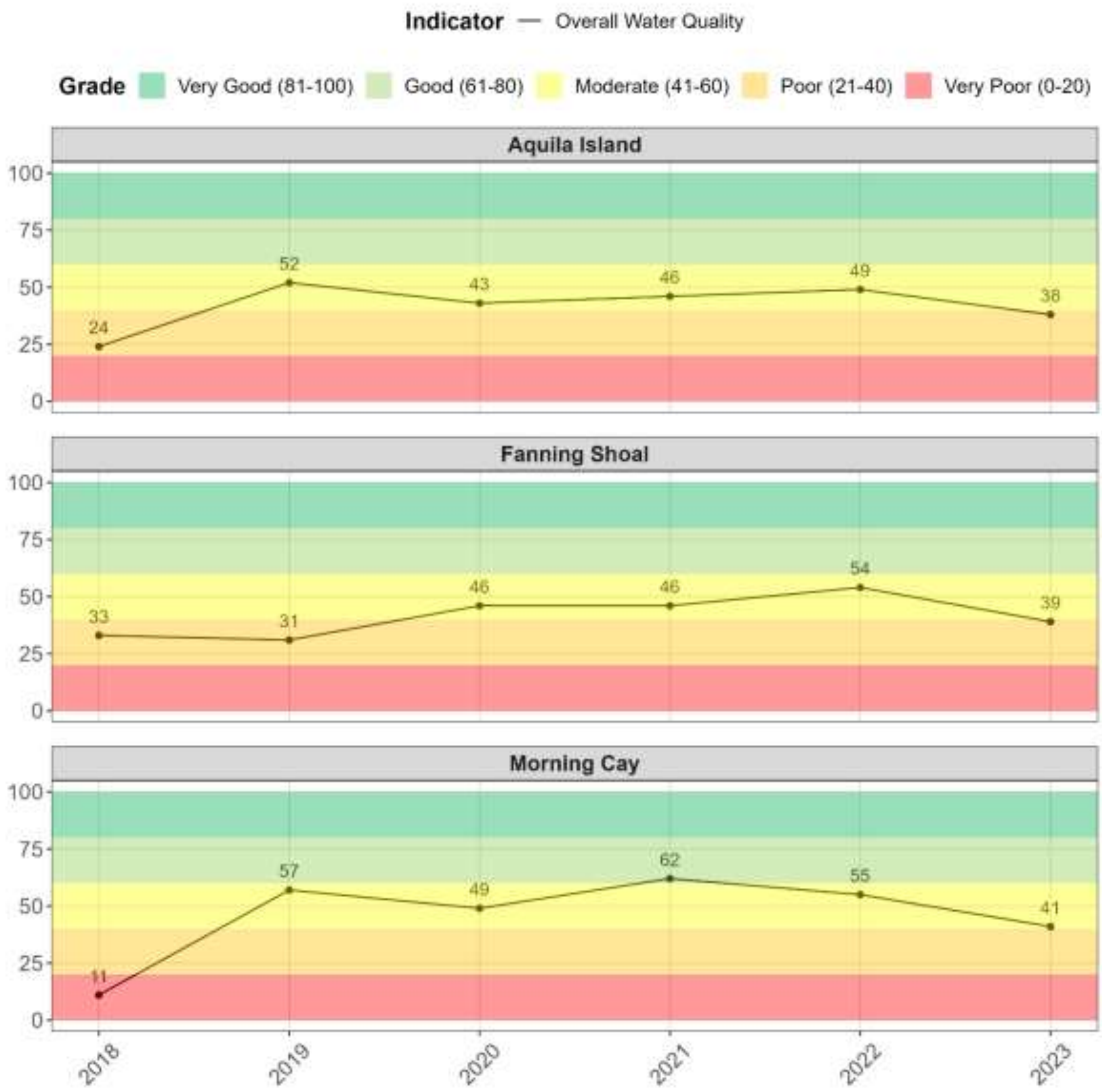

Figure 112. Southern Zone site level overall water quality scores, current reporting compared to the historic record.

Table 51. Southern Inshore Zone summary statistics for water quality indicators in the Southern Zone for marine sites from July 2022 to June 2023. Presented alongside statistics are guideline values, including the statistic that was compared to the guideline. For all indicators except secchi, to meet the guideline the relevant statistic must be lower compared to the guideline (secchi must be higher than the guideline). Significant figures are shown to the same level as given in the relevant guideline value.

Site	Indicator	n	Mean	Minimum	25th %ile	Median	75th %ile	Maximum	Guidelines	
									Comparison Statistic	Guideline Value
MKY_CAM1 (Aquila Island)	NOx (µg/L)	6	1.33	0.5	0.62	1.5	2	2	Median	3
	PN (µg/L)	6	30	12	21	31	36.5	50	Mean	20
	PP (µg/L)	6	4.5	2	2.25	3.5	5.5	10	Mean	2.8
	Chl-*a* (µg/L)	6	0.72	0.45	0.57	0.63	0.8	1.23	Mean	0.45
	TSS (mg/L)	6	8.13	1.7	2.42	5.85	7.55	26	Mean	2
	Secchi (m)	6	2	1	1.62	2	2.37	3	Mean	10
	Turb (NTU)	365*	8.53	0.61	3.57	7.15	12.08	30.47	Mean	2
MKY_CAM2 (Morning Cay)	NOx (µg/L)	6	1.33	0.5	0.62	1.5	2	2	Median	3
	PN (µg/L)	6	36.16	13	30.75	38	45.25	52	Mean	20
	PP (µg/L)	6	3.83	1	3.25	4	4.75	6	Mean	2.8
	Chl-*a* (µg/L)	6	0.64	0.1	0.36	0.65	0.71	1.48	Mean	0.45
	TSS (mg/L)	6	3.84	0.78	2.12	2.65	5.72	8.3	Mean	2
	Secchi (m)	6	2.31	1.2	1.62	2	2.9	4	Mean	10
MKY_CAM3 (Fanning Shoal)	NOx (µg/L)	6	1.75	0.5	1	1.5	2	4	Median	3
	PN (µg/L)	6	23	12	15	21	27	42	Mean	20
	PP (µg/L)	6	4	2	2.25	4	5.75	6	Mean	2.8
	Chl-*a* (µg/L)	6	0.86	0.1	0.35	0.46	0.63	3.15	Mean	0.45
	TSS (mg/L)	6	3.14	0.78	1.22	1.8	4.47	8.1	Mean	2
	Secchi (m)	6	2.7	1.2	2.25	3	3.37	3.5	Mean	10

*While turbidity loggers were deployed for the entire 2022-23 reporting period, sample size is based on daily averages from validated data recovered from this period. Some data points may have been lost due to unforeseen device malfunction or damage.

8.4.1.6 Pesticides

Table 52. Results and deployment periods for marine pesticides. The Pesticide Risk Metric indicator accounting for up to 22 pesticides, reporting aquatic species protected (%) and overall standardised pesticide score for inshore zones for the 2024 Report Card (2022-23 data). Scores comparison between Passive Polar samples and Grab samples. Grab date bolded to indicate event with highest PRM score used to calculate Pesticide score).

Zone	Program	Sites	Value Reported	Passive Polar Samples			Grab Samples		
				Deployments	PRM	Score	Sample Dates	PRM	Score
Northern	NQBP/MMP	Euri Creek	Max	28/10/2022 – 06/01/2023, 16/01/2023 – 13/02/2023 (3 deployments)	**99**	**81**	28/10/2022, 6/12/2022, **16/01/2023**	**99**	**81**
Whitsunday	MMP	Whitsunday Channel	Max	15/11/2022 – 21/01/2023, 24/01/2023 – 01/05/2023 (5 deployments)	**100**	**100**	**15/11/2022** 11/12/2022, 24/01/2023, 10/03/2023, 06/04/2023	**85**	**30**
Central	MMP	Repulse Bay	Max	13/11/2022 - 12/12/2022, 24/01/2023 – 01/05/2023 (4 deployments)	**100**	**100**	13/11/2022, **24/01/2023,** 10/03/2023, 06/04/2023	**98**	**75**
		Flat Top Island	Max	14/11/2022 - 30/04/2023 (5 continuous deployments)	**100**	**100**	**14/11/2022,** 13/12/2022, 12/01/2023, 07/03/2023, 05/04/2023	**99**	**81**
		Sarina Inlet	Max	14/11/2022 – 30/04/2023 (5 continuous deployments)	**100**	**100**	14/11/2022, 13/12/2022, **12/01/2023,** 07/03/2023, 05/04/2023	**87**	**34**
	NQBP	Slade Island	Max	21/01/2023 – 15/02/2023 (1 deployment)	**99**	**81**			
Southern	SIP	Aquila Island	Max	26/10/2022 – 7/12/2022, 7/12/2022 – 1/02/2023, 28/03/2023 – 26/05/2023 3 deployments	**99**	**81**			

Pesticide risk metric (% species protected) risk categories: ■ Very High = <80 | ■ High = 80 to <90 | ■ Moderate = 90 to <95 | ■ Low = 95 to <99 | ■ Very Low = ≥99 | ■ No score/data gap

Pesticide scoring range: ■ Very Poor = 0 to 20 | ■ Poor = >20 to 40 | ■ Moderate = >40 to 60 | ■ Good = >60 to 80 | ■ Very Good = >80 | ■ No score/data gap

8.4.1.7 Offshore Water Quality Historic Scores

Table 53. Offshore Zone Water Quality indicator scores 2016 – 2020 Report Cards.

	Indicator Categories		Water Quality Index
	Chlorophyll-*a*	Water Clarity (Sediments (TSS))	
2020: Very Good	99	99	**99**
2019: Very Good	99	99	**99**
2018: Very Good	99	99	**99**
2017: Very Good	94	89	**92**
2016: Very Good	99	87	**93**

Scoring range: ■ Very Poor = 0 to <21 | ■ Poor = 21 to <41 | ■ Moderate = 41 to <61 | ■ Good = 61 to <81 | ■ Very Good = 81 to 100 | ■ No score/data gap

8.4.2 Coral

8.4.2.1 Reef level indicator scores

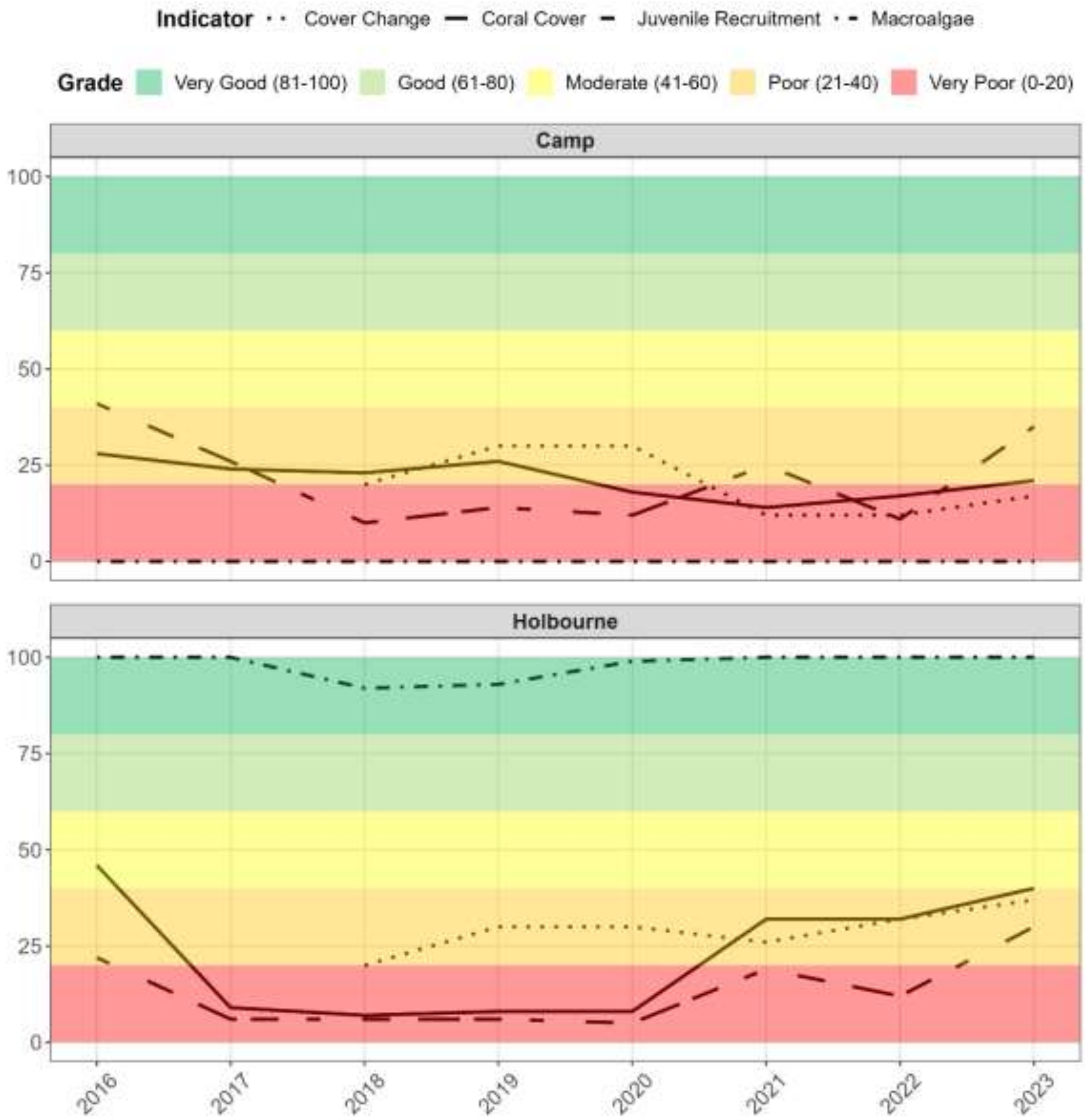

Figure 113. Northern Zone reef-level coral indicator scores and grades for the 2024 Report Card (2022-23 data) compared to the historic record. Scores in the Northern Zone before 2021 are not directly comparable to previous years due to changes in sampling design and before 2020 due to changes in reef aggregation level.

Figure 114. Whitsunday Zone reef-level coral indicator scores and grades for the 2024 Report Card (2022-23 data) compared to the historic record.

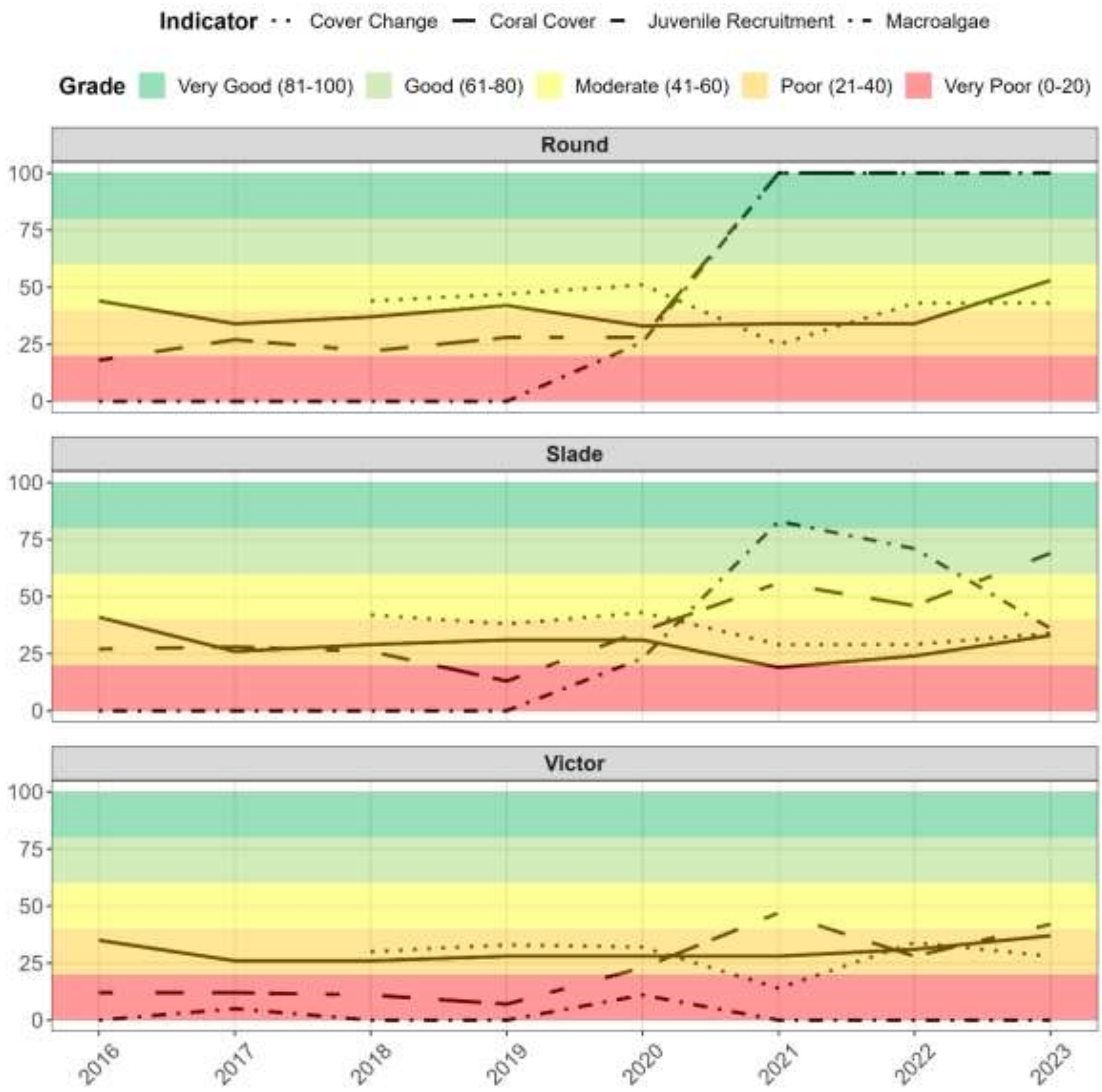

Figure 115. Central Zone reef-level coral indicator scores and grades for the 2024 Report Card (2022-23) compared to the historic record.

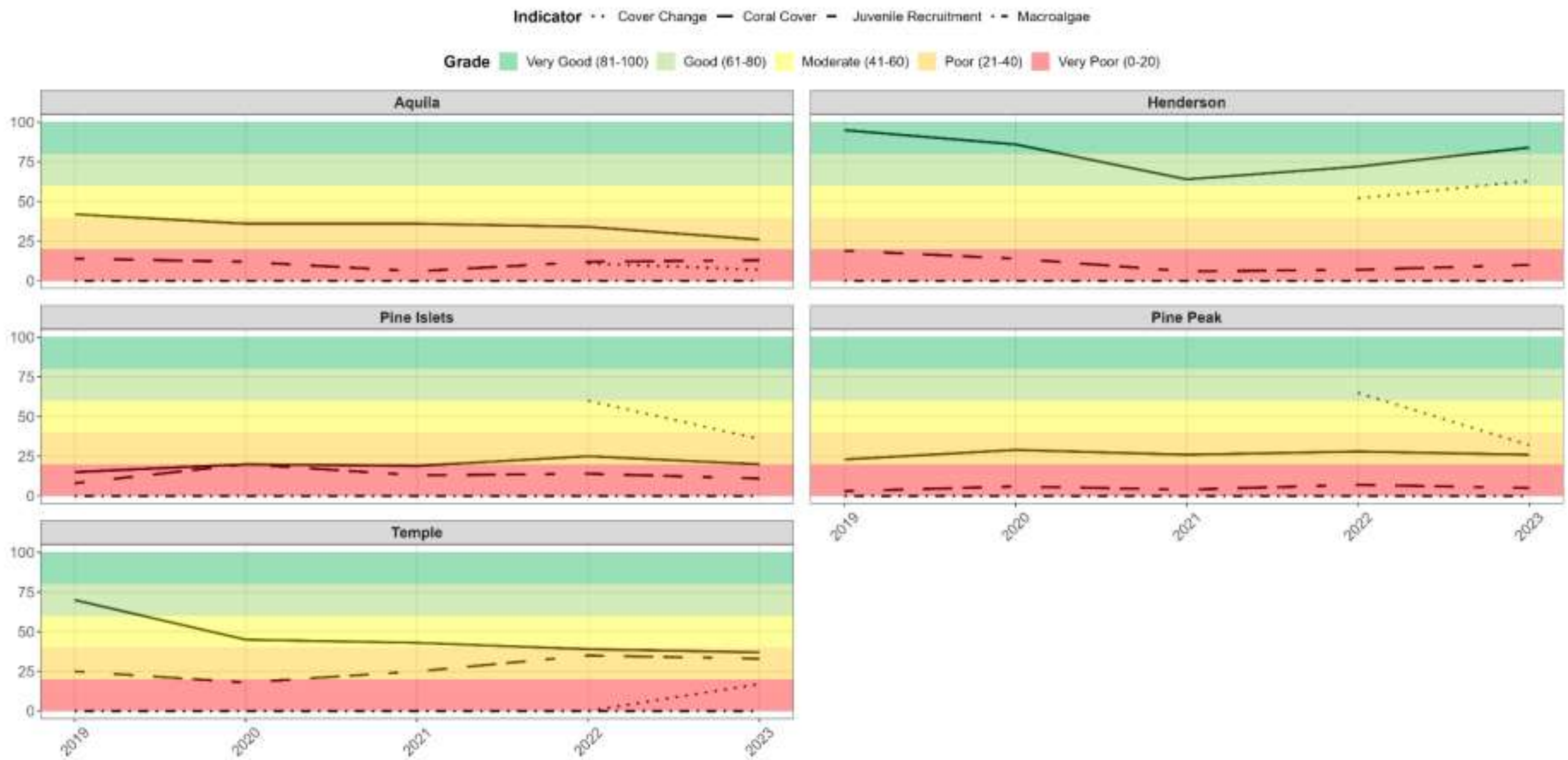

Figure 116. Southern Zone reef-level coral indicator scores and grades for the 2024 Report Card (2022-23 data) compared to the historic record.

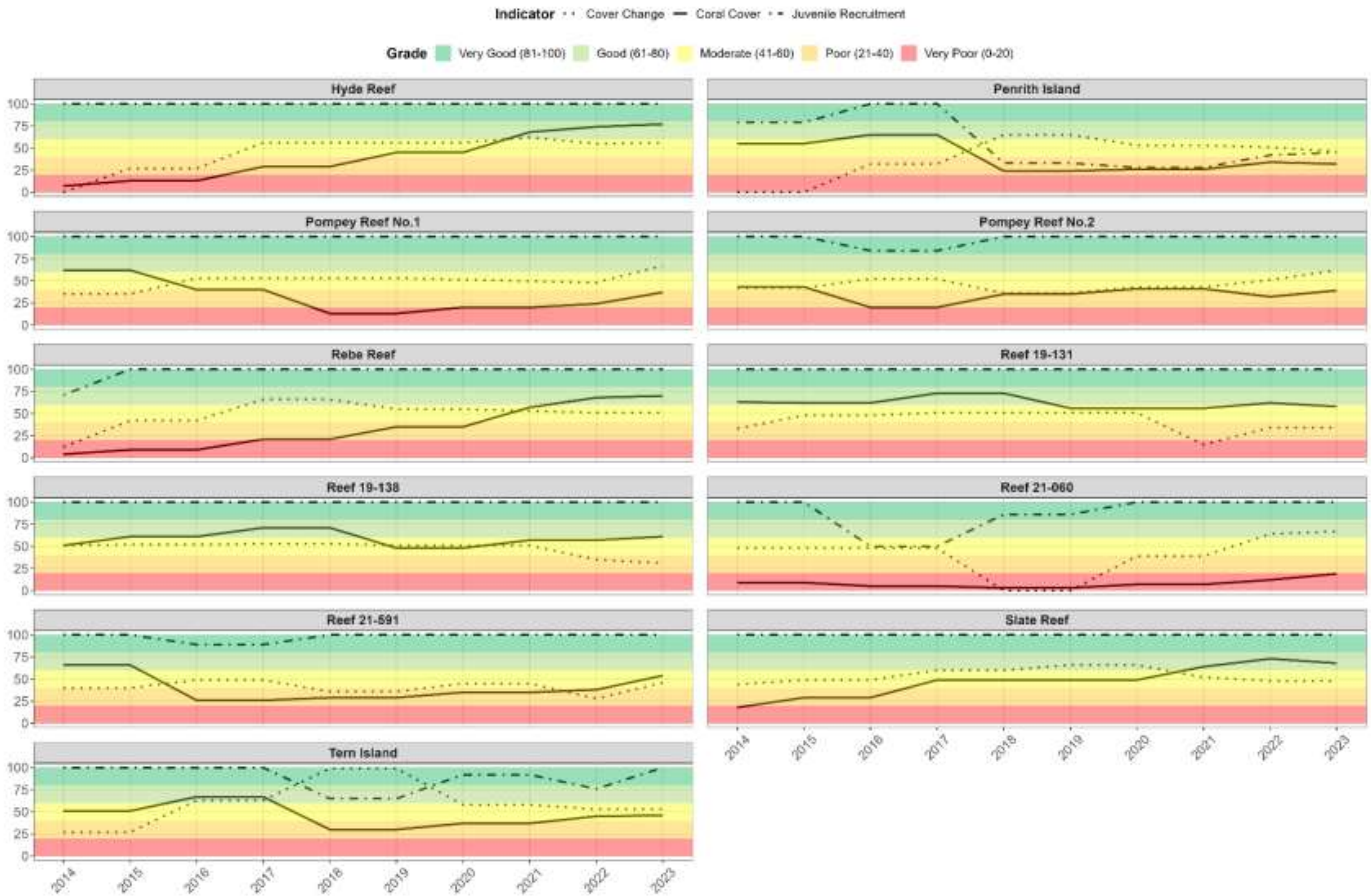

Figure 117. Offshore Zone reef-level coral indicator scores and grades for the 2024 Report Card (2022-23 data) compared to the historic record.

8.4.2.2 Reef level overall scores

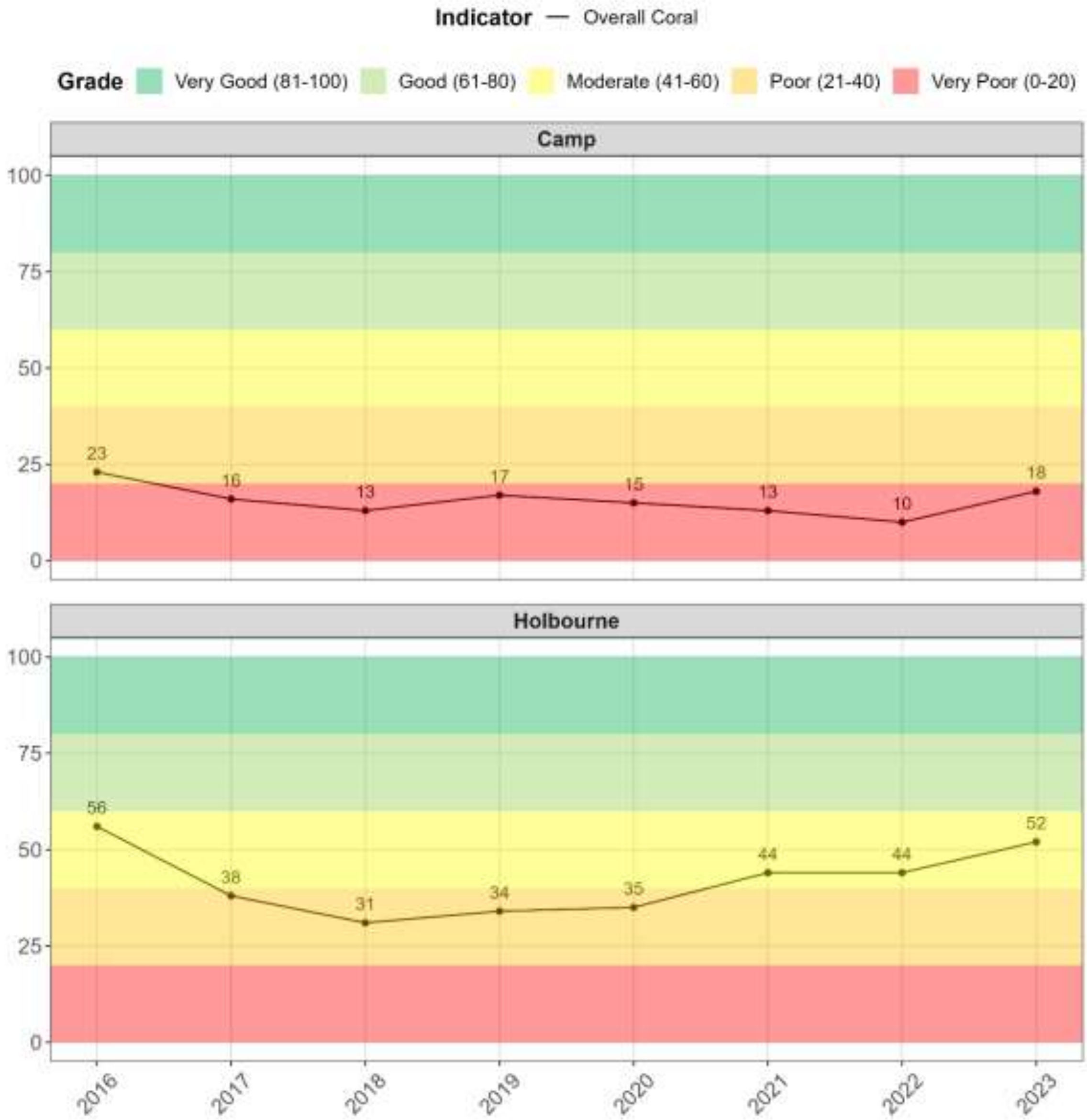

Figure 118. Northern Zone reef-level overall coral scores and grades for the 2024 Report Card (2022-23 data) compared to the historic record. Scores in the Northern Zone before 2021 are not directly comparable to previous years due to changes in sampling design and before 2020 due to changes in reef aggregation level.

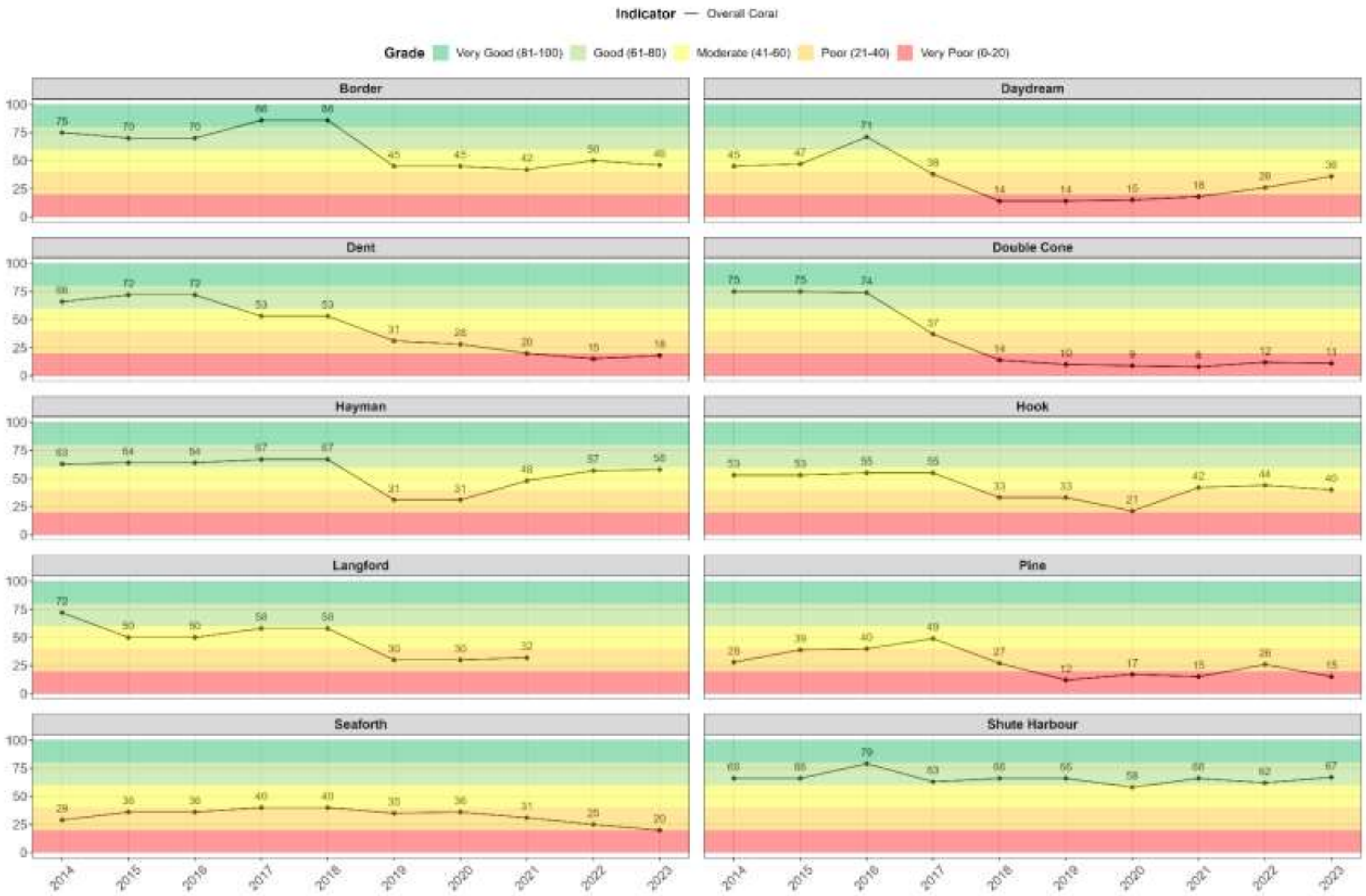

Figure 119. Whitsunday Zone reef-level overall coral scores and grades for the 2024 Report Card (2022-23 data) compared to the historic record.

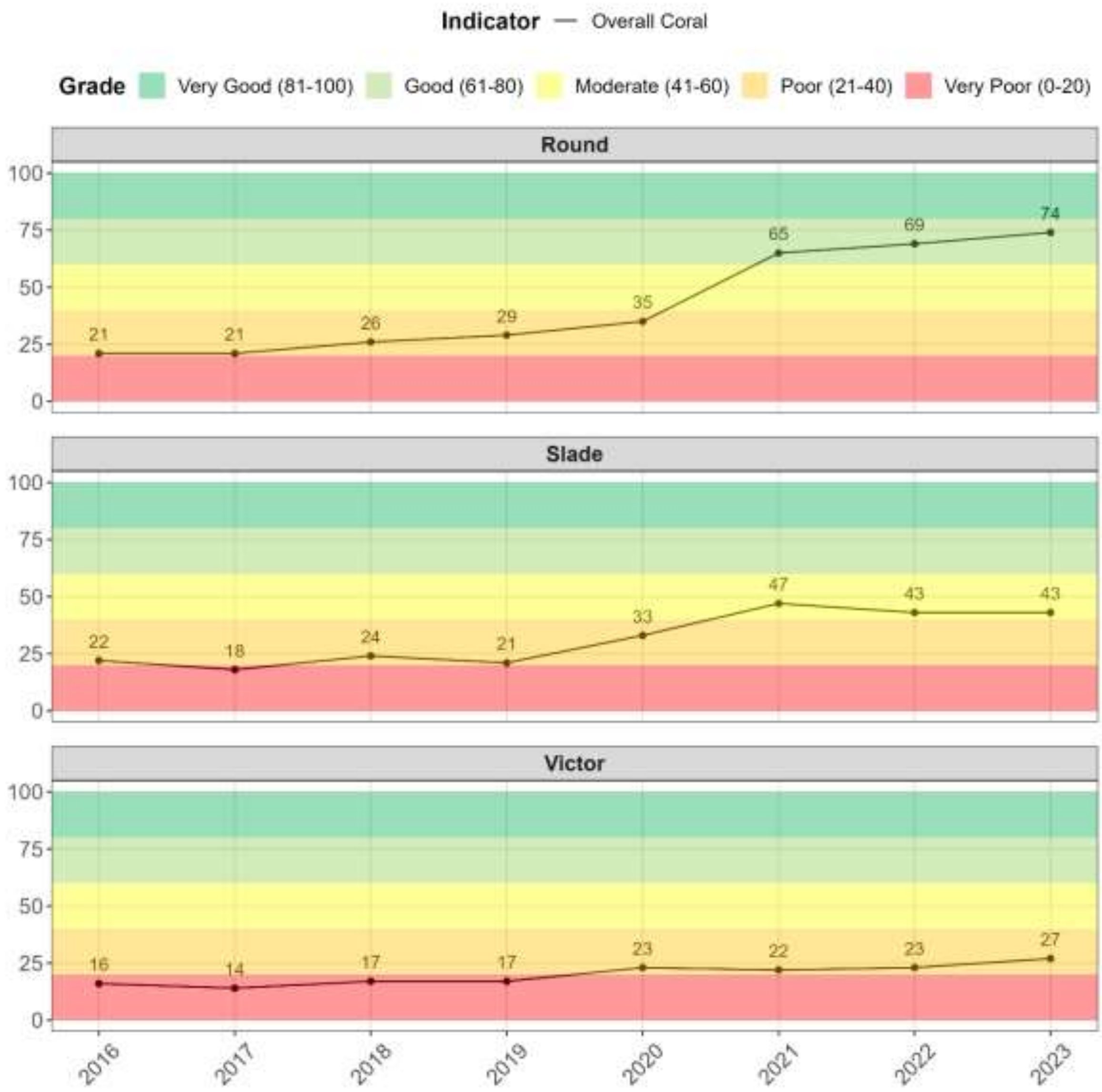

Figure 120. Central Zone reef-level overall coral scores and grades for the 2024 Report Card 2022-23 data) compared to the historic record.

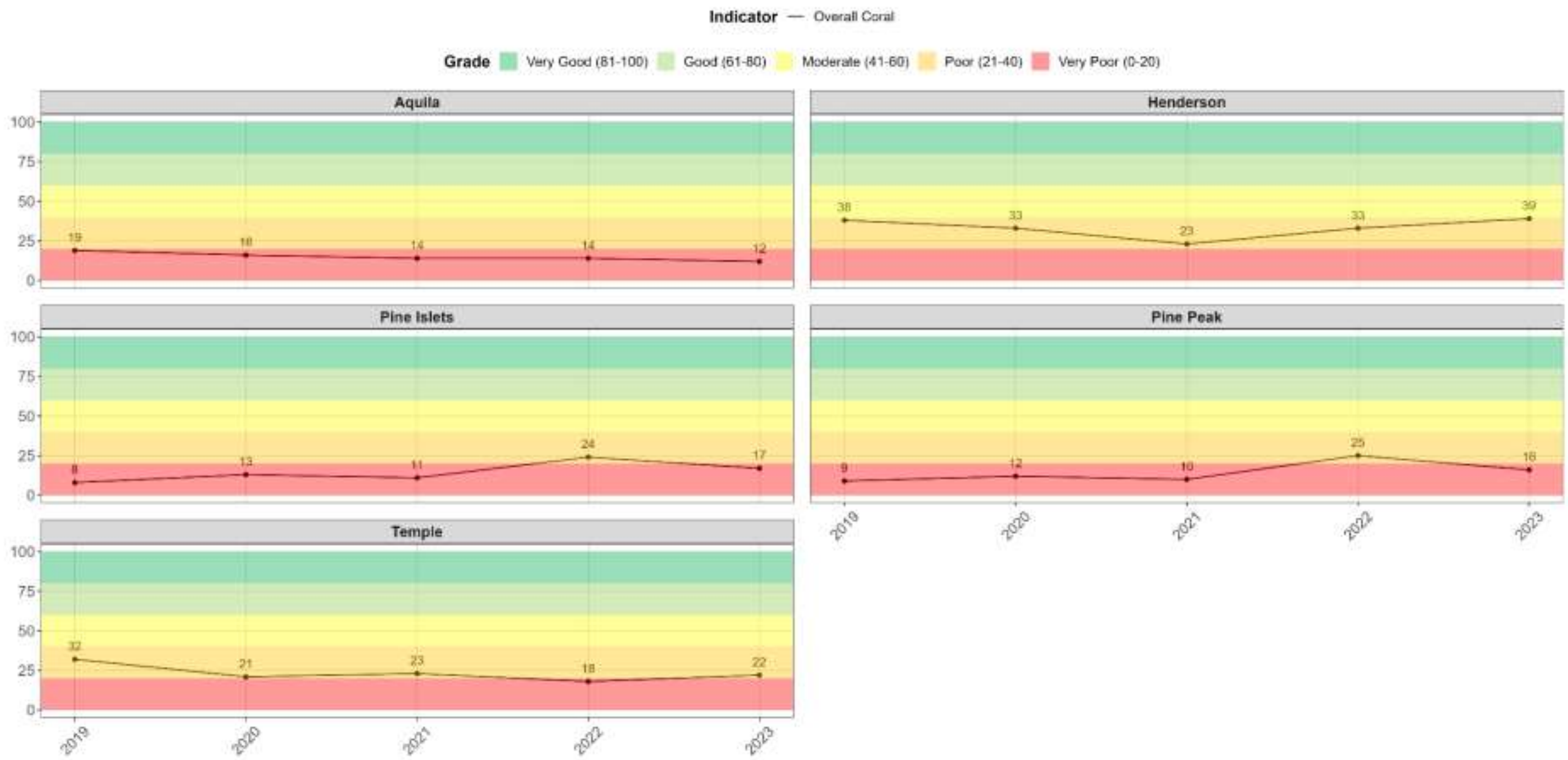

Figure 121. Southern Zone reef-level overall coral scores and grades for the 2024 Report Card (2022-23 data) compared to the historic record.

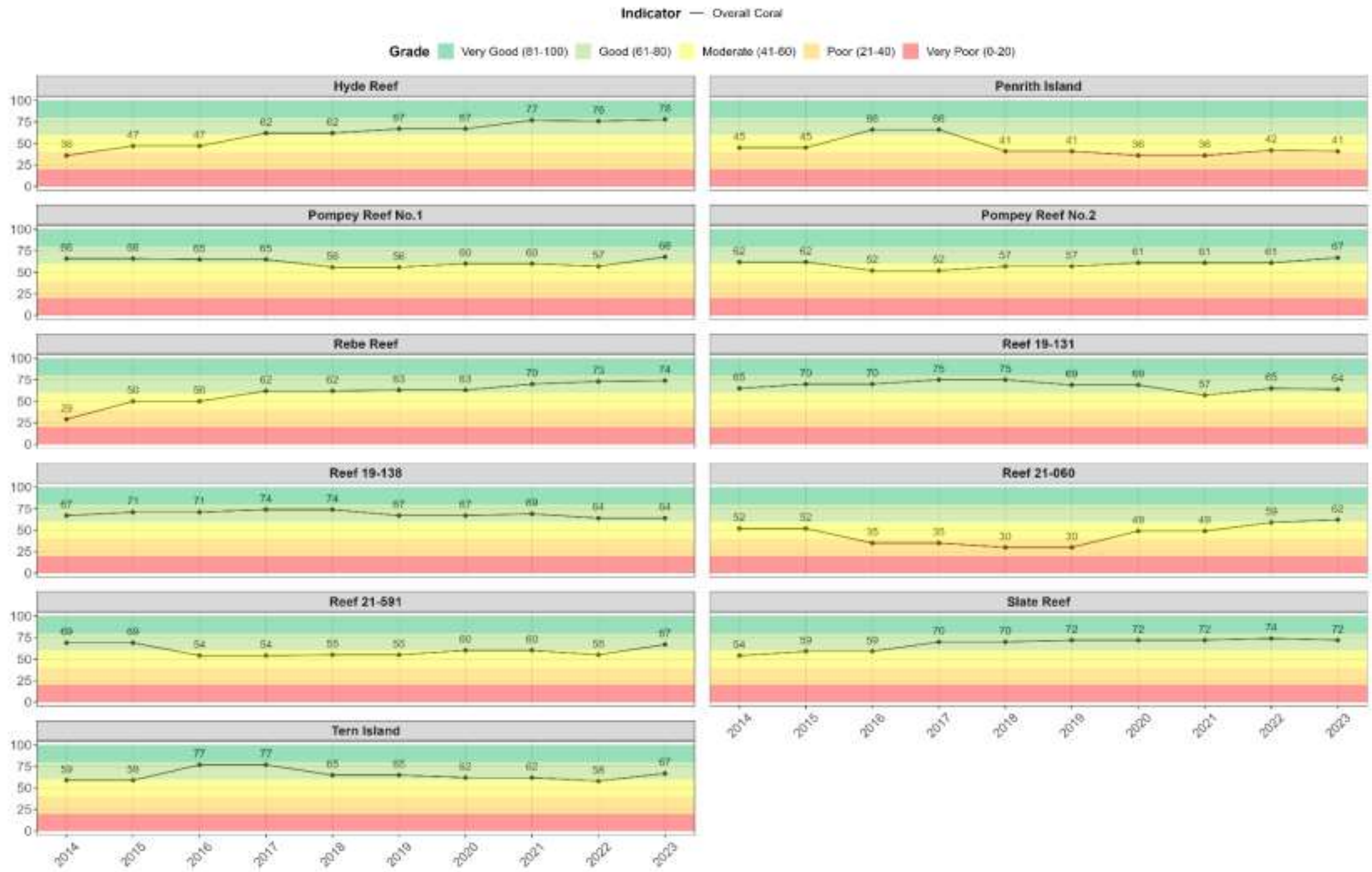

Figure 122. Offshore Zone reef-level overall coral scores and grades for the 2024 Report Card (2022-23 data) compared to the historic record.

8.4.3 Seagrass

Table 54. Inshore seagrass sampling design and site-level indicator results for the 2024 Report Card (2022-23 data). Indicators are based on data collected from the Marine Monitoring Program (MMP) or North Queensland Bulk Ports' (NQBP) Queensland Ports Seagrass Monitoring Program (QPSMP). MMP sites may include surveys completed by SeagrassWatch or QPWS drop-camera.

Zone	Habitat	Depth	Location/Meadow	Meadow/Site	MMP		NQBP			Meadow score	Zone Score
					Abundance	Resilience	Biomass	Area	Sp. Composition		
Inshore Marine Northern	Coastal	Inshore	Abbot Pt.	API3			89	67	88	67	73
				API5			73	100	83	73	
				API9			73	100	88	73	
		Subtidal		APD1-4			80	78	75	77	
		Intertidal	Bowen	BW2–3*	75					75	
Inshore Marine Whitsunday	Reef	Intertidal	Hydeaway Bay	HB1 and2*	81					81	30
			Hamilton Is. 1	HM1	0	30				15	
			Hamilton Is. 2	HM3	0	2.7				1	
			Lindeman Island	LN3	50	14.2				32	
		Subtidal	Tongue Bay	TO1 and 2^	12.5					13	
			Lindeman Island	LN1	25	70				48	
			Cid Harbour	CH4^	25					25	
				CH5^	25					25	
			Whitehaven Beach	WB1^	0					0	
				WB3^	25					25	
	Coastal	Intertidal	Pioneer Bay	PI2 and 3*	63					63	
Inshore Marine Central	Coastal	Intertidal	Midge Point	MP2 and 3	100	89				95	67
			St Helens Beach	SH1*#	75					75	
		Subtidal	Newry Bay	NB1 and 2^	63					62	
	Estuarine	Intertidal	Sarina Inlet	SI1 and 2	25	81				53	
	Coastal	Intertidal/Subtidal	Dudgeon Pt	DP1			85	48	93	48	
		Subtidal	St Bees Island	SB10			77	58	99	58	
			Keswick Island	KW14			85	45	94	45	
			Hay Point	HPD1			90	90	100	90	
			Mackay Offshore	MO5			74	98	100	74	
Inshore Marine Southern	Coastal	Intertidal	Clairview	CVH2			72	83	100	72	70
				CVH6			73	92	79	73	
				CVH7			66	100	74	66	

Scoring range: ■ Very Poor = 0 to 20 | ■ Poor = >20 to 40 | ■ Moderate = >40 to 60 | ■ Good = >60 to 80 | ■ Very Good = >80 | ■ No score/data gap

*= Data provided by SeagrassWatch via MMP; # = Not used in GBR-wide for MMP; ^ = QPWS drop-camera