Mackay-Whitsunday-Isaac Report Card Results 2022

(Reporting on data July 2021 to June 2022)

Technical Report
Mackay-Whitsunday-Isaac Healthy Rivers to Reef Partnership
July 2023

Authorship Statement

The Mackay-Whitsunday-Isaac (MWI) Healthy Rivers to Reef Partnership (the Partnership) 'Mackay-Whitsunday-Isaac 2022 Report Card Results' technical report was compiled by the Partnership's 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 earlier 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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Table of Contents

List of Figures

List of Tables

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 DES.
DES	Department of Environment and Science, 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

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

	and their non-living environment interacting as a functional unit.
Ecosystem health	"An ecological system is healthy and free from 'distress syndrome' if it is stable and sustainable—that is, if it is active and maintains its organization and autonomy over time and is resilient to stress. Ecosystem health is thus closely linked to the idea of sustainability, which is seen to be a comprehensive, multiscale, dynamic measure of system resilience, organization, and vigour." (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 do not meet 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.

NO_x	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).
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

[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

	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
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.

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 2022 Report Card, reporting on the 2021–2022 financial year, is the Partnership's ninth 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, 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 2022 MWI Report Card.

Water type	Index	Indicator Categories	Frequency of Reporting	Last Updated
Freshwater	Water Quality	Sediment	Annually	**2022**
		Nutrients	Annually	**2022**
		Pesticides	Annually	**2022**
	Habitat and Hydrology	In-stream habitat modification	4 Yearly	**2022**—Impoundment Length
				2018—Fish Barriers
		Flow	Annually	**2022**
		Riparian ground cover*	Unknown	**2014** (scores revised in 2016)
		Freshwater wetlands	4 Yearly	**2019**
	Fish	Fish	3 Yearly	**2021**
Estuary	Water Quality	Phys-chem	Annually	**2022**
		Nutrients	Annually	**2022**
		Chlorophyll-*a*	Annually	**2022**
		Pesticides	Annually	**2022**
	Habitat and Hydrology	Riparian Vegetation	4-Yearly	**2022**
		Mangrove and Saltmarsh	4-Yearly	**2022**
		Fish Barriers	4-Yearly	**2019**
Marine	Water Quality	Nutrients	Annually	**2022**
		Water Clarity	Annually	**2022**
		Chlorophyll-*a*	Annually	**2022**
		Pesticides	Annually	**2022**
	Coral	Coral	Annually	**2022**
	Seagrass	Seagrass	Annually	**2022**

*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 rainfall was lower than the long-term mean throughout the MWI region (Bureau of Meteorology (BoM), 2022). Rainfall was varied and patchy across space and time, with less intensity of events recorded during 2021–2022. Overall, rainfall was average in the Don, Proserpine, and O'Connell Basins, and below average in the Pioneer and Plane Basins. In the months leading up to the wet season, rainfall was 'average' or 'below average', except for an 'above average' to 'very much above average' August in all basins (Section 1.4.2 Regional Climate). The beginning and ending of the wet season (November and April, respectively) had 'above average' or 'very much above average' rainfall, with the rest of the time in between having 'average' or 'below average' rainfall. The wet season was followed by a particularly wet May, with all basins recording rainfall above the 90th percentile. This was then followed by a dry June, with rainfall recorded below the 10th percentile in most basins (except the Don, which recorded rainfall between the 10th and 30th percentile). 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.

Extreme events can have long-lasting impacts on aquatic ecosystems. In the summer of 2022, another marine heat wave occurred, resulting in the fourth mass bleaching event on the Great Barrier Reef since 2016 (and the first to occur in a La Niña year).[3] Despite the widespread bleaching, coral recovery still occurred across most of the MWI region. However, with lingering impacts of Tropical Cyclone (TC) Debbie on coral communities across the region, the increased occurrence of bleaching events such as these may continue to hinder coral reef recovery.

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 (Folkers et al., 2014).

[3] https://www2.gbrmpa.gov.au/our-work/reef-snapshot

II. Freshwater Basins

For freshwater basin condition assessments, water quality, impoundment length, and flow scores were updated for this reporting period. The majority of the habitat and hydrology index were based on repeated data (following three or four-year reporting cycles). (Section 2. Freshwater Basin Results)

Freshwater basins key findings:

Overall grades for freshwater basins ranged from 'moderate' to 'good' with all grades remaining the same as the previous reporting cycle. (Table II, Table III).

Table II. Condition grades of freshwater indicator categories and overall basins for the 2022 Report Card.

Freshwater Basin	2022 Report Card				
	Water Quality	Habitat and Hydrology	Fish	Basin Score and Grade	
Don	40	75	88	68	B
Proserpine		50	80	65	B
O'Connell	51	43	83	59	C
Pioneer	50	36	75	54	C
Plane	32	44	73	50	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

Table III. Overall basin grades for the 2022 Report Card compared to the historic record.

Freshwater Basin	2022	2021	2020	2019	2018	*2017	^2016	^2015	^2014
	Basin Score								
Don	68	74	62	71	56	47	48	48	54
Proserpine	65	65	65	65	66	53	53	53	52
O'Connell	59	60	63	63	66	54**	58	57	52
Pioneer	54	52	53	56	54	40	41	41	34
Plane	50	50	53	51	50	50**	52	51	35

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

*Scores have been back-calculated to incorporate updates to freshwater pesticides made in the 2018 Report Card.

**2017–2014 scores do not incorporate additional sites included for the first time in the 2018 Report Card.

^ 2016–2014 Report Card scores do not include back-calculated pesticide updates established for the 2018 Report Card.

MWI **basin water quality index grades were similar** to the previous monitoring period with the exception of the Don Basin, which declined from 'moderate' (60) in 2020–21 to 'poor' (40) in 2021–22 (Section 2.1.4 Water Quality Index Scores). **Sediment scores did not meet guideline values** with 'moderate' to 'very poor' grades observed across the Don, O'Connell, and Plane basins for five or more consecutive years. Pioneer Basin was the exception, with sediment scores within guideline values for the fourth consecutive year (Section 2.1.1 Sediments). **Nutrients indicator category grades declined** in both the O'Connell ('good' to 'moderate') and the Don ('moderate' to 'poor')

Basins. In the Don Basin this is largely due to increased DIN concentration, whereas O'Connell recorded increases in both DIN and FRP concentrations (Section 2.1.2 Nutrients). **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 Pesticides). As with previous years, applications of imidacloprid and diuron due to intensive land use were the key contributors to pesticide risk across most of the MWI region.

Both **impoundment length** indicator and the **flow indicator** category data were updated in the **habitat and hydrology index** in this year's Report Card (Section 2.2 Habitat and Hydrology). Habitat and hydrology grades remained the same in all basins, ranging from 'poor' in the Pioneer Basin to 'good' in the Don Basin (Table I).

III. Estuaries

Estuarine assessments during this reporting period included water quality scores and the habitat and hydrology extent indicators (riparian and mangrove/saltmarsh). Fish barriers, the other contributor to the habitat and hydrology index, is based on repeat data.

Estuaries key findings:

Overall estuary grades ranged from 'moderate' to 'good', with grade declines from 'very good' to 'good' reported in both the Gregory River and Carmila Creek estuaries (Table IV, Table V). These changes were due to incremental declines across many indicators.

Table IV. Condition grades of estuary indicator categories and overall estuaries for the 2022 Report Card.

Estuary	2022 Report Card				
	Water Quality	Habitat and Hydrology	Fish	Estuary Score and Grade	
Gregory River	73	84		78	B
O'Connell River	54	56		55	C
St Helens/Murray Creek	56	70		63	B
Vines Creek	47	63		55	C
Sandy Creek	57	49		53	C
Plane Creek	76	57		66	B
Rocky Dam Creek	52	76		64	B
Carmila Creek	64	95		79	B

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

Table V. Overall estuary grades for the 2022 Report Card compared to the historic record.

Estuary	2022	2021	2020	2019	2018**	2017*	2016*	2015*^
	Estuary Scores							
Gregory River	78	81	81	80	82	79	80	79
O'Connell River	55	56	56	56	51	61	54	57
St Helens/Murray Creek	63	66	67	64	57	61	61	63
Vines Creek	55	60	68	57	68	64	72	73
Sandy Creek	53	49	51	51	58	52	50	52
Plane Creek	66	68	64	63	68	67	59	61
Rocky Dam Creek	64	69	67	66	76	70	73	70
Carmila Creek	79	81	82	78	67	66	73	79

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
*2017, 2016, and 2015 scores include pesticide monitoring data but have not been back-calculated to address changes to the method of assessment and, therefore, are not directly comparable.
**2018 scores do not include pesticide monitoring data and, therefore, are not directly comparable.
^Data from 2015 Report Card are repeated from the 2014 Report Card.

MWI **estuarine water quality index grades** (combining nutrients, chlorophyll-*a* (chl-*a*), phys–chem, and pesticide risk scores) saw a **decline in St Helens / Murray Creek** ('good' to 'moderate') and **Rocky Dam estuary** (from 'good' to 'moderate') (Section 3.1 Water Quality in Estuaries). Change was due to a decline in Chlorophyll-*a* grades at both estuaries, with St Helens/Murray also recording a decline in Phys-chem and Rocky Dam recording a decline in DIN. The **Chl-*a* indicator** scores declined in all eight estuaries, and there has been a general decreasing trend in this indicator in the Gregory, Vines, Rocky Dam, and Murray/St Helens estuaries (Section 3.1.2 Chlorophyll-*a*). **Pesticides** scores remained similar to the previous year, with Metolachlor contributing to a grade decline in the Gregory River estuary and Diuron contributing to a grade decline in Rocky Dam Creek (Section 3.1.4 Pesticides). Other pesticides contributing to increased risk for aquatic species included Imidacloprid, Metsulfuron-methyl, and Imazapic.

IV. Inshore and Offshore Marine

All indicators of inshore marine condition, and offshore marine corals are updated annually. Offshore water quality is not currently reported as new data sources are being investigated.

Inshore and offshore marine key findings:

Overall marine zone grades ranged from 'poor' to 'moderate' and remained the same for the third consecutive year in all inshore zones (Table VI, Table VII).

Table VI. Condition grades of marine indicator categories and overall marine zones for the 2022 Report Card.

Marine Zones	2022 Report Card					
	Water Quality	Coral	Seagrass	Fish	Zone Score and Grade	
Northern	63	28	78		56	C
Whitsunday	41	33	38		37	D
Central	53	46	64		54	C
Southern	54	25	76		51	C
Offshore*		62				

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
* Overall score cannot be determined in years where less than 2/3 of the indicator categories have been assessed.

Table VII. Overall marine zone grades for the 2022 Report Card compared to the historic record.

Marine Zones	2022	2021	2020^^	2019^	2018	2017*
	Zone Scores					
Northern	56	51	50	43	35	44
Whitsunday	37	34	32	25	27	27
Central	54	52	44	36	37	31
Southern	51	42	43	34	22	
Offshore*			77	77	77	76

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
^^2020 scores adjusted to refer to back-calculated results due to changes in water quality and seagrass methods applied in the 2021 Report Card.
^2019 scores adjusted to refer to back-calculated results due to changes in seagrass methods applied in the 2021 Report Card.
*Overall score cannot be determined in years where less than 2/3 of the indicator categories have been assessed.
**2017 scores adjusted to refer to back-calculated results due to changes in pesticide and seagrass methods applied in the 2018 Report Card.

Water quality index grades (Section 4.1 Water Quality) remained similar in the Whitsunday and Southern Zones. In the Northern Zone, improvements in scores were driven by a decline in PN concentration and improvements in water clarity across all sites. Decline in the Central Zone scores was driven by increased concentration of PN, PP, and Chlorophyll-*a*.

Coral index grades (Section 4.2 Coral) remained the same as the previous year with the exception of an improvement in the Southern Zone due to recovery of coral cover following the marine heat wave in February 2020.For the five years since TC Debbie, Coral Cover in the Whitsunday and Northern Zones have remained 'poor' or 'very poor', demonstrating limited recovery of these coral communities, however Juvenile Recruitment received a 'moderate' score in the Whitsundays for the first time since TC Debbie. The Central Zone scored 'moderate' for the second consecutive year, driven by increased juvenile recruitment and decreased macroalgae coverage.

Seagrass index grades (Section 4.3 Seagrass) did not change in Northern or Whitsunday Zones. Both Central and Southern Zones saw improvement from 'moderate' to 'good', demonstrating continued recovery after impacts from TC Debbie in 2017.

1 Introduction

1.1 Purpose of this document

The purpose of this document is to provide detailed results to support the 2022 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).

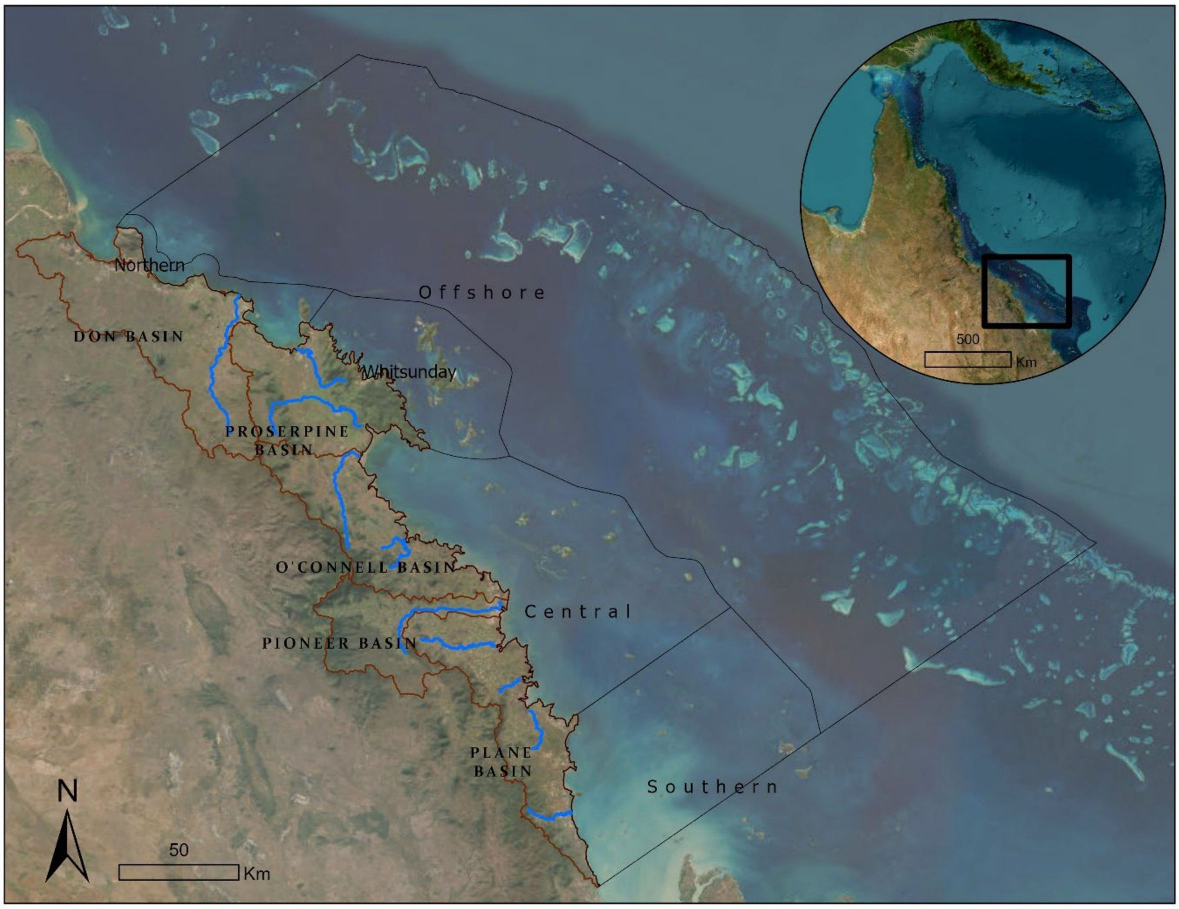


Figure 1. The MWI Healthy Rivers to Reef Partnership reporting region, showing marine zones, freshwater basins, and monitored rivers.

This document presents scores and grades based on data collected between July 1st 2021 and June 30th 2022 (refer to the Mackay-Whitsunday-Isaac 2022 Report Card Methods[4] (hereafter referred to as the Methods Report) for indicators that are updated on three and four-year cycles). The 2022 condition assessments (scores) for environmental indicators are presented alongside confidence levels associated with results.

The 2022 Report Card results have been compared to 2014-2021 results where applicable. Where this is not the case, previous results back-calculated using alternate methods are presented for reference. Additional information associated with 2022 Report Card results are contained in appendices.

[4] https://healthyriverstoreef.org.au/report-card/report-card-download/

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 2022 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[5] outlines the guiding framework for the development and scope of the 2022 Report Card. Since the publication of the Program Design in 2018, changes to the scope of assessment (monitoring sites and methods) have occurred and are highlighted where relevant throughout this document. For more detail, refer to the Methods Report and the MWI Report Card Program Design 2017 to 2022.[5]

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

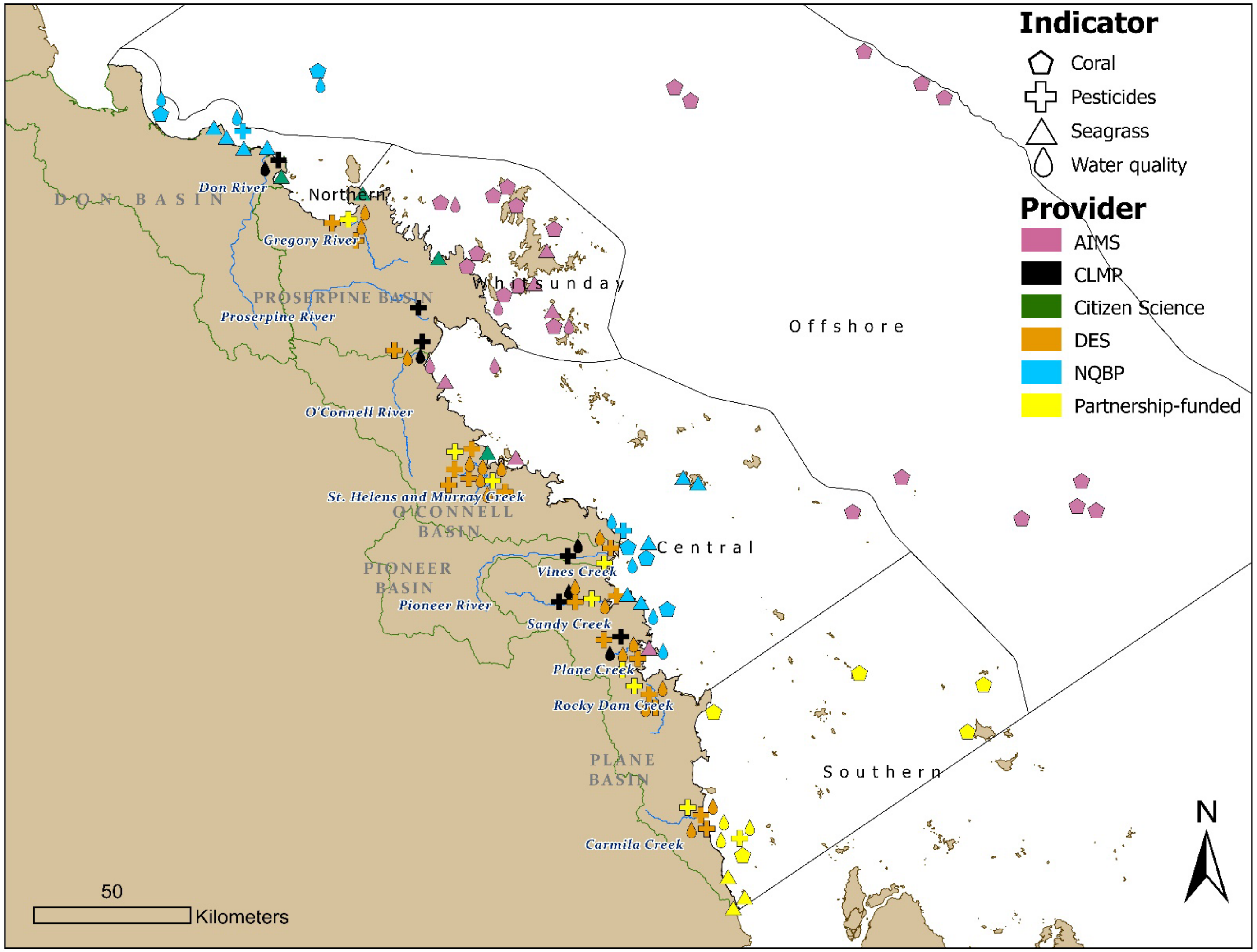


Figure 2. Mackay-Whitsunday-Isaac reporting region showing sampling sites within freshwater basins, inshore (designated by the local or state jurisdictional boundary), and offshore marine zones (designated by the commonwealth boundary).

1.3 Terminology

The Report Card assesses ecosystem health (environmental) indicators to report on the overall condition of MWI waterways. Scores for indicators are aggregated depending on the aspect of the environment they are assessing 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). Presentation of the coasters can be with or without the outer ring (i.e., indicators). 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 GBR 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 During 2021–2022

Climate, population, and the economy are the key external forces that influence the condition of waterways in the MWI Region, either directly or by driving activities that put pressure on local waterways (Figure 4).[6] The MWI Partnership 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 the Don River in the north to the Carmila coast in the south. Land use in the region is dominated by agricultural activities, including sugarcane, grazing and horticulture, and other activities, such as mining and urban development. These terrestrial activities can put pressure on local freshwater and estuarine waterways due to the mobilisation of sediments, nutrients, pesticides, and other contaminants via surface water run-off. Increased loads of these pollutants are ultimately received by coastal waters through river discharge and move to inshore and offshore waters (Figure 4). 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. Source: J. Prange, GBRMPA.

Weather events are a key driver likely to affect scores of many environmental indicators. Recent events within Mackay-Whitsunday-Isaac include below average rainfall between 2019–2022, marine heat waves in 2020 and 2022, and the residual impacts of Tropical Cyclone (TC) Debbie in March 2017.

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

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 MWI region may experience elevated rainfall, tropical lows, and TCs. TCs may generate considerable rainfall and flooding in addition to increased sediment resuspension in the marine environment. In the northern extent of the region (i.e., Don Basin), predominant trade winds create a similar but smaller-scale effect; 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 including drought, bushfires, and floods within natural ecosystems. Such variability also extends to changes in modified environments, including agricultural land, and can dictate how land management activities evolve within and between seasons.

1.4.3 Climate Change and 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.[7] 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 5).

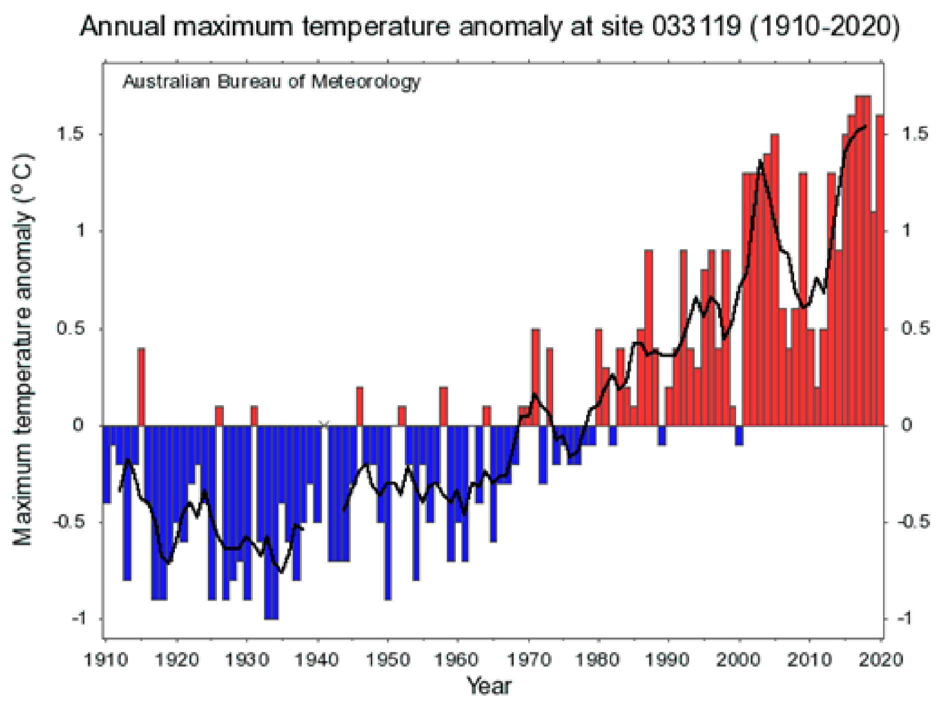
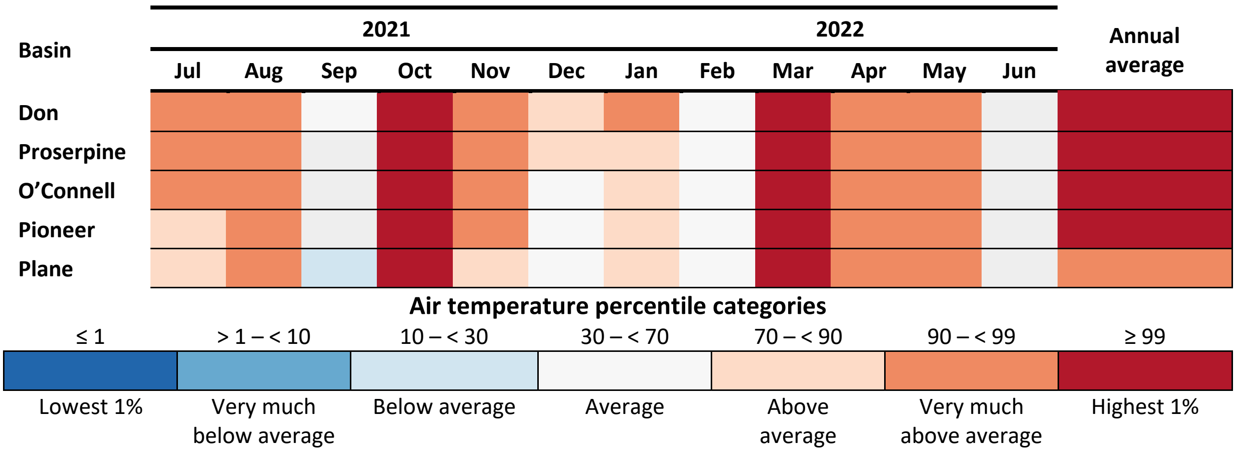


Figure 5. Annual maximum temperature (˚C) anomaly at Mackay (site 033119) from 1910 to 2022. A rolling five-year average is shown by the black line. Source: Bureau of Meteorology, Australia climate change site data (http://www.bom.gov.au/climate/change/hqsites/).

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

The Don, O'Connell, Proserpine, and Pioneer Basins experienced annual air temperatures that are in the highest 1% of recorded temperatures since 1910, and the Plane Basin similarly recorded annual air temperature that was 'very much above average' (Table 2). These temperature anomalies were between 0.8 to 1.4 °C above the long-term mean (Figure 6).

Table 2. Monthly temperature percentiles and annual average percentiles for basin areas of the Mackay-Whitsunday-Isaac Region for 2020–21. Data source: Bureau of Meteorology



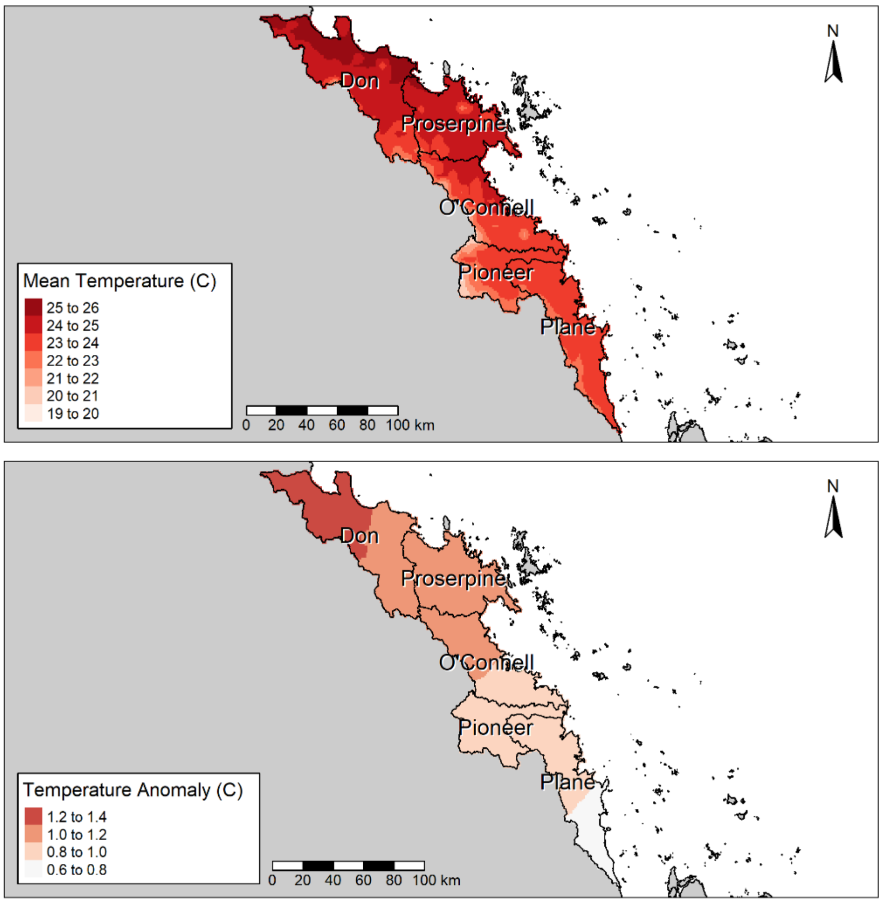


Figure 6. Mean temperature in the MWI region in 2021-22, and difference of 2021-22 temperature from long-term mean. The long-term mean is represented as a 'difference from mean temperature' of 100% and was based upon historical temperature records from 1910 to 2022. Data source: Bureau of Meteorology.

Rainfall variability has increased such that while wet season rainfall has increased in northern Australia since the 1970s, annual rainfall totals are below average across much of this region. The intensity of rainfall events has increased, causing a higher risk of flash flooding that can impact agricultural and urban communities and natural ecosystems.[7]

In Australian waters, the average sea surface temperature (SST) has risen by more than 1° C since 1900. Eight of the ten warmest years on record have occurred since 2010.[8] Consequently, marine heatwaves (defined by temperatures in the upper range of historical baseline conditions for 5+ days) have increased in frequency and duration. This is of concern, as 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.[8]

In addition to these impacts, rising atmospheric CO_2 levels are causing oceans to increase their CO_2 uptake, causing a decline in ocean pH. This process of ocean acidification reduces the calcification rate in species that produce shells or have calcium carbonate skeletons, such as corals. Since the 1880s, the average pH of Australia's surface waters has decreased by 0.12—a 30% increase in acidity.[8]

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.[9] 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.[7]

[8] http://www.bom.gov.au/state-of-the-climate/oceans.shtml

[9] http://www.bom.gov.au/state-of-the-climate/future-climate.shtml

1.4.4 Rainfall

Australian rainfall for the 2021–22 period was 9% above the 1961–90 climatological averaging period, similar to the 2020–21 period (10% above; both a departure from the preceding three drier-than-average periods: 2017–18, 2018–19, and 2019–20, respectively). La Niña was established in late November for the second year in a row, peaking in late January and weakening (though with some atmospheric signals persisting) throughout autumn.[10] Rainfall in the MWI Region ranged from 400 to 1,800 mm, with rainfall anomalies ranging from -100 mm in the Don Basin to -500 mm in parts of the O'Connell, Pioneer, and Plane Basins (Figure 7).

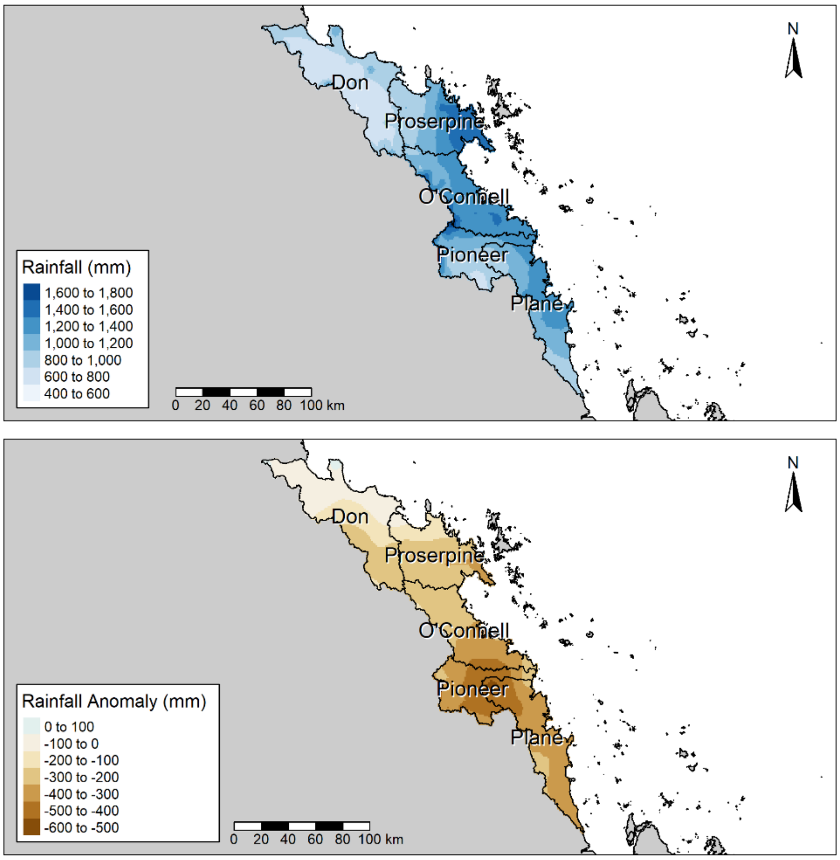


Figure 7. Total rainfall in the MWI region in 2021-22 (top), and anomaly of total annual rainfall in 2021-22 from the long-term mean (bottom). The long-term mean is represented as a 'difference from annual rainfall' of 100% and was based upon historical rainfall records from 1911 to 2017. Data source: Australian Water Outlook (https://awo.bom.gov.au/).

The Don Basin has consistently been the driest of the MWI basins since 1911, with a long-term mean of 907 mm compared to between 1,413 and 1,568 mm for the other basins (Table 3). In the last ten years, the Don and Plane Basins recorded eight years of annual rainfall below this mean, with the other three basins recording seven out of the past ten years below the long-term mean (Appendix 8.1). All basins had lower annual rainfall in 2021–22 than the long-term mean (i.e., 73–86% of the long-term mean), with lower annual rainfall in the Proserpine and O'Connell Basins during the 2021–22 reporting year compared to the 2020–21 reporting year.

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

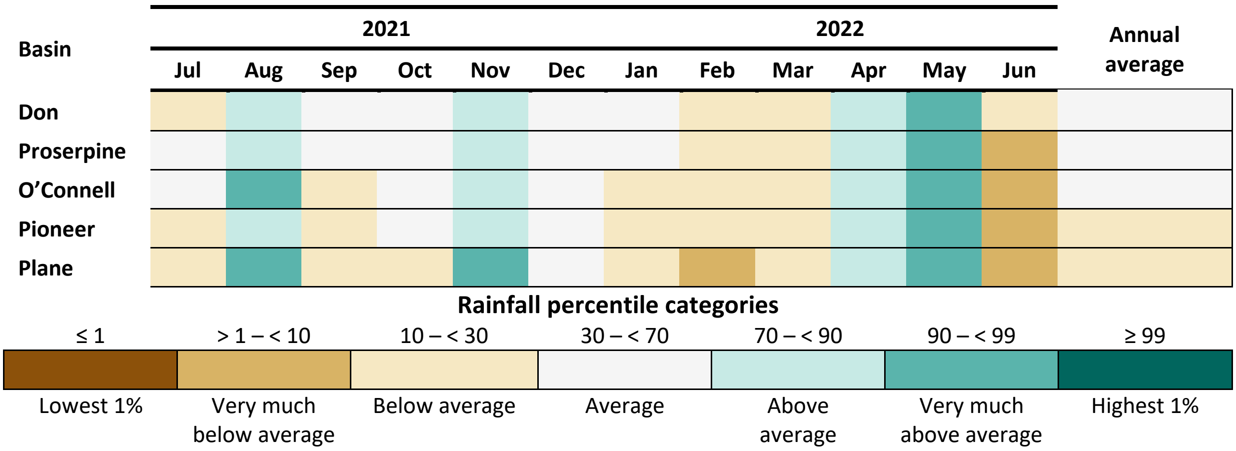
Table 3. Annual rainfall statistics for basins in the MWI region for 2021-22.

Basin	Total (mm)	Long-term mean (mm)	Decile	Anomaly (mm) (+/- long-term mean	Percentage (%) of long-term mean
Don	785	907	5	−123	86%
Proserpine	1176	1413	4	−237	83%
O'Connell	1271	1568	4	-297	81%
Pioneer	1070	1460	3	-391	73%
Plane	1120	1486	3	-366	75%

Decile category: 1: very much below average, 2–3: below average, 4–7: average, 8–9: above average, 10: very much above average.

Annual rainfall patterns obscure the variation in rainfall observed throughout the year, with some months recording 'very much above average' rainfall and others being 'very much below average' (Table 4). May 2022 reported 'very much above average' rainfall across all MWI basins, as was the case for most of the state, resulting in the fifth wettest May on record in Queensland.[11] In contrast, the following month (June 2022) was a relatively dry month, with all basins except the Don reporting 'very much below average'. This pattern was seen across Capricornia and the Southeast Coast of Queensland, though contrasted to northern and western districts of the state where 'above average' rainfall was observed for the month of June.[12]

Table 4. Monthly rainfall percentiles and annual average percentiles for basin areas for the Mackay-Whitsunday-Isaac Region for 2021–22. Data source: Australian Water Outlook (https://awo.bom.gov.au/).



Due to the low rainfall across the MWI region for 2021–22, discharges measured at gauging stations across the region were generally much lower than the long-term mean annual discharge (Figure 8).[13] This can impact ecosystem condition scores across freshwater, estuarine, and marine MWI zones. Due to the impacts of climate change, declines in annual streamflow are being seen across the

[11] ttp://www.bom.gov.au/climate/current/month/qld/archive/202205.summary.shtml
[12] http://www.bom.gov.au/climate/current/month/qld/archive/202206.summary.shtml
[13] http://www.bom.gov.au/climate/current/annual/qld/summary.shtml

country, with many of Australia's largest basins (e.g., the Murray–Darling Basin) showing declining trends since 1975.[7]

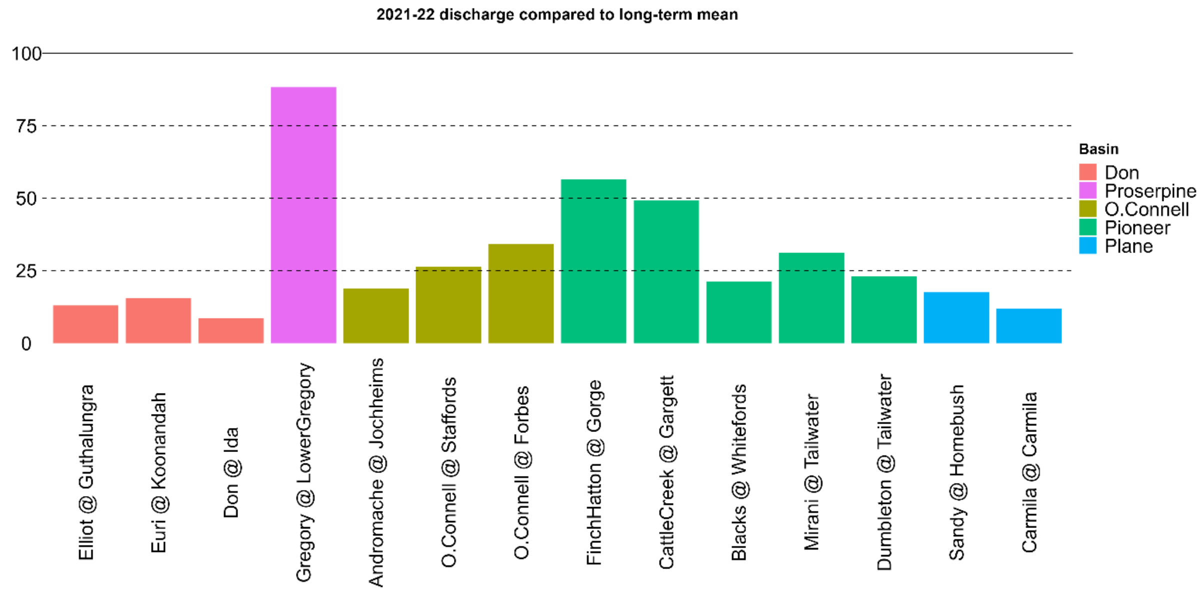


Figure 8. Proportion of 2021–22 discharge recorded from gauging stations at major river channels in Mackay-Whitsunday-Isaac Region compared to the long-term mean. The long-term mean is represented by a solid black horizontal line, while dashed lines represent 25%, 50%, and 75% of long-term mean. Long-term mean annual discharge is based on historical gauging station records until present; the time frame varies according to station. Source: Queensland Government (water-monitoring.information.qld.gov.au).

1.4.4.1 Agricultural Context

Late wet season conditions in 2021 caused cane planting to be delayed until after July, or in some areas to September following late August rain. Late season planting meant that fertiliser applications also occurred later, often between October – January depending on paddock and weather conditions {P. Trendell, pers. comm. 06/04/23).

Imazapic products are often applied during the late dry season (July – August), before weed growth, as they remain UV stable and are activated by rainfall or irrigation. Fertiliser, nutrient, and imidacloprid applications were delayed until rainy periods began to pick up in October and early November, with first flush periods evident in November for Pioneer and Plane Basins and both herbicide and imidacloprid use increasing with increases in weed growth and soil moisture (P. Trendell, pers. comm. 06/04/23).

Cane crush was completed in Plane Creek and Proserpine by the end of November, however Mackay Sugar continued until late December. Herbicides linked to plant cane weren't detected after December, however herbicides linked to ratoons were detected through March, suggesting that they were applied from January through early March. High rainfall across the March to May period meant that limited work was done on fallow blocks due to wet conditions (P. Trendell, pers. comm. 06/04/23).

1.4.5 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.[14] The marine heatwave of 2022 resulted in the first mass bleaching event to occur during a La Niña year.[15] In the MWI region, 2022 had more DHW than 2021, with parts of the inshore reef reaching over eight DHW in the Northern Inshore Zone and six to eight DHW in parts of the Whitsunday and Central Inshore Zones (Figure 9). Aerial bleaching surveys conducted by AIMS in March 2022 showed severe bleaching in both the inshore and offshore reefs of the Northern and Whitsunday zones.[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]

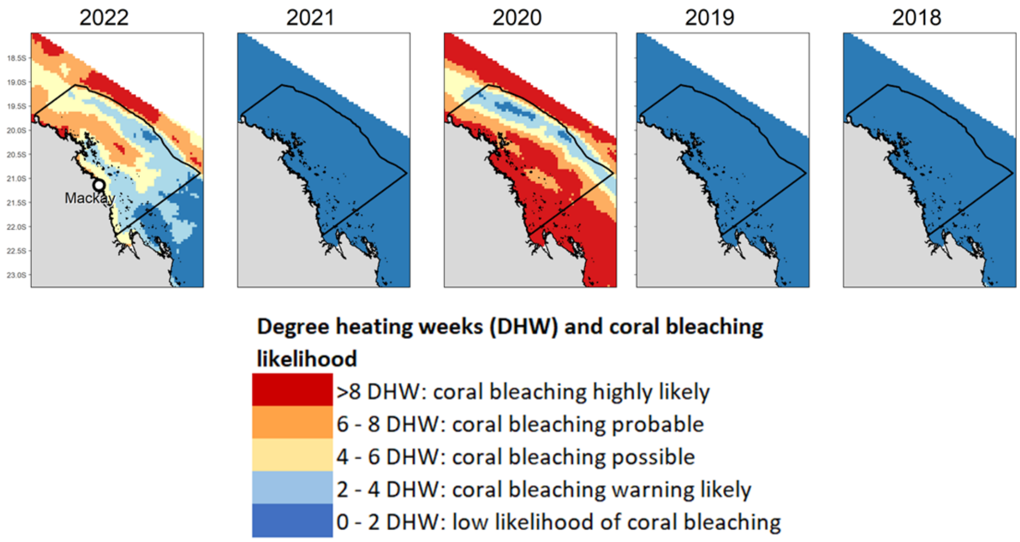


Figure 9. Degree heating weeks (DHW) for the MWI Region from 2018 to 2022. This is a measure of heat stress accumulation over the past 12 weeks by summing SSTs exceeding 1°C above the long-term mean maximum temperature. DHW values as indicators of thermal stress on the Great Barrier Reef are interpreted as follows: DHW values from 0–2: low risk, 2–4: bleaching warning, 4–6: bleaching possible, 6–8: bleaching probable, >8: severe bleaching. Source: NOAA coral reef watch.

While MWI reefs were directly impacted by the heatwave of 2022, there was evidence of recovery across the region (discussed further in Section 4.2 Coral), as the 2022 bleaching event was less intense than the previous three events (2016, 2017, and 2020).[18] 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.

1.4.6 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

[14] https://coralreefwatch.noaa.gov/satellite/education/tutorial/crw24_dhw_product.php
[15] http://www.bom.gov.au/state-of-the-climate/oceans.shtml
[16] https://elibrary.gbrmpa.gov.au/jspui/handle/11017/3916
[17] https://www.aims.gov.au/monitoring-great-barrier-reef/gbr-condition-summary-2021-22

during 2021–2022.[18] This is in line with current climate trends, showing a decline in the number of TCs across Australia since 1982.[5] It has, however, been predicted that the intensity of storms will increase.[7]

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.[19] 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] http://www.bom.gov.au/cyclone/tropical-cyclone-knowledge-centre/history/past-tropical-cyclones/
[19] http://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 10). Due to differences in the time scales at which changes occur for each indicator and/or logistical constraints, 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.

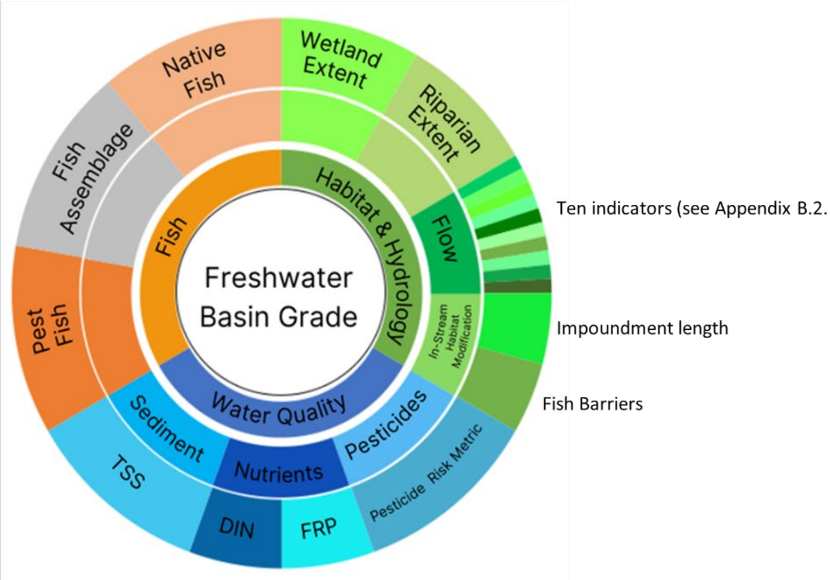


Figure 10. Indicators (outer ring), indicator categories (middle ring) and indices (inner ring) that contribute to overall freshwater basin scores.

Table 5. Frequency of reporting for specific indicator categories and their update status for the 2022 Report Card. Note: the reporting frequency is the same for each freshwater basin indicator within an indicator category.

Index	Indicator Categories	Frequency of Reporting	Last Updated
Water Quality	Sediment	Annually	**2022**
	Nutrients	Annually	**2022**
	Pesticides	Annually	**2022**
Habitat and Hydrology	In-stream habitat modification	4 Yearly	**2022**—Impoundment Length
			2018—Fish Barriers
	Flow	Annually	**2022**
	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 2022 Report Card were derived using data obtained from the Great Barrier Reef Catchment Loads Monitoring Program (GBRCLMP). Scores were based on samples collected from end-of-catchment monitoring sites: one in each of the Don Basin (Don River mouth), Pioneer Basin (Dumbleton Weir) O'Connell Basin (O'Connell Caravan Park) and two in the Plane Basin (Sandy Creek at Homebush and Plane Creek at Sucrogen Weir) (Figure 11).

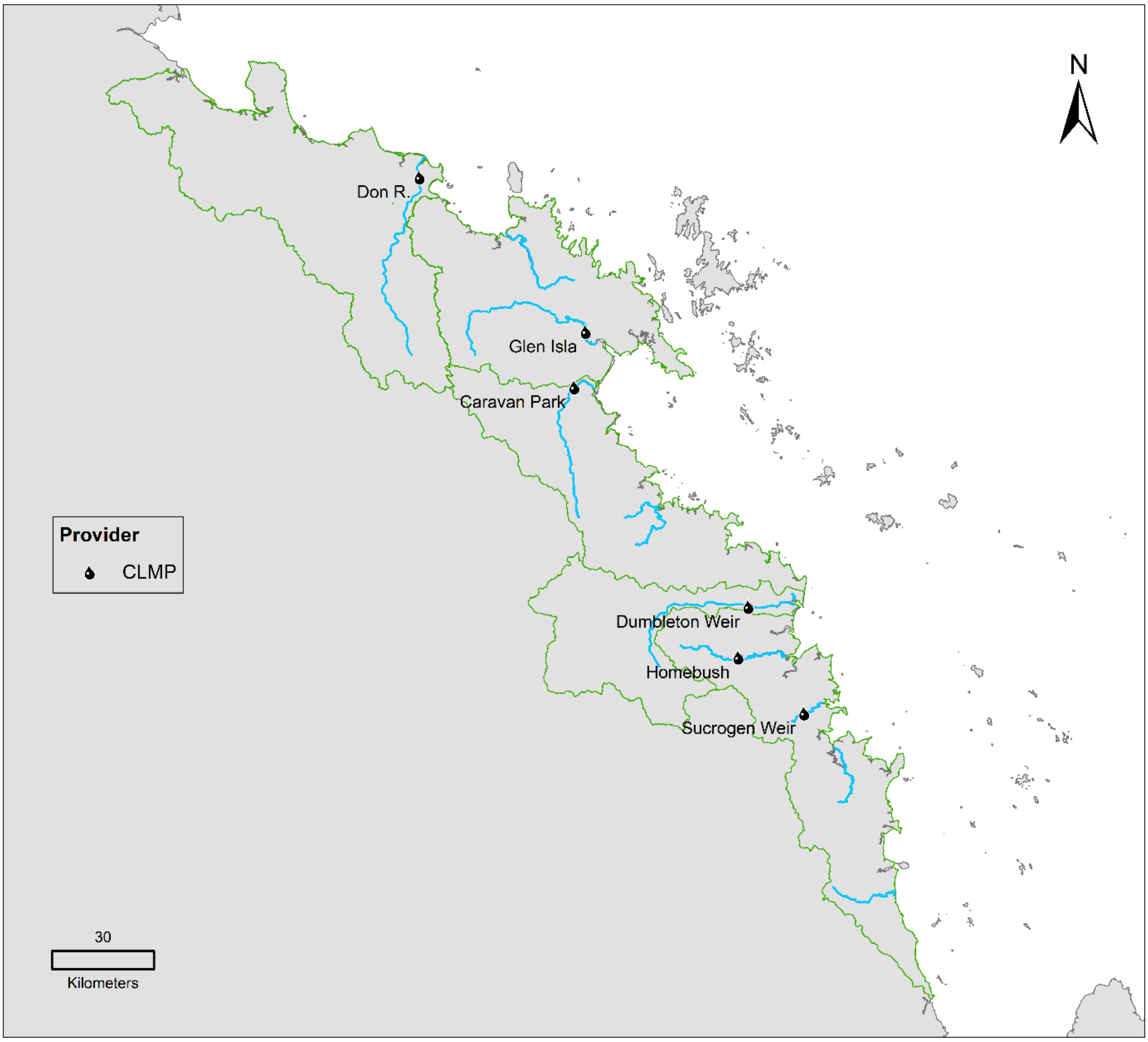


Figure 11. Sampling locations for freshwater water quality monitoring (including pesticides) in the MWI region for the 2022 Report Card. Data provided by the Catchment Loads Monitoring Program (CLMP) as part of the Queensland Government.

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.

Water quality samples in 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.[20]

Water quality criteria for assessment was derived from the Queensland Water Quality Guidelines (DES, 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.

Notes on data interpretation for 2022 Report Card results:

Tidal Influence in Proserpine River: While water quality data were collected from the Proserpine River end of the Catchment Loads Monitoring site at Glen Isla, the site is located in the estuary. Therefore, concentrations of nutrients and sediments at this site are influenced by tidal movements and are not suitable for reporting the ambient state (concentration) of nutrients and sediments in the freshwater ecosystem. As a result, and consistent with previous reporting since 2018, nutrient and sediment indicator category results for the Proserpine Basin are not reported in the 2022 Report Card. The dilutive potential of the tidal inflow of seawater is not anticipated to decrease the magnitude of the Pesticide Risk Metric (PRM) score substantially (see Methods Report for further detail), 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 2021–22 monitoring period water quality monitoring in this basin was restricted to periods of substantial rainfall in the area, specifically from January–Feb 2022 and again in May 2022. 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 not be directly compared to previous Report Card grades that were calculated using data from uninterrupted sampling and should be considered in light of wet season representation.

[20] 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 TSS. This indicator category is particularly vulnerable to changes in rainfall, wherein periods of high flow can suspend large amounts of sediment in a basin. There was average rainfall across most of the region during the 2021–22 wet season, with the Don, Pioneer, and O'Connell Basins receiving their maximum median sediment concentrations between November 2021 and January 2022. The Pioneer and Plane Basins experienced a second peak in April – May 2022.

Results (Table 6, Figure 12)**:**

Table 6. Results for the sediment indicator category (based on a measure of TSS) for water quality in freshwater basins for the 2022 Report Card (2021–22 data).

Freshwater Basin	Sediment Score
Don (Don River)*	49
Proserpine (Proserpine River)^	
O'Connell (O'Connell River)	59
Pioneer (Pioneer River)	61
Plane (Sandy and Plane Creeks)	56

■ 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

*Due to limited sampling availability, grades should be considered in light of wet season representation and should not be directly compared to previous scores calculated from uninterrupted sampling.

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

Key Message:

1) Sediment scores indicated three of the four graded basins within the MWI region failed to meet the guideline values, with 'moderate' to 'very poor' grades observed for six or more consecutive years in the Don, O'Connell, and Plane Basins.

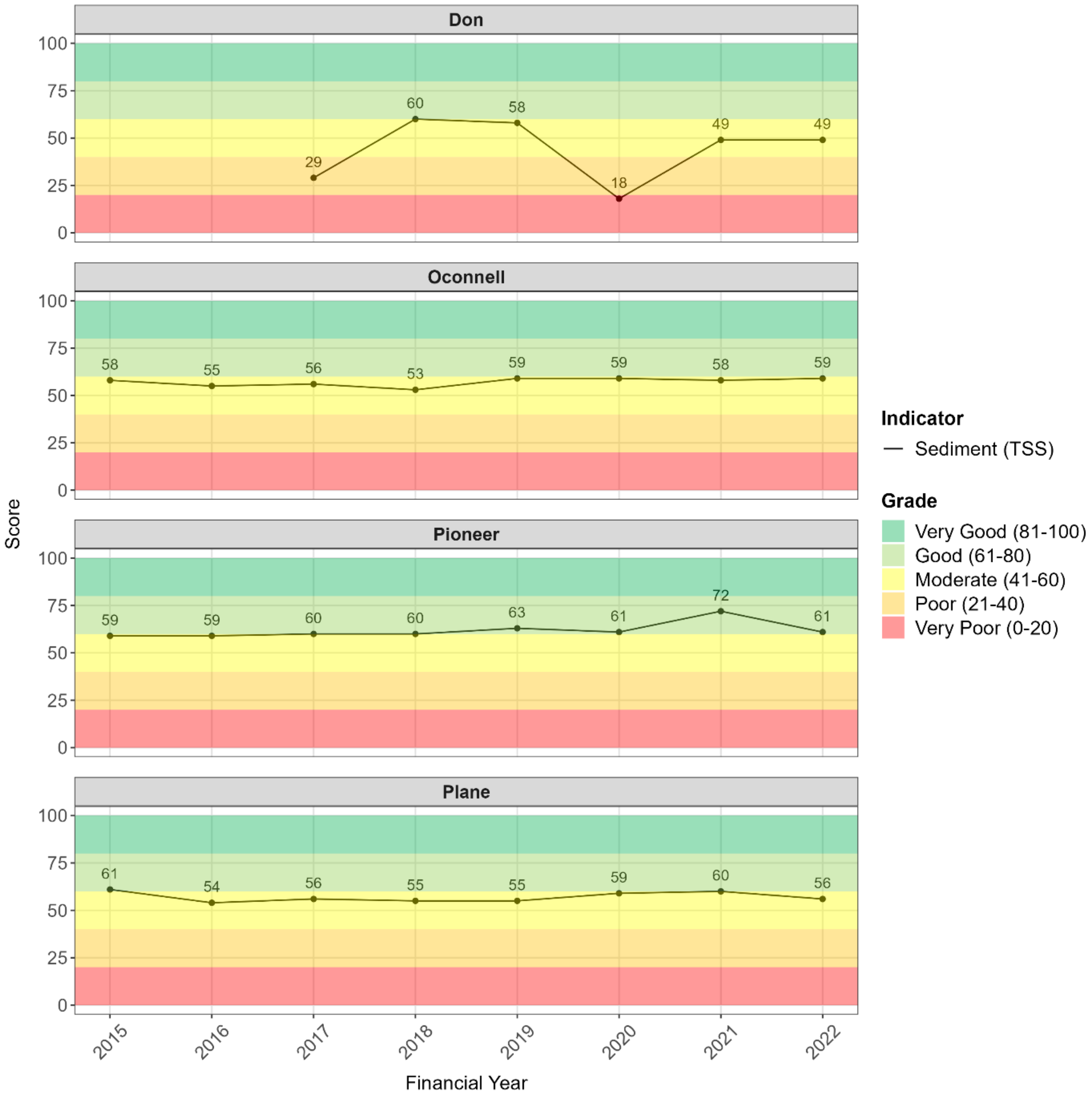


Figure 12. Results for the sediment indicator category (based on a measure of TSS) for water quality in freshwater basins for the 2022 Report Card (2021–22 data) in comparison to 2015–2021 scores. Scores from 2018 onwards include combined additional sites in the O'Connell and Plane Basins.

2.1.2 Nutrients

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

Results (Table 7, Figure 13, Figure 14, Appendix 8.2.3)

Table 7. Results for DIN and FRP indicators and overall nutrients indicator category scores for water quality in freshwater basins for the 2022 Report Card (2021–22 data).

Freshwater Basin	2022 Report Card		
	DIN	FRP	Nutrients
Don	24	40	32
Proserpine^			
O'Connell	61	59	60
Pioneer	58	59	58
Plane	39	9	24

■ 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 were the same in both the Pioneer and Plane Basins in the current year compared to the previous reporting period.
2) O'Connell Basin declined from 'good' (66) to 'moderate' (60) due to declines in both FRP and DIN.
3) The Don Basin declined from 'moderate' (48) to 'poor' (32) largely due to a decrease in DIN scores (47 to 24), although this was likely due to the restricted period of sampling due to lack of surface flow outside of major rain events.

2.1.2.1 Filterable Reactive Phosphorus (FRP)

FRP scores declined in the Don (moderate 49 to poor 39), O'Connell (good 65 to moderate 59), and Plane (moderate 49 to very poor 9) Basins.

FRP in Plane: FRP decline was due to scores decline in both monitored locations, at the Sandy Creek site from 45 to 2 and the Sucrogen Weir site from 60 to 33. Monthly medians for FRP at the Sandy Creek site failed to meet the guideline value for all months in the 2021–22 reporting period. The lower FRP grade in Sandy Creek compared to the neighbouring Plane Creek is likely reflective of relevant land use differences within these catchments. High concentrations of FRP may be related to runoff from mill mud applications on pasture or plant cane, where the planting season and harvest were later than usual (P. Trendell, pers. comm. 28/04/23). The highest values recorded at Sucrogen Weir coincide with rainfall events in late November 2022 associated with the first flush of the wet season (C. Bueno, pers. comm. 28/04/2023). The Sandy Creek site recorded relatively 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).

2.1.2.2 Dissolved Inorganic Nitrogen (DIN)

DIN remains an indicator of concern for the MWI Region. All monitored basins in the region were graded 'moderate' or 'poor' in the 2021–22 reporting period. This indicates that none of the annual medians for DIN in those basins met the relevant guidelines for the protection of environmental values in the 2021–22 reporting period.

DIN in Pioneer: For the third consecutive year, an improvement in the score for DIN was evident in the Pioneer Basin, increasing from 41 in 2019–20 to 52 in the previous reporting cycle, and 58 in the current reporting cycle (Table 7). The 2022 Report Card DIN score (58) is the highest yet recorded in the Pioneer, and the first time the basin has consecutively improved in score over three report cards. Monthly median concentrations in the basin exceeded guideline values for most of the year, however, exceedances for this indicator were not as high as in previous years.

DIN in O'Connell: The O'Connell Basin declined from 'good' (67) to 'moderate' (60). In the upper catchment (Stafford's Crossing), dominant guideline value exceedances occurred in November and December 2021, while in the lower catchment dominant exceedances occurred in December 2021 – January 2022, and following late wet season events from March – May 2022.

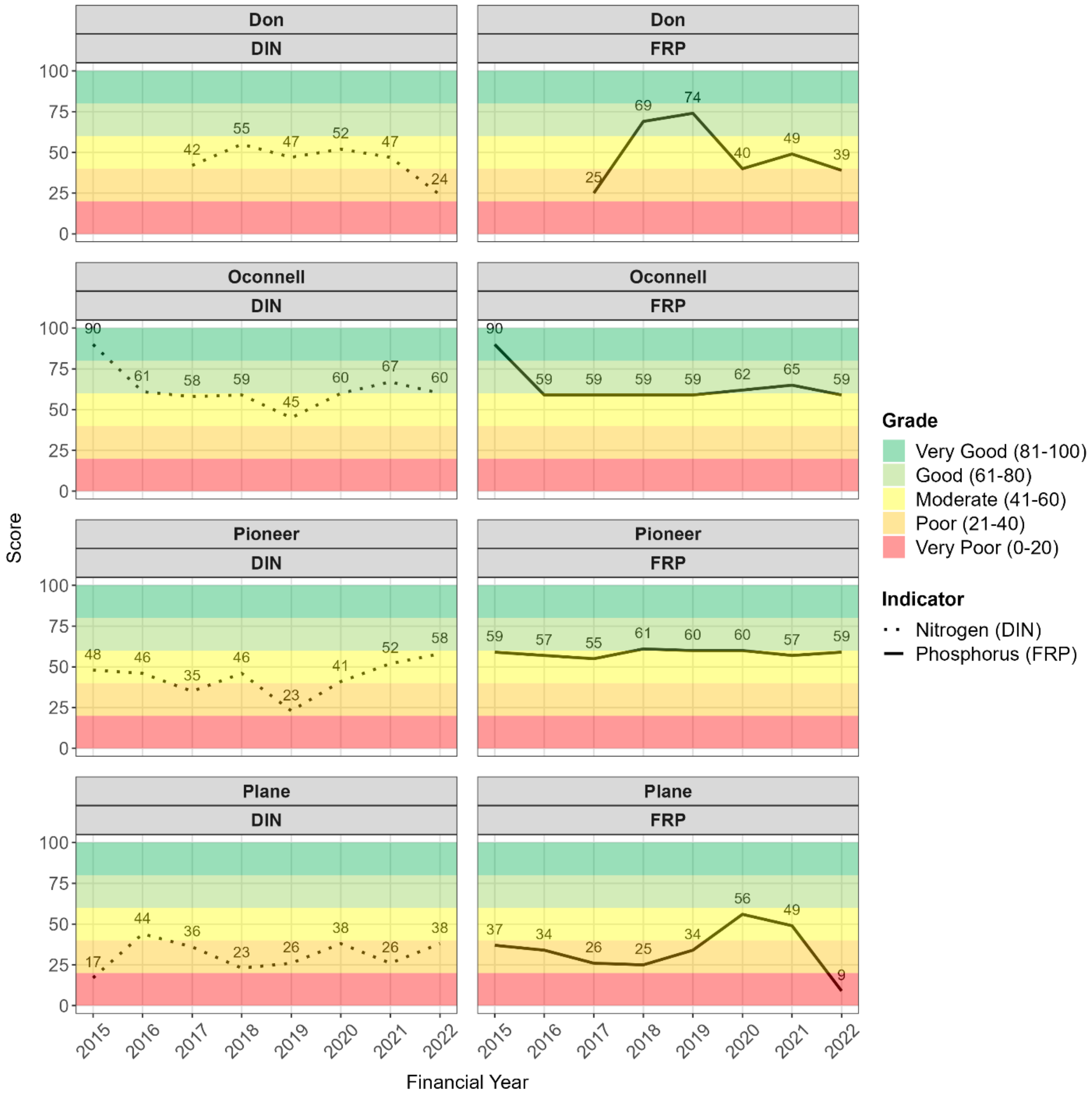


Figure 13. Nutrients indicator scores per Basin, 2022 and historic record.

DIN in Plane: Scores improved in the Plane Basin from 26 to 39 yet remained 'poor'. Improvement was due to decline in DIN concentrations at the Sandy Creek monitoring site. Separate from any other basin site in the MWI Region, DIN guideline value exceedances for Sandy Creek in the 2021–22 year occurred in every month bar October. The four highest monthly median concentrations of DIN occurred during the dry season (July – September 2021 and June 2022). The pattern of Sandy Creek receiving a lower DIN grade than the nearby Plane Creek over multiple years (Section 7.2.3) reflects a higher proportion of intensive land use practices in the Sandy Creek catchment.

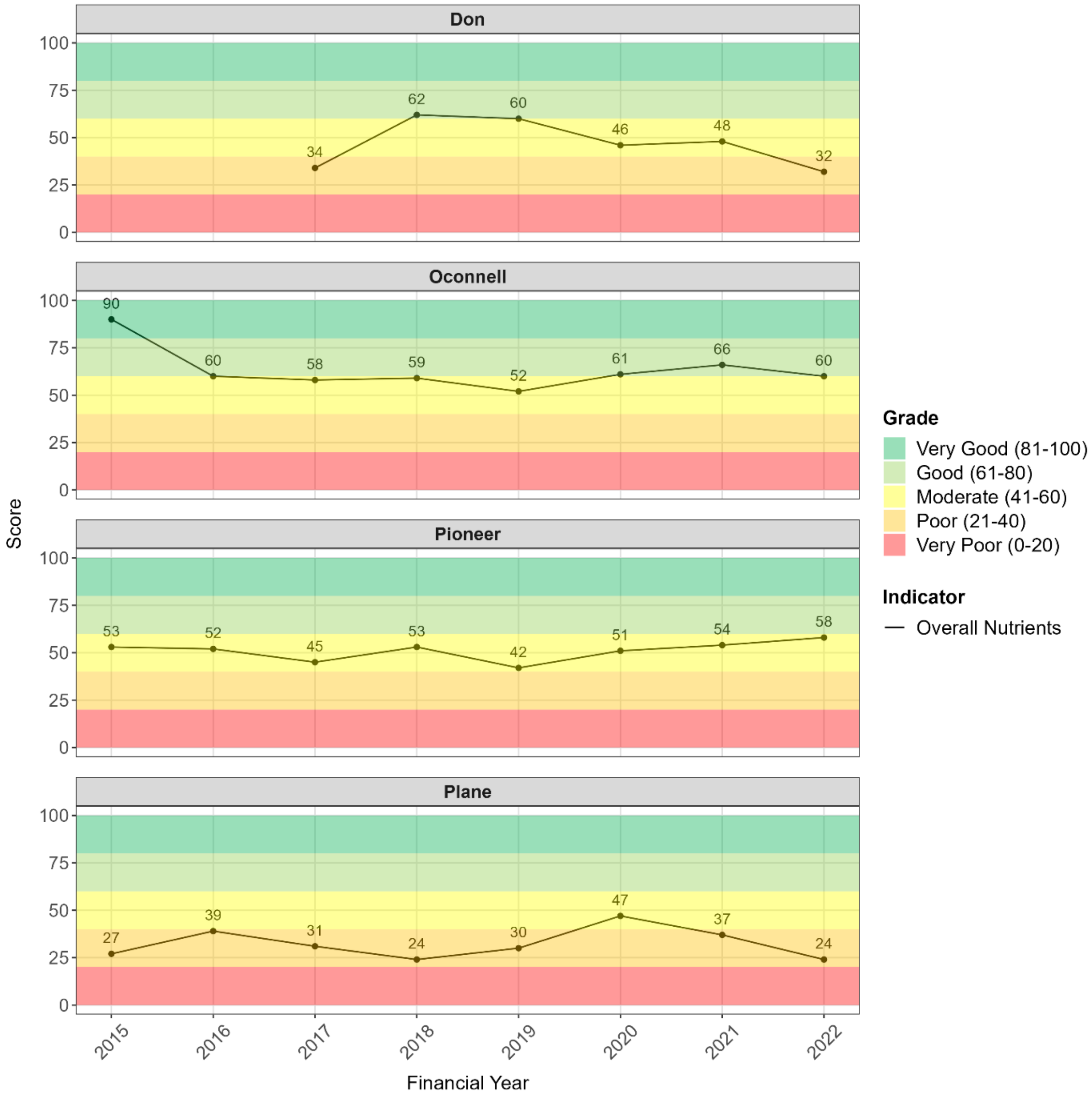


Figure 14. Results for overall nutrients indicator category scores for water quality in freshwater basins for the 2022 Report Card (2021–22 data) in comparison to 2015–2021 Report Card scores. Scores from 2018 onwards are derived from results obtained at additional sites in the O'Connell and Plane Basins. 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) approach. This approach quantifies the ecological risk associated with exposure to a mixture of pesticides. Measured concentrations of up to 22 different pesticides in each sample are converted to a PRM that expresses risk as the percent of aquatic species that may be adversely affected by a mixture of pesticides. For further information on the methodology adopted for the calculation of the PRM, refer to the Methods Report[3]. The PRM can be used to estimate the risk to aquatic ecosystem, and for this it is expressed as the percentage of species protected, and it can also be used to estimate the proportional contribution of individual pesticides.

Results (Table 8, Figure 15, Figure 16)

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 2022 Report Card.

Pesticides	2022 Report Card	
Freshwater Basin	**PRM (% species Protected)**	**Standardised Pesticide Score**
Don	88	37
Proserpine	65	17
O'Connell	90	41
Pioneer	86	33
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, diuron, and metsulfuron-methyl were the key contributors to the overall pesticide risk across basins in the region. Variation in the pesticide risk profile across the region reflects relevant land-use applications; specifically, the Don Basin is dominated by horticultural crops as opposed to sugarcane farming in the other basins.

2) Overall, pesticides remained the poorest scoring indicator for basin water quality in the MWI region in the 2021–22 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 six 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 included Metalachlor, Imazapic, and Atrazine.

The **Pioneer and O'Connell Basins** both improved, from 'very poor' (20) to 'poor' (32) and 'poor' (35) to 'moderate' (41) respectively. Imidacloprid and Diuron were the biggest contributors to this change. Imidacloprid levels were similar in both, while Diuron concentrations were larger in the Pioneer Basin.

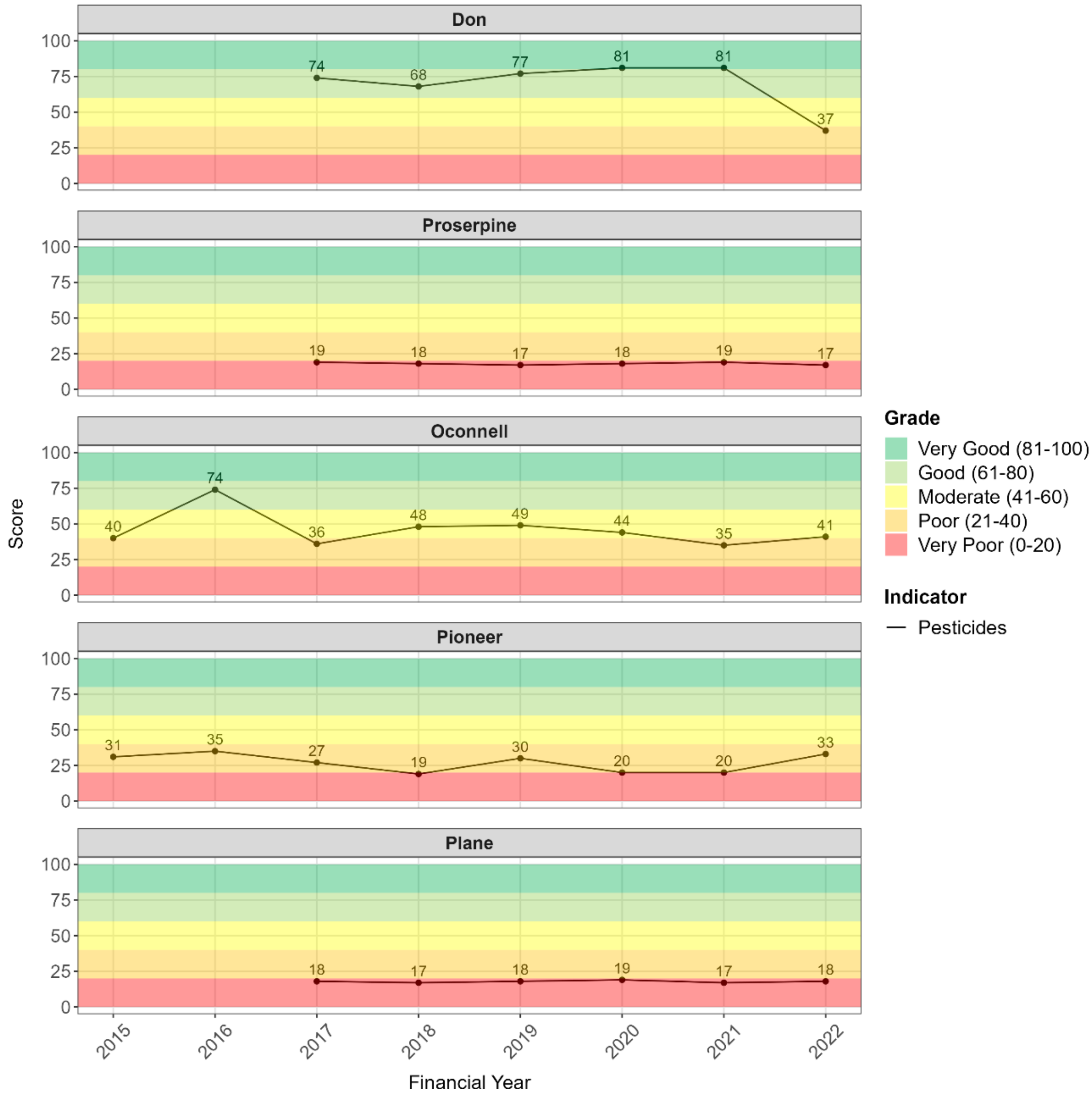


Figure 15. Results for the Pesticide indicator (accounting for 22 pesticides) for freshwater basins in the 2022 Report Card compared to the historic record. Pesticides scores in 2017 have been back-calculated to incorporate changes in the methods that occurred for the first time in the 2018 Report Card. Since 2021, O'Connell Basin grades include data from one monitoring site (Caravan Park), whereas previous years have incorporated data from an upstream site (Stafford's Creek).

The **Don Basin** declined from 'very good' (81) to 'poor' (37). This is the first year that the Don has scored below the guideline value for this indicator and decline was associated with concentrations of metsulfuron-methyl, an application associated with urban/industrial use. 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). Metalochlor and Atrazine, associated with horticulture and sugarcane, were also detected at levels that pose risk to aquatic species.

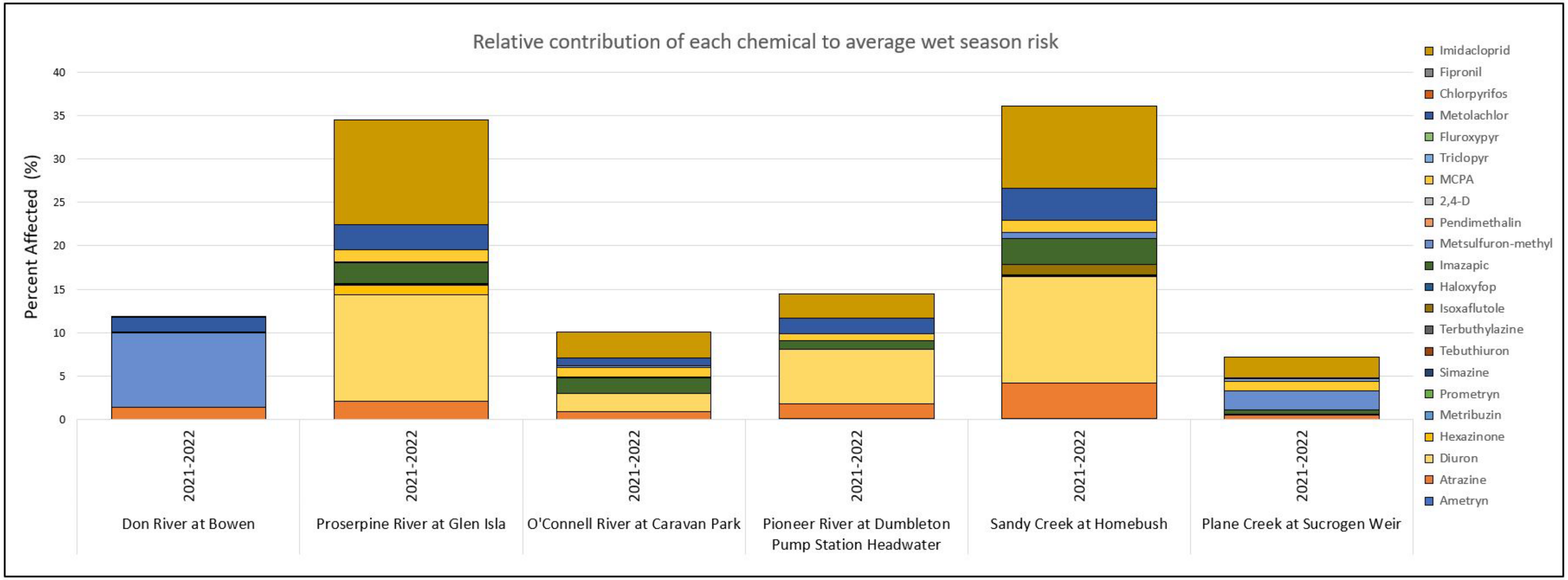


Figure 16. The proportional contribution of each chemical to the final Pesticide Risk Metric (PRM) score, for the 2021–22 reporting year. In this instance, the PRM is expressed as the % species affected fraction. Source: QLD Government, GBR CLMP.

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 17)

Table 9. Results for water quality indicator categories and final water quality index scores in freshwater basins for the 2022 Report Card (2021–22 data).

Freshwater Basin	2022 Report Card			
	Sediment	Nutrients	Pesticides	Water Quality Index
Don	50	33	37	**40**
Proserpine			17	
O'Connell	57	58	41	**52**
Pioneer	61	59	33	**51**
Plane	56	24	18	**33**

■ 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) In the 2022 Report Card, most regional basins received the same water quality grade as in the previous monitoring period, apart from the Don Basin, which declined from 'moderate' (58) to 'poor' (40), largely due to decline in pesticides scores. This is the lowest recorded score in the Don Basin since the Report Card's inception.

2) This is the sixth consecutive year that scores for water quality have not met the desired criteria in the O'Connell Basin, and the ninth year in the Pioneer and Plane basins.

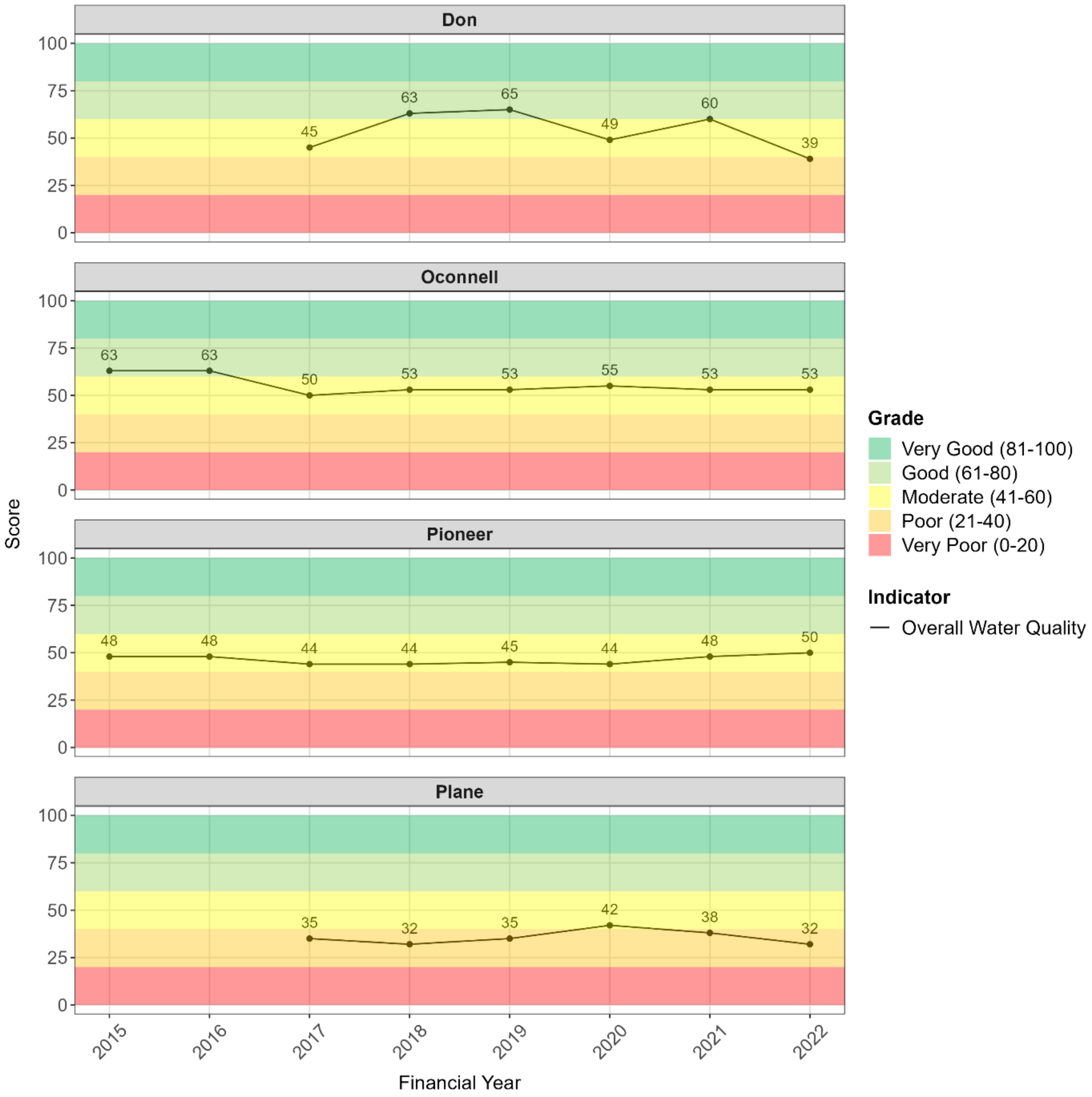


Figure 17. Results for water quality indicator categories and overall index scores in freshwater basins for the 2022 Report Card (2021-22 data) in comparison to 2015 - 2021 Report Cards. Scores from 2017 have been back-calculated to incorporate updates to freshwater pesticides made in the 2018 Report Card, however 2016-2014 have not been back-calculated. Scores in 2017 do not incorporate additional sites that were included for the first time in the 2018 Report Card.

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.

Confidence in water quality scores for 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 low spatial representativeness of the monitoring program. However, this was changed to 'low' for pesticide monitoring due to decreased 'directness' and 'maturity of the methodology'. In addition, 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.

Table 10. Confidence associated with water quality index results in freshwater basins in the 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	1	2	1 [0.5]	2	2	6.6 [5.6]	2 [1]
Water Quality Index						**8.1 [7.1]**	**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: three indicator categories (in-stream habitat modification, riparian extent, and wetland extent), which are updated every three to four years, and flow, which is updated annually.

2.2.1 In-stream Habitat Modification

The in-stream habitat modification indicator category comprises two sub-categories: fish barriers and impoundment, which are updated every four years. The results here for fish barriers were last updated in the 2019 Report Card. A recent assessment on fish barriers for the MWI region was conducted in 2021 (Power et al., 2022) and will be incorporated into the 2023 Report Card when the fish barriers indicator is reassessed. Impoundment length has been updated for the 2022 Report Card.

2.2.1.1 Fish Barriers

The fish barrier index is based on an assessment of three indicators: 'barrier density', 'proportion of stream length to the first barrier', and 'proportion of stream length to the first low/no passability barrier'. Freshwater basins ranged from 'poor' to 'good' for this indicator.

Results (2018-19 data, Table 11)

Table 11. Results for fish barrier indicators in freshwater basins in the 2022 Report Card (2018–19 data) compared to the 2018 Report Card (2014–15 data). Indicators were assessed on Stream Orders (SO) ≥3 or ≥4 as indicated. Scoring ranges and corresponding grades for specific metrics are presented below the scores.

Freshwater Basin	2022 Report Card								2018
	Barrier Density		Stream to the 1st Barrier		Stream to the 1st Low "Passability" Barrier		Fish Barriers		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)	Fish barriers (standardised)
Don	18.2	5	44.3	3	93.0	4	12	70	60
Proserpine	2.7	2	38.5	3	63.9	3	8	41	50
O'Connell	5.5	3	41.7	3	85.3	4	10	60	60
Pioneer	5.6	3	0.1	1	0.5	1	5	21	21
Plane	2.4	2	27.9	2	70.5	4	8	41	41

Scoring ranges and grades for each metric

Metric	Very Poor	Poor	Moderate	Good	Very Good	
Barrier Density	0-2 km (1)	>2 – 4 km (2)	>4 – 8 km (3)	>8 – 16km (4)	>16 km (5)	No data
% of Stream Before 1st Barrier	0 - <10% (1)	10 – 30% (2)	30 – 50% (3)	50 – 100% (4)	100% (5)	
% of Stream to 1st Low "Passability" Barrier	0 - 50% (1)	>50 – 60% (2)	>60 – 70% (3)	>70 – 95% (4)	>95% (5)	
Total Score	3 - 4	5 - 7	8 – 10	11 – 13	14 – 15	
Fish Barriers (standardised)	0 - 20	21 - 40	41 – 60	61 – 80	81 - 100	

Key Messages:

1) The Don and O'Connell Basins recorded higher fish barrier grades ('good' and 'moderate', respectively) compared to the Proserpine Basin and southern freshwater basins of the Plane and Pioneer, which graded 'moderate' and 'poor', respectively.
2) The Proserpine, Pioneer, and Plane freshwater basins are home to large population centres in the region (Proserpine, Mackay, and Sarina, respectively), 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.

Weirs: Many of the low passability barriers are weirs. The impacts of these structures are particularly pronounced in the Pioneer Basin, which was graded 'very poor' for the 'proportion of stream length to the first low/no passability barrier' indicator (T. Power, pers. Comms., 29/04/2020). These factors also contributed to the declined barrier condition grades in the Proserpine, Pioneer, and Plane freshwater basins (Moore, 2016).

Fish barrier field validation: Several potential fish barriers were reclassified in the Don and Proserpine Basins following a 2019 field validation, as it was determined they did not impede fish passage. In the **Don Basin**, this review resulted in an improved fish barrier score. These findings are encouraging, as the freshwater streams of the Don Basin are ephemeral in nature; they are 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). In the **Proserpine Basin**, although there were some barrier reclassifications that were improved, the overall grade declined from 'good' to 'moderate', as a large low passability barrier was identified close to the estuarine interface. This dam, created to impound water for irrigation, blocks connectivity to a large proportion (>60%) of the Proserpine River.

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. Basins within the MWI region scored between ‘poor’ to ‘very good’ for this indicator (Table 12).

Results (Table 12)

Table 12. Results for the impounded stream indicator in freshwater basins in the 2021 22 Report Card.

Freshwater Basin	Not Impounded (km)	Impounded (km)	Total (km)	% Total	Standardised Impoundment
Don	954	0	954	0.0	**100**
Proserpine	524	41	565	7.3	**39**
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) The Proserpine is the only basin to record a grade change (from ‘moderate’ to ‘poor’) in impoundment length since the initial assessment in 2015. This indicates that there has been little change in the net proportion of ponded channel habitat within each basin since the Report Card’s inception.
2) Most basins remained the same in 2021-22 as in the most recent (2018) assessment, apart from the O’Connell which recorded a minor change in impoundment length (70 to 72). This update was due to an illegal sand dam that had been removed and the grade remained ‘good’.

A permitted sand dam on the **Proserpine River**, impounding approximately 4km of linear stream length, was incorporated in the impoundment assessment for the first time in the 2018 Report Card. The presence of this sand dam was of concern, as water impoundment may result in an extended inundation of riparian vegetation, contributing to potential increased erosion if submerged vegetation dies. This impoundment may also affect the efficacy of the fishway, which enables migratory fish to travel upstream. The inclusion of the sand dam shifted scores in the Proserpine Basin from ‘moderate’ (43) to ‘poor’ (39).

The **Pioneer Basin** also graded ‘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 condition grade of ‘very good’.

2.2.1.3 In-stream Habitat Modification Indicator Category

The impoundment and fish barrier indicators are aggregated to form the in-stream habitat modification indicator category. As highlighted above, fish barrier scores for the 2022 Report Card are based on repeat data (2018–19), while impoundment length has been updated for the current reporting cycle.

Results (Table 13)

Table 13. Results for the in-stream habitat modification indicator category in freshwater basins for the 2021 22 Report Card compared to 2018.

Freshwater Basin	2022 Report Card			2018
	Impoundment	Fish Barriers	In-stream Habitat Modification	In-stream Habitat Modification
Don	100	70	**85**	**80**
Proserpine	39	41	**40**	**44**
O'Connell	72	60	**66**	**65**
Pioneer	22	21	**21**	**21**
Plane	60	41	**50**	**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) There were no changes to the in-stream habitat modification grades for the Pioneer, and Plane, which were graded as ‘poor’, and ‘moderate’, respectively.
2) The in-stream habitat modification grade changed from ‘good’ to ‘very good’ in the Don Basin between 2017–18 and 2018–19, owing to improvements in the condition of the fish barrier indicator, which shifted from a ‘moderate’ to ‘good’ grade in the most recent assessment.
3) Conversely, there was a decline observed in the aggregated score for the Proserpine Basin, owing to reductions in the condition of the fish barrier indicator.

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)

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 2022 Report Card (2013–14 data), which should be noted when interpreting these results.

Riparian extent: The riparian extent indicator is updated in broad accordance with mapping updates produced by the Remote Sensing Centre, Department of Environment and Science (DES). Consequently, the reporting frequency period is generally every four years. However, the data collected in 2017 is subject to considerable change, including amendments to the satellite imagery and data processing, to improve the resolution and accuracy of vegetation mapping. The updated mapping is scheduled to be released after the development of the 2022 Report Card. Additionally, revised mapping and methods for calculating riparian extent will need to be reviewed by the regional report cards' Technical Working Group (TWG) to ensure that they are suitable for reporting here. 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 14)

Key Messages:

1) Wetland extent grades ranged from 'very good' in the Don Basin[21], to 'very poor' in the O'Connell and Plane Basins.
2) Although no natural or modified wetlands have been lost since the previous assessment, 'poor' and 'very poor' scores 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.

[21] This is a somewhat false representation masking the losses of converted estuarine wetlands and significant losses of freshwater wetlands in other locations.

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.[22] 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.

Table 14. Results showing % of riparian and wetland extent loss compared to pre-clearing conditions for the 2021 22 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	2022 Report Card					2022 Report Card	
	Wetland extent		Riparian extent				
	Hectares lost since pre-development	% loss since pre-development	Hectares lost since pre-development	% loss since pre-development		Standardised Wetland Extent	Standardised Riparian Extent
Don	0*	-3*		29		100	41
Proserpine	848	15		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).

[22] 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 18). 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 (B. Cockayne, pers. comms., 22/04/2020).

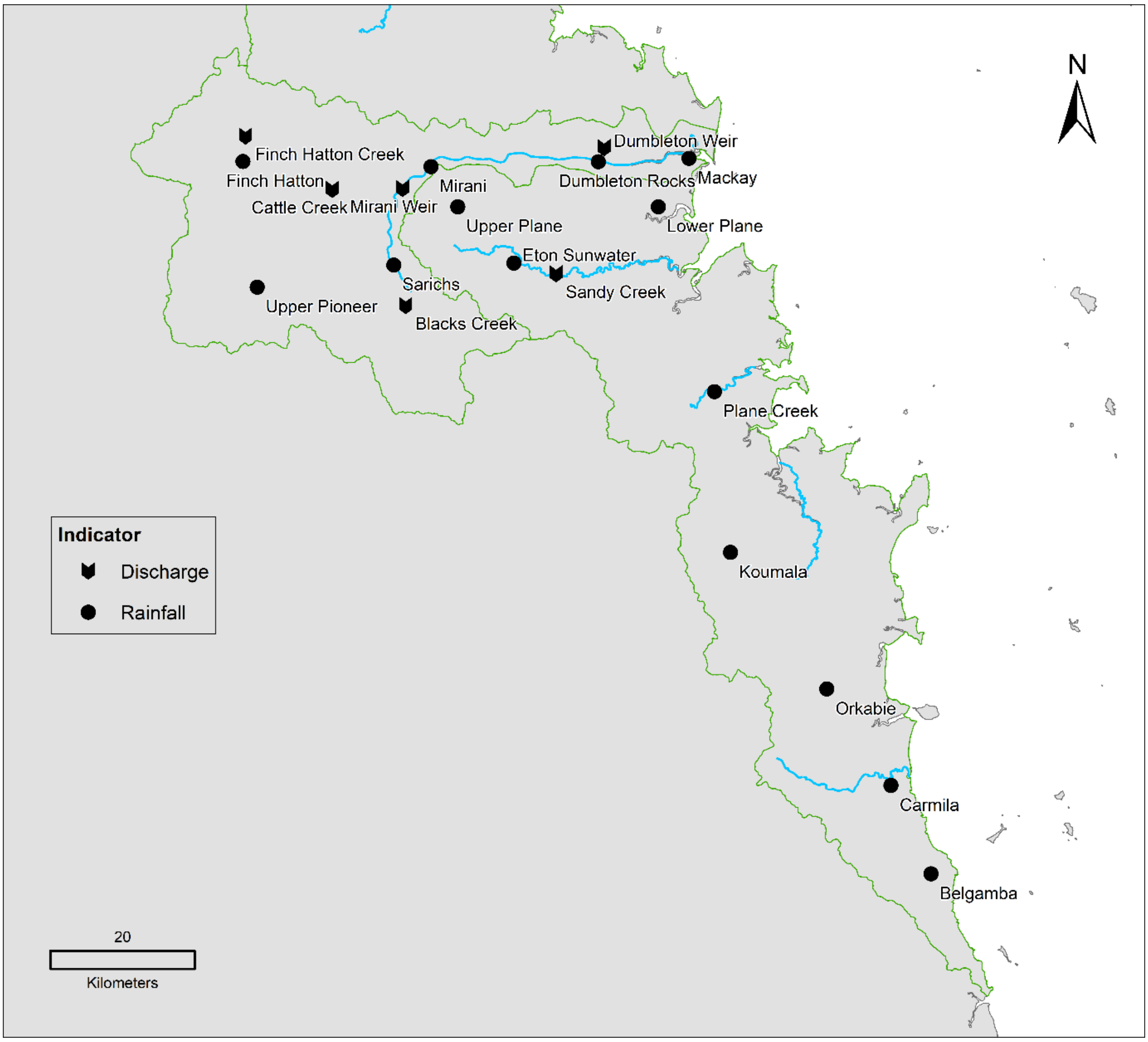


Figure 18. Sampling locations for flow monitoring in the MWI region Pioneer and Plane Basins for the 2022 Report Card. Flow rainfall data provided by the Bureau of Meteorology (BoM) and the QLD SILO database. Flow discharge data provided by the Queensland Department of Regional Development, Manufacturing and Water (DRDMW).

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. Work is currently being undertaken to fill these data gaps and is currently progressing in collaboration with the TWG and BoM. Information on the methods employed for the flow indicator are available in the Methods Report.

Notes on data interpretation for 2022 Report Card results

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 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).

Results (Table 15, Appendix 8.2.2)

Table 15. Results for the flow indicator for freshwater basins for the 2022 Report Card and the climate type based on average rainfall, as compared to the 2018–2021 Report Cards.

Freshwater Basin	2022		2021		2020		2019		2018	
	Climate	Score	Climate	Score	Climate	Score	Climate	Score	Climate	Score
Don^										
Proserpine^										
O'Connell*									Dry	78
Pioneer	Dry	55	Drought	45	Dry	49	Average	72	Drought	66
Plane	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' (61) in the Plane Basin with no change from the previous reporting year.
2) The Pioneer Basin remained moderate with a score increase (from 45 to 55). Grade changes in the flow indicator potentially reflect changes in agricultural water use.

Monitoring sites: The Pioneer Basin flow score was assessed from five stream gauging stations (with individual stations grading 'moderate' to 'good'). Flow in the Plane Basin was based on one monitoring location which received a 'good' grade (61) (Appendix 8.2.2).

Climate: The climate type for 2021–2022 was classed as dry for both the Plane and Pioneer Basins using the flow indicator tool (Table 15). Conditions were particularly dry in Pioneer Basin during June 2022, and in Plane Basin during both February and June 2022 with rainfall average 'very much below' average during this period (AWO data, Table 4). Both basins however, had 'very much above average' rainfall in May 2022 and additionally in August and November 2021 in Plane Basin. The annual average was classed as 'below' the long-term average annual rainfall for those basins, as calculated by both the flow indicator tool and AWO (Table 15, Table 4).

2.2.4 Habitat and Hydrology Index Scores

The overall habitat and hydrology index grades for basins in the 2022 Report Card ranged from 'poor' to 'good' across the MWI Region, the same as in the previous two reporting periods. Updates in the current reporting cycle include flow in the Pioneer and Plane basins, and impoundment length in the O'Connell Basin. These scores include repeat data (e.g., riparian extent from 2013–14 and wetland extent from 2018–19), and do not fully capture changes in conditions associated with major weather events (including TC Debbie) or potential anthropogenic impacts which may have occurred.

Results (Table 16, Table 17)

Table 16. Results for habitat and hydrology indicator categories and the aggregated index in freshwater basins in the 2022 Report Card. In-steam habitat modification and Flow use data from this reporting period, all others have been repeated from previous years.

Freshwater Basin	2022 Report Card				
	In-stream habitat modification	Flow	Riparian Extent	Wetland Extent	Habitat and Hydrology Index
Don	85		41	100	75
Proserpine	40		50	59	50
O'Connell	66		51	14	43
Pioneer	21	55	54	12	36
Plane	50	61	41	23	44

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

Table 17. Results for habitat and hydrology indicator categories and the aggregated index in freshwater basins in the 2022 Report Card compared to the 2017–2021 Report Cards.

Freshwater Basin	2022	2021	2020	2019	*2018	*2017
	Habitat and Hydrology Index					
Don	**75**	**75**	75	75	73	73
Proserpine	**50**	**50**	50	50	51	52
O'Connell	**43**	**43**	43	43	52	43
Pioneer	**36**	**38**	34	40	38	29
Plane	**44**	**44**	39	37	38	38

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

* Scores have been back-calculated to incorporate changes associated with refinements to the source mapping used to assess wetland extent in 2019.

2.2.4.1 Confidence

Overall confidence for the habitat and hydrology indicator category was 'moderate' (Table 18).

Table 18. Confidence associated with habitat and hydrology index results in freshwater basins for the 2021 2022 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 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 with all basins scoring within guideline values.

Notes on data interpretation for 2022 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 (see Methods Report).

Reporting lag: When interpreting the results from this index, please note that the most recent assessment (first published in the 2021 Report Card) took place in September–October 2020, while the previous assessment took place in 2017.

Species richness vs. health: At face value, 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, it is important to note that the fish and pesticide grades for the region represent two quite different measures and should not be compared. For example, fish grades strictly represent the *species richness*, rather than the *abundance* or *health* of fish within each waterway.[23]

Individual site conditions: Due to the nature of how the fish indicator is calculated, there was variation for these indicators (mainly for POISE) both within sites and across the MWI Region (Figure 19, Figure 20). For example, there were sites in each basin for the POISE indicator that fell into the 'poor' grading range. As we calculate our grades based on the median of site-level scores, the overall fish index grades do not necessarily reflect the condition of individual sites.

Interpreting grades: We report against reference condition guideline values for each indicator (see Methods document) with discrete ranges, allowing us to capture broad indicator condition trends over time. However, this also 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.

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

Results (2020-21 data, Table 19, Figure 19, Figure 20)

Table 19. Results for fish indicators in freshwater basins in the 2021 2022 Report Card (2020–21 data) compared to the 2020 Report Card (2017–18 data) and the 2017 Report Card (2014–15 data).

	2022 Report Card			2020*	2017*
Basin	Proportion of Indigenous Fish Richness (POISE)	Proportion of Non-Indigenous Fish	Fish Index	Fish Index	Fish Index
Don	76	100	**88**		
Proserpine	74	86	**80**	79	
O'Connell	69	98	**83**	**92**	**65**
Pioneer	64	87	**75**	**82**	**48**
Plane	60	86	**73**	**79**	**79**

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

*Scores are based on a superseded methodology and are not directly comparable.

Key Messages:

1) Overall, the fish index recorded the same grade as in the previous assessment for three of the region's basins (Proserpine, O'Connell, and Plane Basins). The Pioneer Basin recorded a grade decline, shifting from 'very good' (82) in the previous assessment to 'good' (75).

2) The Don Basin was included in the fish index assessment for the first time and received the highest grade of any basin in the region ('very good' (88)).

3) The proportion of alien (pest) fish in catches (samples) were graded as 'very good' across all the basins assessed for the second assessment in a row. This means that the median proportion of catches for pest fish comprised less than 3% of fish recorded during the assessment.

4) Native fish species richness reported between 'moderate' to 'good' grades for all basins in the region with three basins (Proserpine, Pioneer, and Plane) reporting the same grade as in the previous assessment. The O'Connell declined from a 'very good' (84) grade to a 'good' (69) grade.

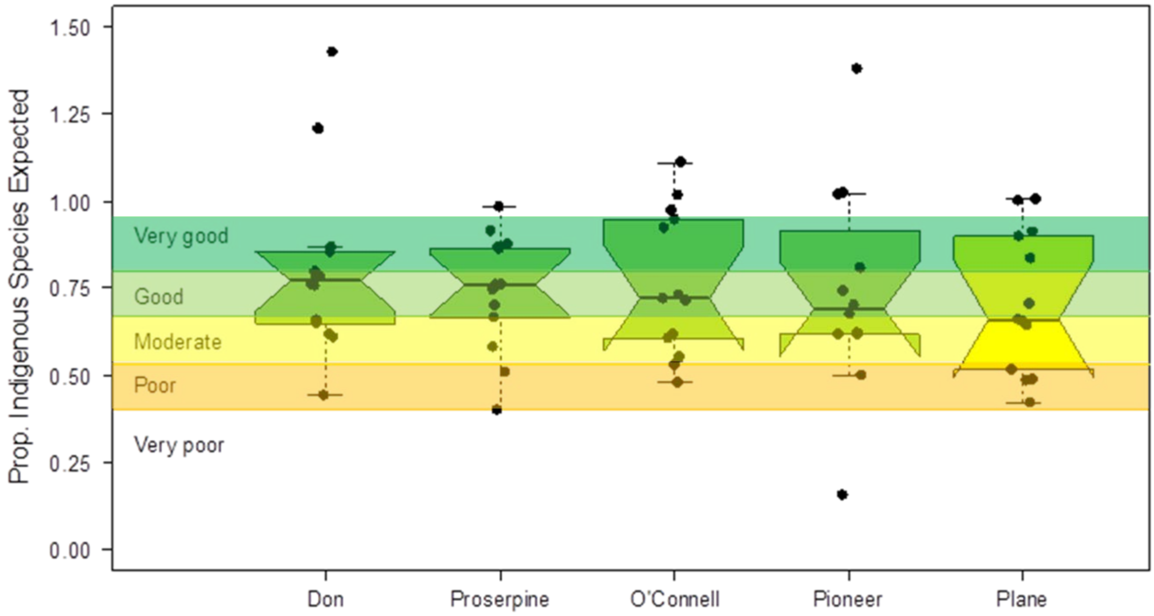


Figure 19. Distribution of the median proportion of indigenous species expected (POISE) for freshwater fish, showing the variability amongst sites within each basin of the MWI region. Coloured bands indicate the range of values that fall within each grade zone. The median value is represented by a horizontal 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.

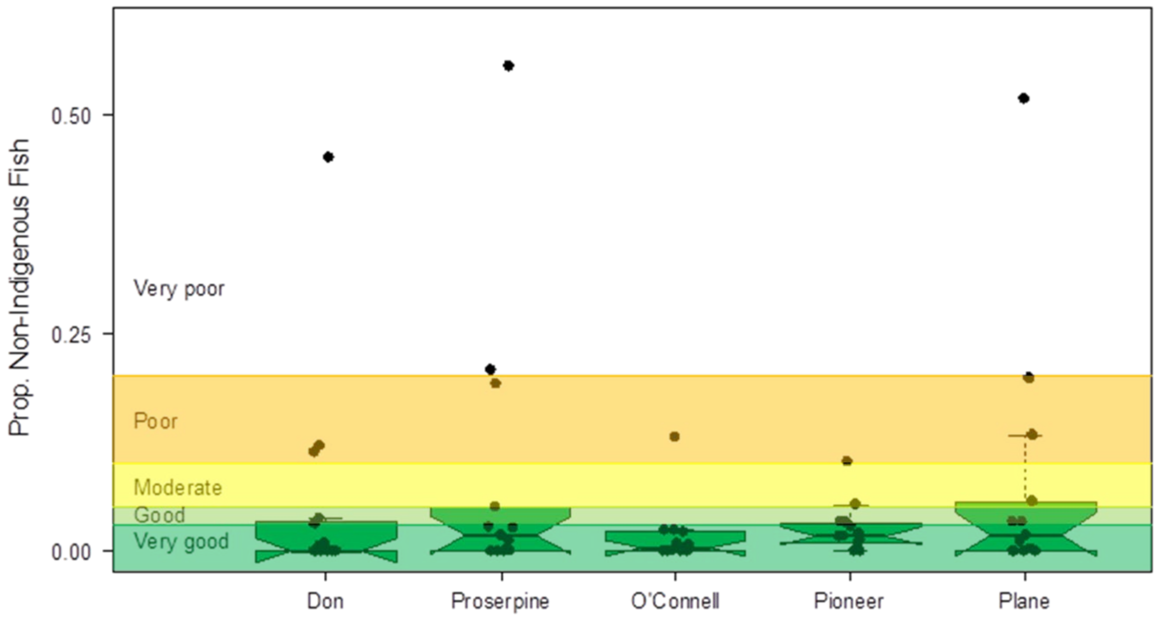


Figure 20. Distribution of the median proportion of non-indigenous (PONI) freshwater fish species, showing the variability amongst sites within each basin of the MWI region. Coloured bands indicate the range of values that fall within each grade zone. The median value is represented by a horizontal black 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.

2.3.1 Confidence

Confidence associated with freshwater fish results was 'moderate' (Table 20).

Table 20. Confidence associated with fish index results in freshwater basins for the 2022 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 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)	1	2	2	3	1	9.0	3
Proportion of Non-Indigenous Fish	1	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 the majority of both the habitat and hydrology and fish indices are based on repeat data, changes to the overall basin scores in the 2022 Report Card are driven primarily by score changes for the water quality index.

Results (Table 21, Table 22)

Table 21. Condition grades and scores of freshwater basins for the 2022 Report Card.

Freshwater Basin	2022 Report Card				
	Water Quality	Habitat and Hydrology	Fish	Basin Score and Grade	
Don	40	75	88	**68**	**B**
Proserpine		50	80	**65**	**B**
O'Connell	51	43	83	**59**	**C**
Pioneer	50	36	75	**54**	**C**
Plane	32	44	73	**50**	**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 overall freshwater basin scores ranged from 'moderate' to 'good'. There were no grade changes in comparison to the previous Report Card. The Don Basin recorded the largest difference in score, declining from 74 to 68, yet remained 'good'. This can largely be attributed to the decline in pesticides score from 'very good' (81) to 'poor' (37).
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.

Table 22. Condition grades and scores of freshwater basins for the 2022 Report Card compared to the historic record.

Freshwater Basin	2022	2021	2020	2019	2018	*2017	^2016	^2015	^2014
	Basin Score								
Don	**68**	**74**	62	71	56	47	48	48	54
Proserpine	**65**	**65**	65	65	66	53	53	53	52
O'Connell	**59**	**60**	63	63	66	54**	58	57	52
Pioneer	**54**	**52**	53	56	54	40	41	41	34
Plane	**50**	**52**	53	51	50	50**	52	51	35

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

*scores have been back-calculated to incorporate updates to freshwater pesticides made in the 2018 Report Card.

**2017–2014 scores do not incorporate additional sites that were included for the first time in the 2018 Report Card.

^2016–2014 scores do not include back-calculated pesticide updates that were established for the 2018 Report Card.

3 Estuary Results

The overall estuary grade is derived from the habitat and hydrology and water quality indices, each comprising a series of indicator categories and indicators (Figure 21). There is no established methodology for the assessment of estuarine fish, therefore no score is reported for this index at this stage. Due to minimal data availability, flow is currently not reported for estuaries. Indicator categories and indicators within two indices, habitat and hydrology and water quality, are reported annually or on four-year cycles (Table 23).

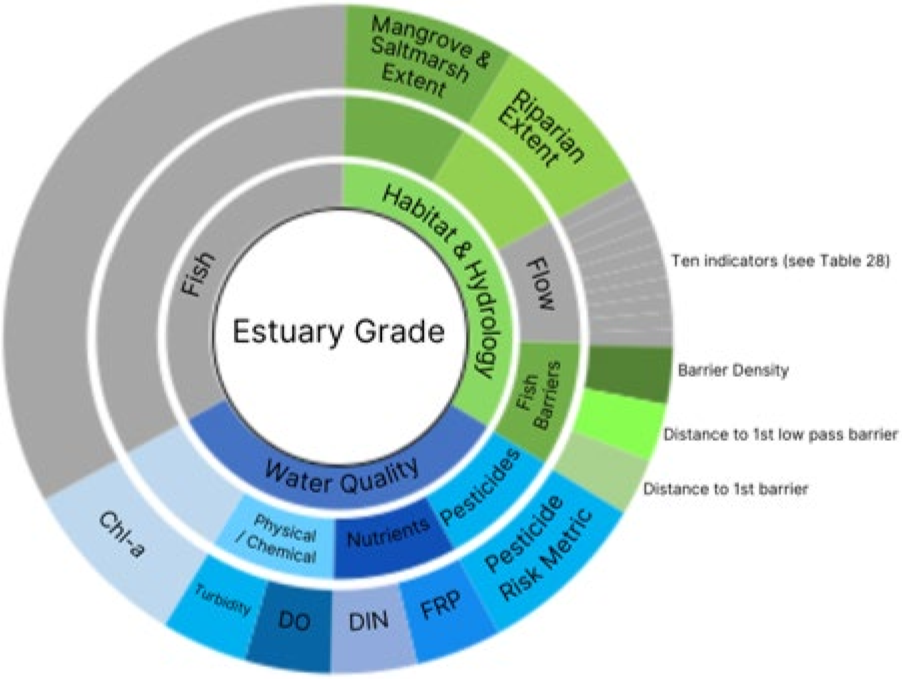


Figure 21. Indicators (outer ring), indicator categories (middle ring) and indices (inner ring) that contribute to overall estuary scores.

Table 23. Frequency of reporting for specific indicator categories and their update status for the 2022 Report Card.

Index	Indicator Categories	Frequency of Reporting	Last Updated
Water Quality	Phys–chem	Annually	**2022**
	Nutrients	Annually	**2022**
	Chlorophyll-*a*	Annually	**2022**
	Pesticides	Annually	**2022**
Habitat and Hydrology	Flow		
	Riparian Vegetation	4 Yearly	**2022**
	Mangrove and Saltmarsh	4 Yearly	**2022**
	Fish Barriers	4 Yearly	**2019**
Fish			

<u>Notes on data interpretation for 2022 Report Card results</u>

Impact of reporting cycle variability: When comparing overall scores and grades between reporting years, it is important to note that differences in scores are largely due to changes in water quality as this indicator category is assessed annually, while habitat and hydrology indicator includes repeat data. In the current reporting cycle, both mangrove/saltmarsh extent and riparian extent have been updated, although fish barriers have not been updated since the 2019 Report Card.

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 22). Indicators used to report on the water quality index in estuaries include DIN, FRP, turbidity, dissolved oxygen (DO), Chlorophyll-*a* (Chl-*a*), and pesticides (which are reported using the PRM). The results for DIN and FRP are aggregated to form the nutrients indicator category, while turbidity and DO are aggregated to form the physical–chemical (phys–chem) indicator category (Figure 21).

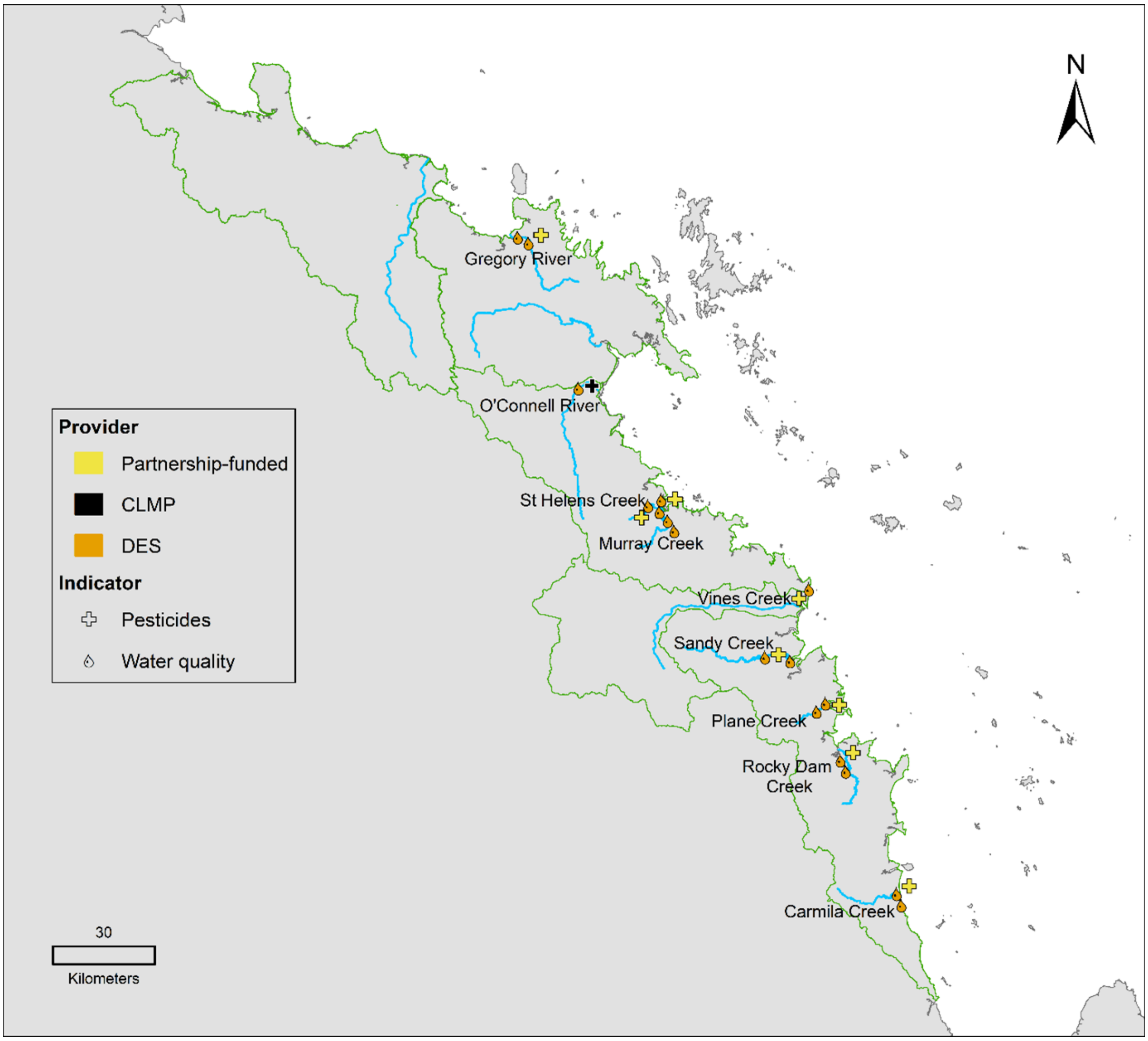


Figure 22. Sample locations for estuary water quality and pesticides monitoring for the MWI region for the 2022 Report Card. Water quality data (including pesticides) provided by the QLD Department of Science (DES); additional pesticide data provided by a Partnership-funded initiative and the CLMP.

Notes on data interpretation for 2022 Report Card results

Sampling regime and climatic variability: When interpreting estuarine water quality grades, it should be noted that all 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). As such, scores in this section may be influenced disproportionately by the timing of meteorological 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 24, Figure 23, Figure 24, Appendix 8.3)**:**

Table 24. Results for DIN and FRP indicators and nutrients indicator category in estuaries for the 2021-22 Report Card.

Estuary	2022 Report Card		
	DIN	FRP	Nutrients
Gregory River	77	90	**83**
O'Connell River^	59	90	**74**
St Helens/Murray Creek	54	81	**67**
Vines Creek	24	74	**49**
Sandy Creek	38	69	**54**
Plane Creek	62	90	**76**
Rocky Dam Creek	40	90	**65**
Carmila Creek	64	90	**77**

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) All estuaries retained the same nutrients grade as in the previous monitoring period, ranging from 'moderate' to 'very good'.
2) All estuaries recorded measurements within their respective annual median guideline values for FRP, with 6 waterways scoring 'very good' (Gregory, O'Connell, Murray/St Helens, Plane, Rocky Dam, and Carmila).
3) DIN grades changed in half of the estuaries. Gregory and Rocky Dam Estuaries decreased ('very good' to 'good' and 'moderate' to 'poor', respectively), while Vines and Carmila Estuaries increased ('very poor' to 'poor' and 'moderate' to 'good', respectively).

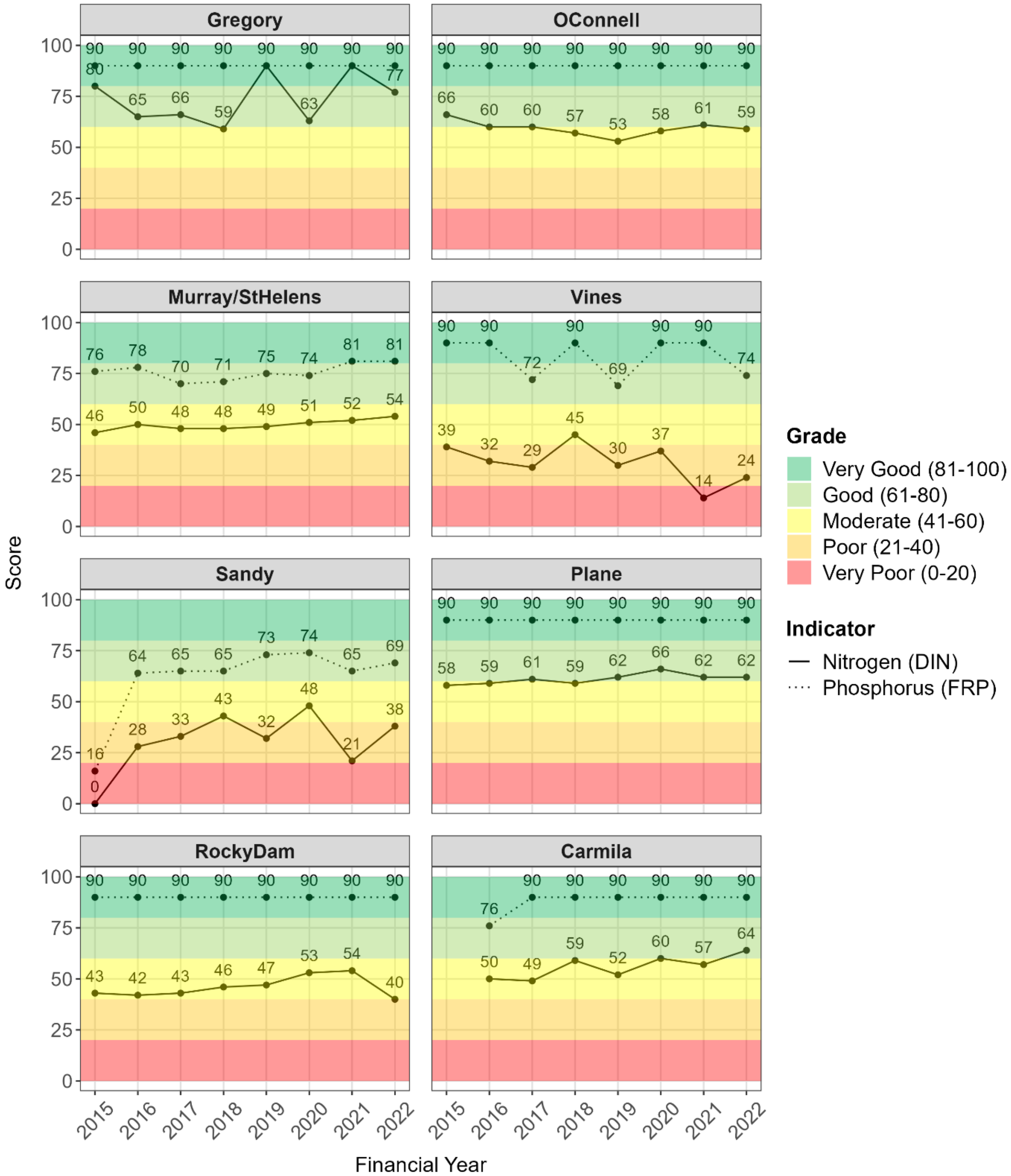


Figure 23. Nutrients indicator scores (DIN and FRP) per estuary, 2022 and historic record.

Gregory River Estuary retained a 'very good' grade in 2022 (the only estuary to do so), despite an increase in monthly median exceedances of the recommended guideline value for DIN, with the only exceedances taking place in February and May of 2022. Although **Sandy Creek Estuary** received a 'moderate' grade for the second year in a row, the score for nutrients improved from 43 to 54 due to improved scores for both DIN and FRP. **Vines Estuary** recorded a grade decrease in FRP (from 'very good' to 'good' balanced by a grade increase in DIN ('very poor' to 'poor').

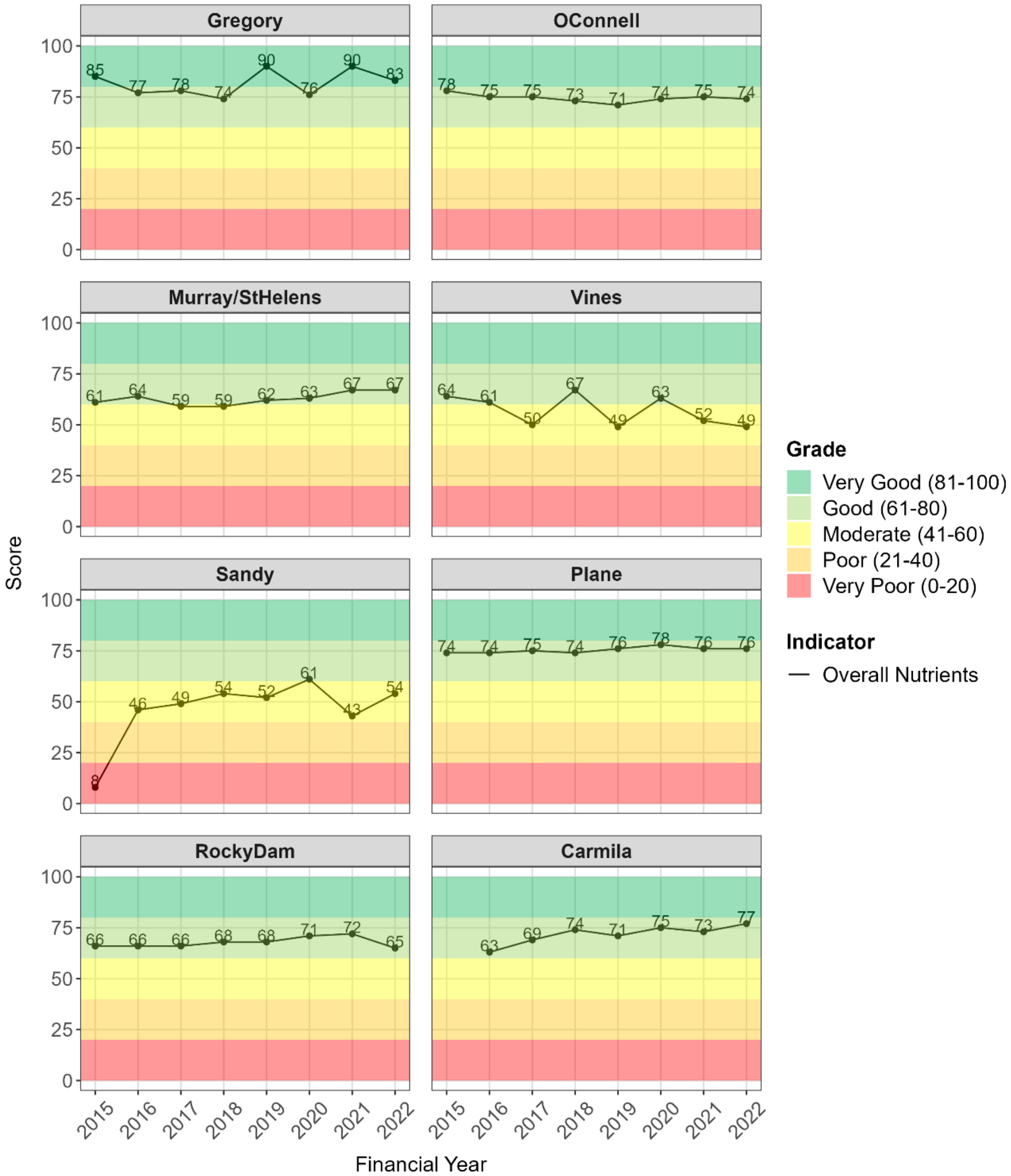


Figure 24. Results for nutrients indicator category in estuaries for the 2021-22 Report Card compared to the historic record.

3.1.2 Chlorophyll-*a*

Results (Table 25, Figure 25, Appendix 8.3)

Table 25. Chlorophyll-*a* (Chl-*a*) indicator scores within estuaries for the 2022 Report Card.

Estuary	2022 Report Card
	Chl-*a*
Gregory River	**54**
O'Connell River^	**43**
St Helens/Murray Creek	**36**
Vines Creek	**41**
Sandy Creek	**65**
Plane Creek	**72**
Rocky Dam Creek	**8**
Carmila Creek	**10**

■ 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 decreased in all eight estuaries in the 2021–2022 monitoring period resulting in a grade decline in four of those estuaries (O'Connell, St Helens/Murray, Rocky Dam, and Carmila Creek).

2) The Gregory, St Helens/Murray, Vines, and Rocky Dam Estuaries recorded their lowest Chl-*a* scores (54, 36, 41, and 8, respectively) since the Report Card's inception.

Since the inception of the Report Card, there has been a **general decreasing trend** for the Chl-*a* indicator in the Gregory, Vines, Rocky Dam, 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 (e.g., management practice changes).

The greatest change in Chl-*a* scores in the 2021–22 monitoring period came from the **Carmila Creek Estuary**, which saw a decline from 'moderate' (48) to 'very poor' (10). Chl-*a* is often above 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 CQU suggest that fluctuations may be influenced by the timing of sampling in relation to rainfall events, coupled with the small size of the catchment and creek and the large tidal range (Flint et al., 2022). Water quality trends in Carmila Creek will continue to be investigated.

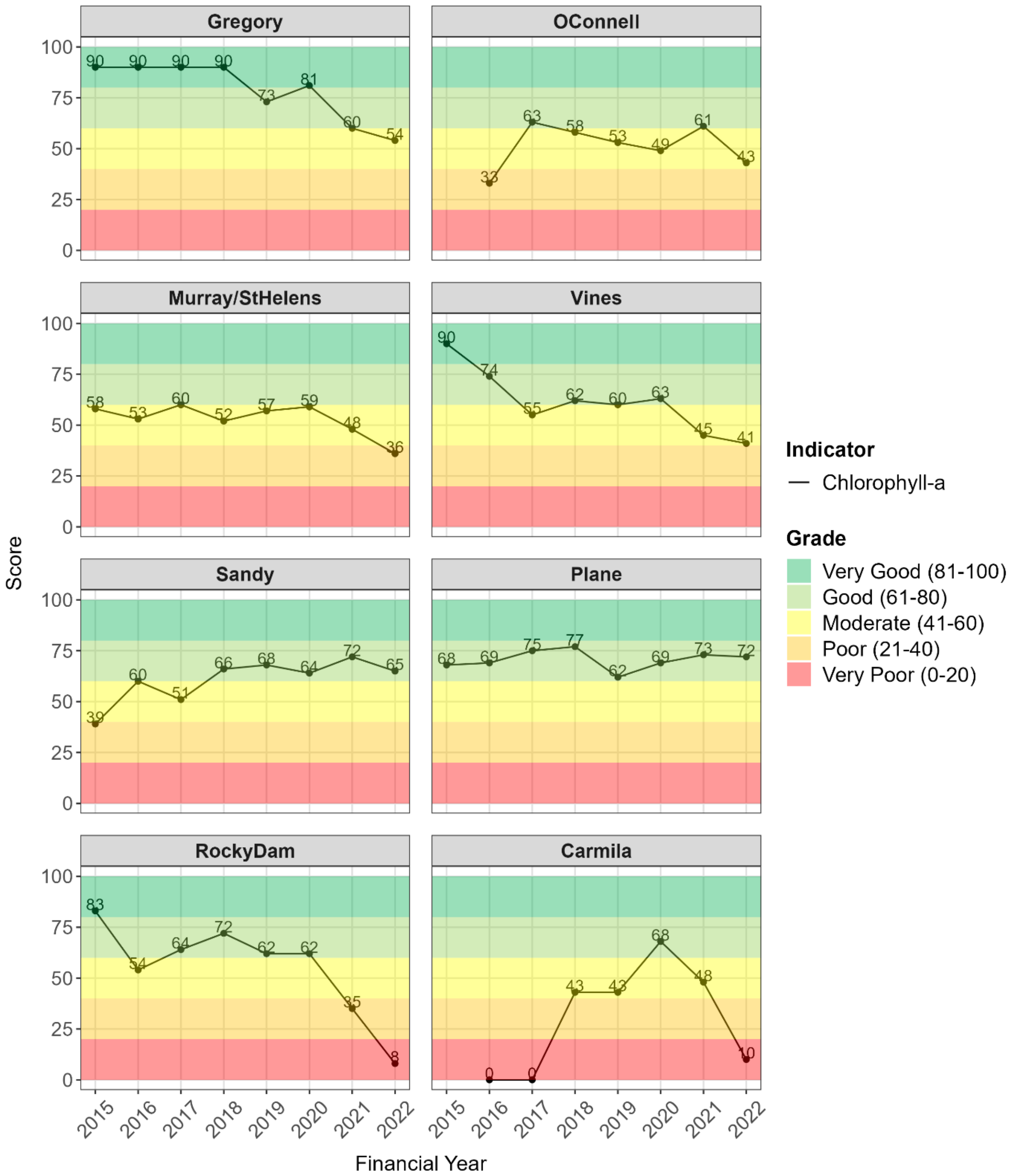


Figure 25. Chlorophyll-*a* (Chl-*a*) indicator scores within estuaries for the 2022 Report Card compared to the historic record.

3.1.3 Phys–chem

Notes on data interpretation for 2022 Report Card results

Phys–chem scores: The phys–chem indicator category scores were generated by the aggregation of the turbidity and upper and lower DO indicators. In accordance with the guideline values, the reported DO indicator scores are based upon the percent saturation of DO. To avoid over-representation of the DO indicator in the final score, the most conservative result of the two (upper and lower DO) is adopted for aggregation.

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 26, Figure 26, Figure 27, Appendix 8.3):

Table 26. Results for turbidity, DO, and aggregated phys–chem indicator category within estuaries for the 2022 Report Card. 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 is derived from the condition of DO.

Estuary	2022 Report Card			
	Turbidity	Lower DO	Upper DO	Phys–chem
Gregory River	90	71	90	**80**
O'Connell River^	32	90	90	**61**
St Helens/Murray Creek	59	90	90	**74**
Vines Creek	67	43	90	**55**
Sandy Creek		90	90	**90**
Plane Creek		90	90	**90**
Rocky Dam Creek		90	90	**90**
Carmila Creek		90	72	**72**

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 Message:

1) Phys–chem grades decreased in the Gregory River ('very good' (84) to 'good' (80)) and Vines Creek ('very good' (82) to 'moderate' (55)) Estuaries. Both had a decrease in score for Lower DO, and Vines Creek had a decreased turbidity score as well.
2) Conversely, Sandy Creek Estuary improved from 'good' (80) to 'very good' (90) due to an improvement in the Lower DO score.
3) O'Connell River grade improved from 'moderate' (54) to 'good' (61) due to an increase in Upper DO scores from very poor (19) to very good (90) that balanced a decline in turbidity scores from very good (90) to poor (32). High turbidity readings were likely due to the timing of samples following flow events.

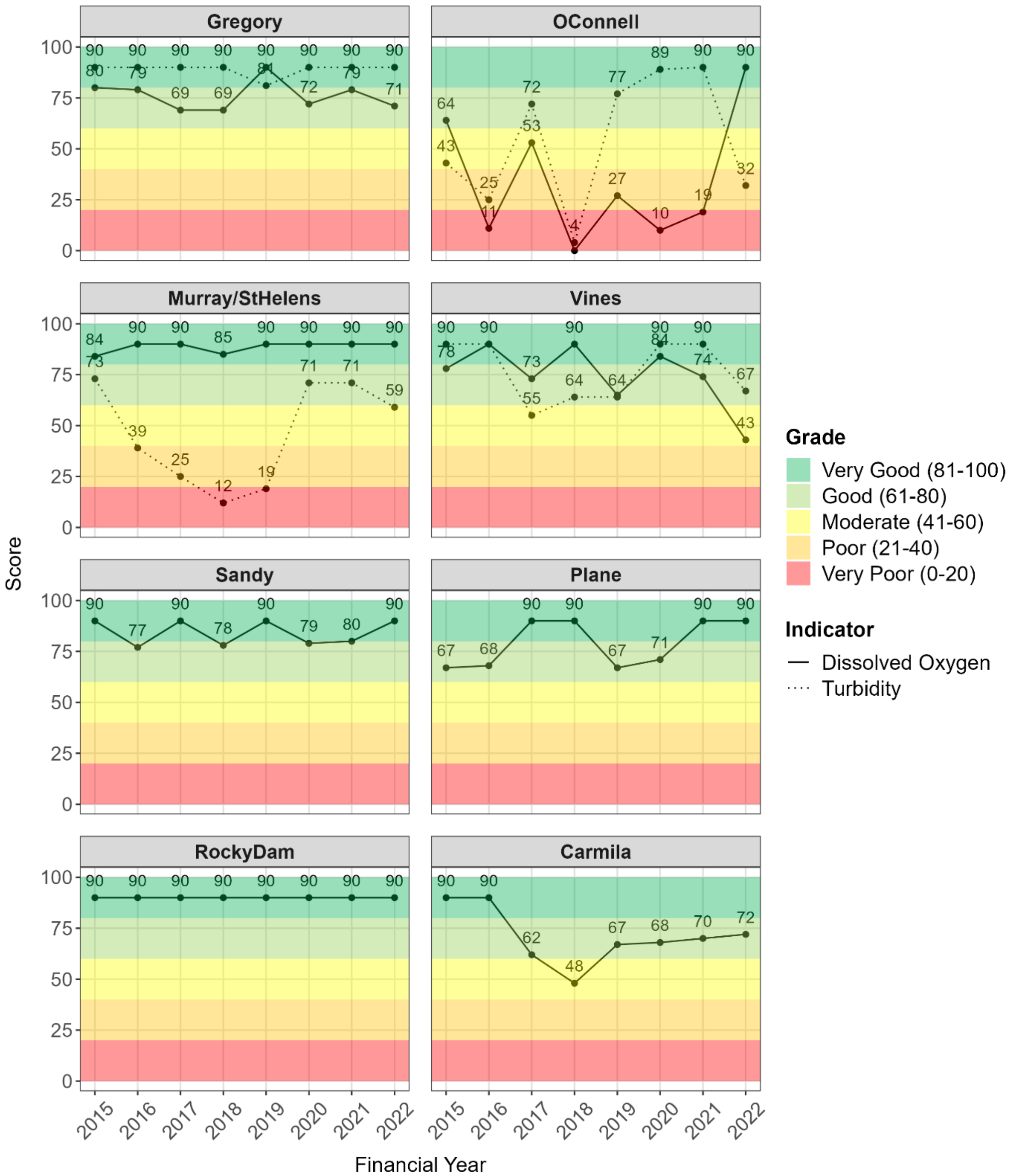


Figure 26. PhysChem indicator scores (DO and NTU) per estuary, 2022 and historic record. Only the poorer score between Low and High DO is used for the DO score. The southern most-estuaries in the region do not record turbidity as there is no suitable Guideline Value.

Turbidity grades declined in the O'Connell, St Helens/Murray, and Vines Creek Estuaries. O'Connell declined from 'very good' (90) to 'poor' (32), St Helens/Murray declined from 'good' (71) to 'moderate' (59), and Vines declined from 'very good' (90) to 'good' (67).

Lower DO grades were similar to those of last year, except for an improved grade in Sandy Creek Estuary ('good' (80) to 'very good' (90)) and a decline in grade for Vines Creek Estuary for the second year in a row from 'good' (74) to 'moderate' (43). However, the decrease in Vines may be related to the timing of sampling in relation to rainfall events (A. Moss, pers. comm. 24/01/2023).

Upper DO grades remained the same, bar O'Connell River which improved from 'very poor' (19) to 'very good' (90) with the only other score change in the Carmila Creek Estuary, which improved from 70 to 72.

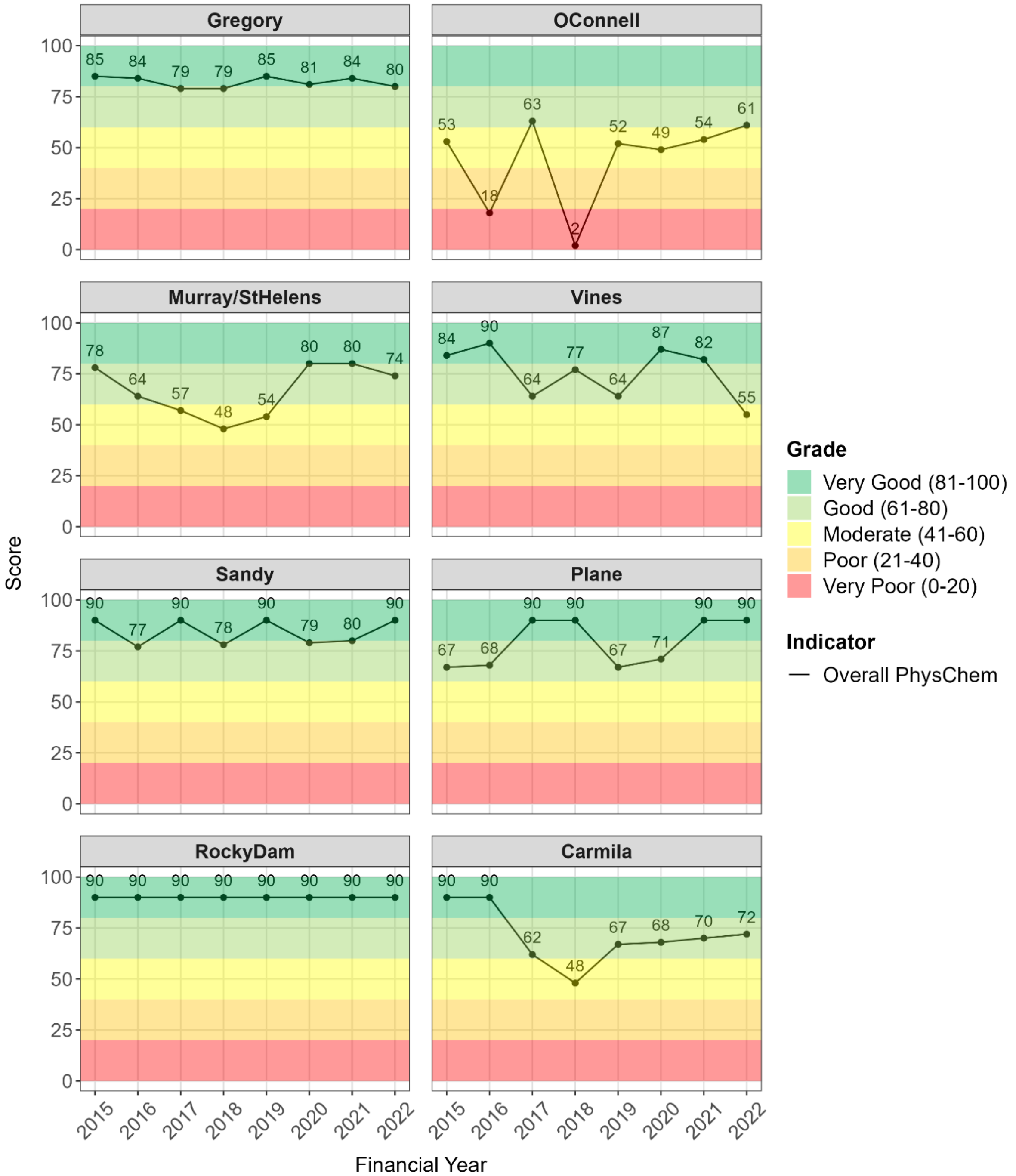


Figure 27. Results for aggregated phys–chem indicator category within estuaries for the 2022 Report Card in comparison to 2015–2021 Report Card scores for phys–chem. The aggregated phys–chem score is calculated by averaging the poorer DO score with the turbidity score. In the absence of a suitable turbidity score, phys–chem results are derived from the lower DO score.

3.1.4 Pesticides

Reporting of pesticides in the MWI estuaries follow similar methods to those adopted for freshwater basins in which measured concentrations of up to 22 different pesticides in each sample are converted to a PRM that expresses risk as the percentage of aquatic species that may be adversely affected/protected by a mixture of pesticides. Further information on the method for assessing pesticide condition is presented in the Methods Report.

Notes on data interpretation for 2022 Report Card results

Chemical use: Metsulfuron-methyl is not registered for use in sugarcane and applications are likely not agricultural in origin. This is particularly relevant in the Vines Creek region, where the land use is primarily urban (Figure 25).

Results (Table 27, Figure 28, Figure 29)**:**

Table 27. 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 2022 Report Card.

Estuary	2022 Report Card	
	PRM (% species protected)	Standardised Pesticide Score
Gregory River	98	**75**
O'Connell River^	89	**40**
St Helens/Murray Creek	91	**48**
Vines Creek	90	**44**
Sandy Creek	75	**18**
Plane Creek	96	**66**
Rocky Dam Creek	91	**45**
Carmila Creek	99	**98**

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) Most PRM estuarine grades remained the same in the 2021-22 monitoring period with respect to the previous year. Estuaries that declined in grade included the Gregory ('very good' (81) to 'good' (75)), St. Helens/Murray ('good' (62) to 'moderate' (49)), and Rocky Dam ('good' (64) to 'moderate' (48)).
2) Imidacloprid and diuron were the key contributors to the overall PRM in all the estuaries assessed, with the exception of the Vines and Plane Creek Estuaries, where metsulfuron-methyl was the key contributor and the Gregory where Metolachlor was the key contributor. Notably, atrazine contributed less of the total PRM across the region than in the previous year.

3) The Sandy Creek, O'Connell River, Vines Creek, and St. Helens/Murray estuarine waters experienced 'very high', 'high', and 'moderate' pesticide risks, respectively. These results highlight that estuarine species are at moderate to high risk of experiencing toxic effects due to high pesticide concentrations in five monitored MWI waterways, particularly in the Mackay region. There is a strong need to adopt management measures to mitigate impacts to aquatic biota in the catchments where the pesticides are applied.

The Rocky Dam Estuary had the largest fluctuation in score of all monitored estuaries for the second consecutive year, from 'poor' (24) in 2019-20 to 'good' (63) in 2020–21 to 'moderate' (45) in 2021-22. This is primarily due to a decrease in risk for atrazine, diuron, imidacloprid, and imazapic, which are chemicals associated with agricultural practice in the region.

The PRM score for **Vines Estuary** remained 'moderate' (44) following last year's decline from 71 to 48. This score change was primarily due to an increase in risk for the chemicals imidacloprid, diuron, and metsulfuron-methyl.

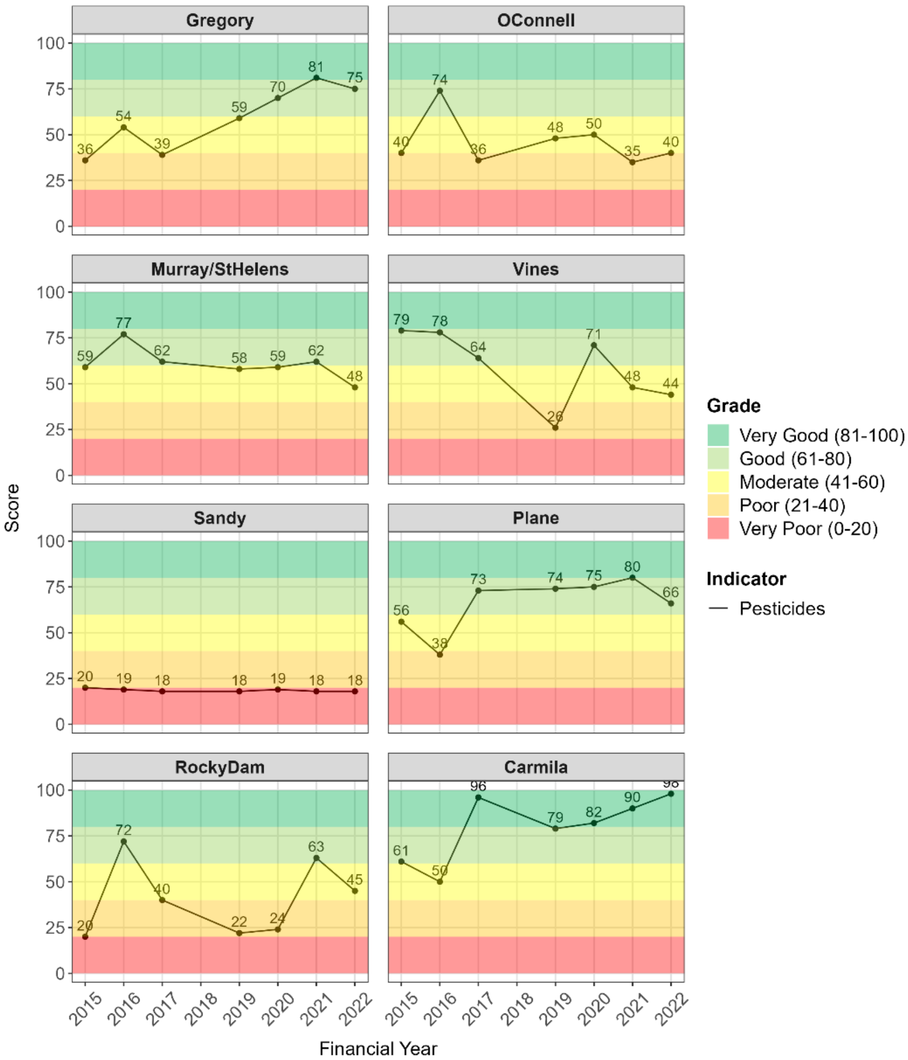


Figure 28. Results for the Pesticide Risk Metric (PRM) indicator accounting for 22 pesticides, expressed as standardised pesticide score, for eight estuaries in the MWI Region in the 2022 Report Card compared to the historic record. Note that there were no estuary pesticides scores in 2018.

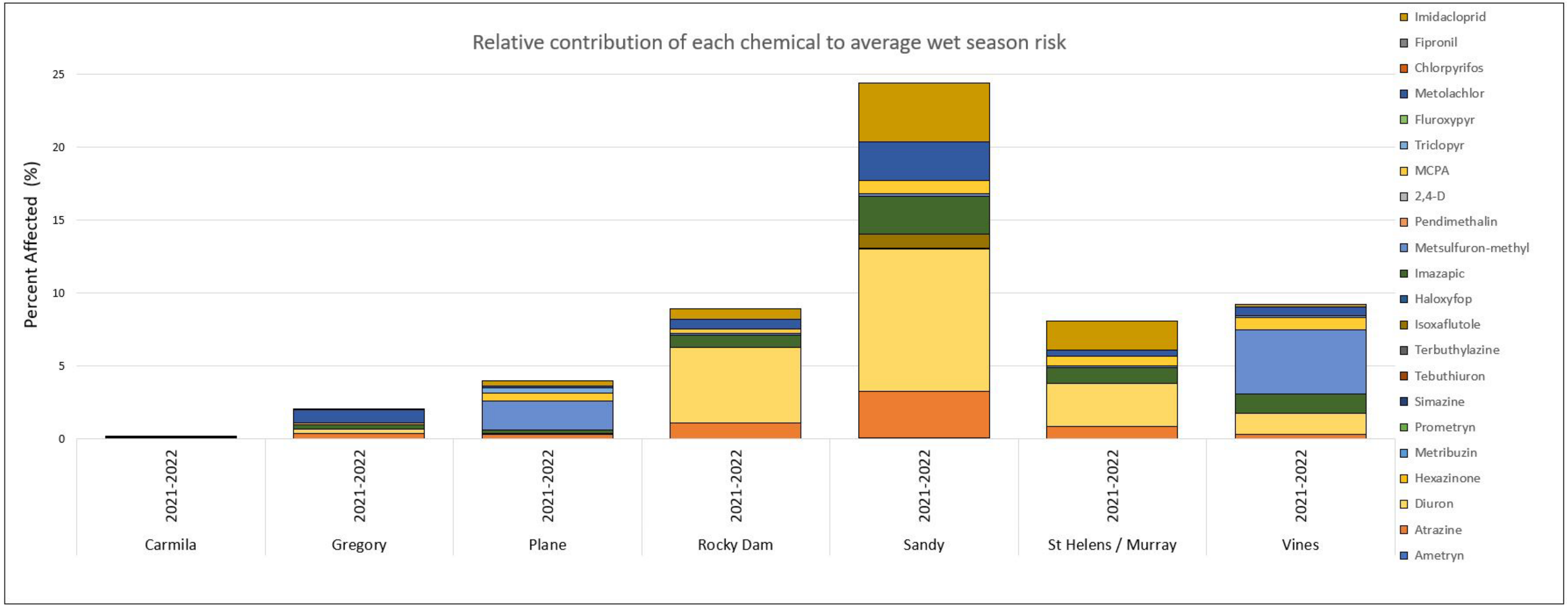


Figure 29. Proportional contribution of each pesticide to as the total percentage of species affected (PAF) as calculated using the Pesticide Risk Metric (PRM) for the 2021–22 reporting year in the MWI estuaries. Source: QLD Government, GBR CLMP.Water Quality Index Scores

3.1.5 Water Quality Index Scores

Notes on data interpretation for the 2022 Report Card

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 28, Figure 30, and Appendix 8.3)**:**

Table 28. Results for water quality indicator categories and overall index scores in estuaries for the 2022 Report Card.

Estuary	2022 Report Card				
	Phys–chem	Nutrients	Pesticides	Chl-*a*	Water Quality Index
Gregory River	80	83	75	54	**73**
O'Connell River^	61	74	40	43	**54**
St Helens/Murray Creek	74	67	48	36	**56**
Vines Creek	55	49	44	41	**47**
Sandy Creek	90	54	18	65	**57**
Plane Creek	90	76	66	72	**76**
Rocky Dam Creek	90	65	45	8	**52**
Carmila Creek	72	77	98	10	**64**

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 from the 2015 Report Card are repeated from the 2014 Report Card.

^ 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) Water quality grades ranged from 'moderate' to 'good' in the current assessment period, where three of the eight estuaries met the water quality objective for the monitoring period.
2) Decline in grade from 'good' to 'moderate' in St. Helens/Murray was due to a decline in Chl-*a* 'moderate' (48) to 'poor' (36) and Turbidity 'good' (71) to 'moderate' (59).
3) Decline in Rocky Dam from 'good' to 'moderate' was due to decline in Chl-*a* 'poor' (35) to 'very poor' (8) and DIN 'moderate' (54) to 'poor' (40).

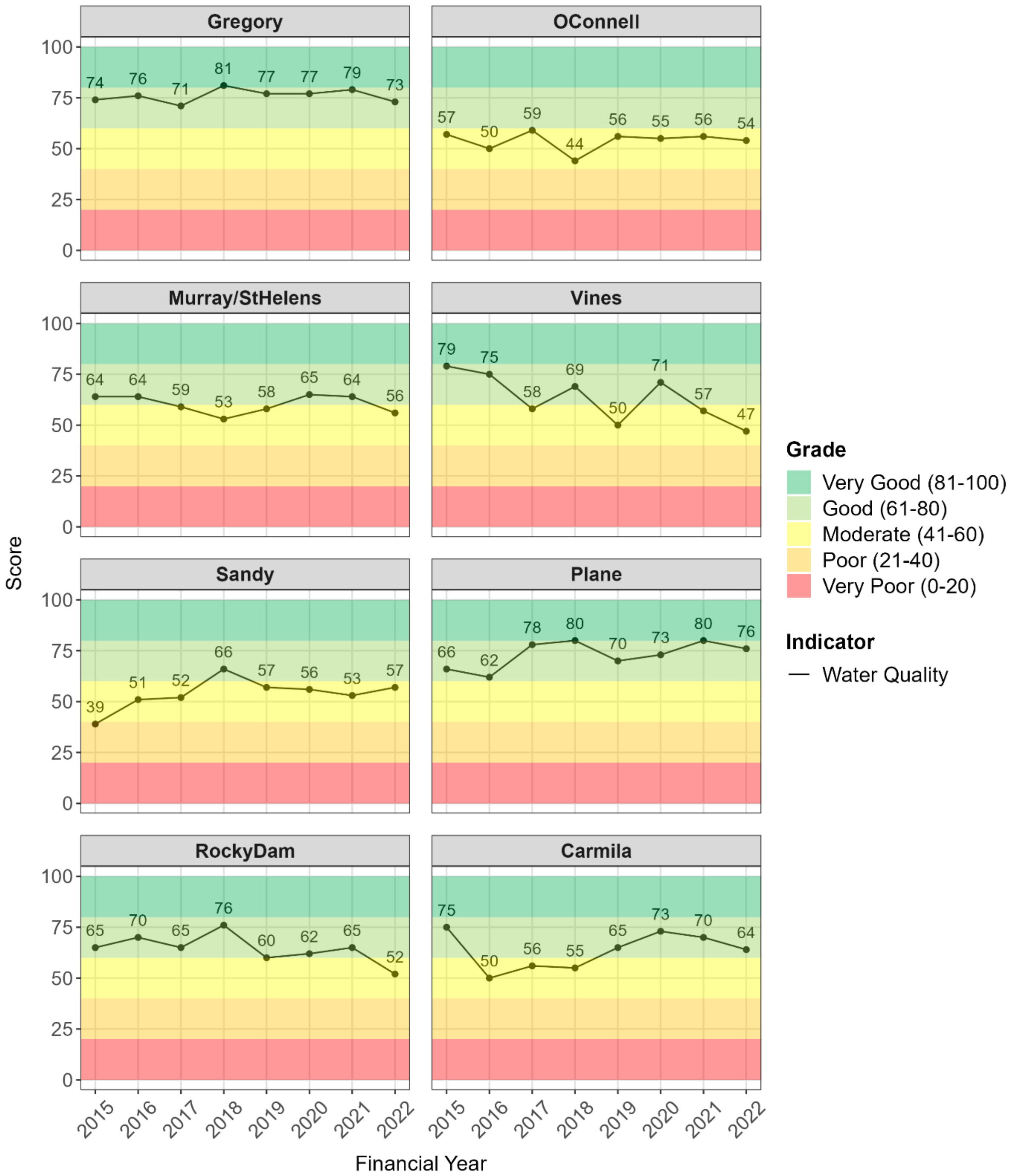


Figure 30. Results for overall water quality index scores in estuaries for the 2022 Report Card in comparison to the 2015 to 2021 Report Card scores.

3.1.5.1 Confidence

Confidence in water quality index scores in estuaries is shown in Table 29 below. Lower confidence scores in the O'Connell, Vines, and Carmila Creek Estuary water quality (excluding pesticides) scores are due to data collection occurring at only one sample site. Higher confidence scores in other estuaries reflects higher spatial representation.

Table 29. Confidence associated with water quality index results in estuaries for the 2022 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 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 square parentheses. 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, including fish barriers, riparian extent, and mangrove/saltmarsh extent. Impoundments are not assessed as a component of the estuaries. To assess vegetation condition in the estuaries, the same broad principles of assessment used in basins are applied within the target area, which 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 23.

3.2.1 Fish Barriers

Similar to freshwater basins, the estuary fish barriers indicator is updated every four years and was last updated for the 2019 Report Card. A recent assessment on fish barriers for the MWI region was conducted in 2021 (Power et al., 2022) and will be incorporated into the 2023 Report Card when the fish barriers indicator is reassessed.

Results (Table 30, 2018–19 data):

Table 30. Results for fish barrier indicators in estuaries in the 2022 Report Card (2018–19 data) compared to the 2019 Report Card (2014–15 data). Indicators assessed on Stream Order (SO) ≥3 or ≥4 as indicated. NB: no barriers. NLPB: no low "passability" barriers.

Estuary	2022 Report Card								2018
	Barrier Density		Stream (%) to the First Barrier		Stream (%) to 1st Low "Passability" Barrier		Fish Barriers		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)	Fish Barriers (standardised)
Gregory River	35	5	96	4	97	4	13	80	80
O'Connell River	5	3	85	4	NLPB	5	12	70	70
St Helens/Murray Creek	4	3	67	3	83	3	9	50	41
Vines Creek	13	4	96	4	NLPB	5	13	80	80
Sandy Creek	3	2	44	2	90	4	8	41	41
Plane Creek	2	1	48	2	76	2	5	21	21
Rocky Dam Creek	5	3	74	3	NLPB	5	11	61	61
Carmila Creek	NB	5	NB	5	NLPB	5	15	100	100

Scoring ranges and grades for each metric

Metric	Very Poor	Poor	Moderate	Good	Very Good	
Barrier Density	0-2 km (1)	>2 – 4 km (2)	>4 – 8 km (3)	>8 – 16km (4)	>16 km (5)	No data
% of Stream Before 1st Barrier	0 - <10% (1)	10 – 30% (2)	30 – 50% (3)	50 – 100% (4)	100% (5)	
% of Stream to 1st Low "Passability" Barrier	0 - 50% (1)	>50 – 60% (2)	>60 – 70% (3)	>70 – 95% (4)	>95% (5)	
Total Score	3 - 4	5 - 7	8 – 10	11 – 13	14 – 15	
Fish Barriers (standardised)	0 - 20	21 - 40	41 – 60	61 – 80	81 - 100	

Key Messages:

1) Since the previous assessment, there has been no change to the overall fish barrier grade in any of the estuaries assessed. There was an improvement in the ‘barrier density’ indicator in the St Helens/Murray Creek Estuary reporting area, which shifted from a ‘poor’ to ‘moderate’ grade. This improvement was driven by the remediation of a high priority fish barrier located on Niddoe Creek with the construction of a rock ramp fishway. In addition, field validation of two potential barriers in the Murray Creek Estuary reporting area determined that these structures were not barriers to fish passage and were subsequently removed from the assessment.
2) The Vines Creek, O’Connell, and Gregory River Estuary assessment areas all received fish barrier grades of ‘good’, where systems comprise large areas of connected stream habitats upstream from the estuary mouth, with only a few fish barriers located on smaller tributaries and no low “passability” barriers (Moore, 2016).

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.

The **Carmila Creek Estuary** assessment area reported no barriers to fish passage, scoring a grade of ‘very good’. Fish barriers in Carmila Creek Estuary are located in the middle and upper river reaches, falling outside the estuary extent (18.5 m above the declared downstream limit (DDL)).

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.

Notes on data interpretation for the 2022 Report Card

Updated methodology: In previous Report Card analyses, polygons were only included in Regional Ecosystem analysis if the dominant ecosystem type was within the target ecosystems (RE 8.1.1 – re 8.1.5).[24] Methodology has been updated in the 2022 Report Card to include proportions of polygons represented by the target ecosystems. This has resulted in changed back-calculated results across all estuaries, however the changes have been reviewed by DES and were within an acceptable margin of error.

Results (Table 31, 2018-19 data):

Table 31. Results for riparian and mangrove/saltmarsh extent loss since pre-clearing (%), hectares remaining, and standardised riparian and mangrove/saltmarsh extent in estuaries in the 2021 2022 Report Card (2017 2019 data). Hectares were rounded to the nearest whole number.

Estuary	2022 Report Card					
	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
St Helens/Murray 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 scores use the previous methodology as the spatial extent was not available. It is expected to be updated following release of this Report Card.

[24] https://apps.des.qld.gov.au/regional-ecosystems/

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 (scoring 'good' or 'very good') except for the Vines Creek Estuary, which scored 'moderate' (52).

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.

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 for the 2022 Report Card.

Considerable work has been undertaken to fill data gaps and is currently progressing in collaboration with the TWG and BoM. 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 riparian and mangrove/saltmarsh extent were updated in the 2022 Report Card, however scores for fish barriers are repeated from the 2019 Report Card. Scores have been 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.

Results (Table 32 and Appendix 8.3):

Table 32. Results for habitat and hydrology indicator categories and index in estuaries for the 2022 Report Card (2018–19 data) compared to the 2018 Report Card (2014–15 data).

Estuary	2022 Report Card					2018*
	Mangrove/ Saltmarsh Extent	Riparian Extent	Fish Barriers	Flow	Habitat and Hydrology Index	Habitat and Hydrology Index
Gregory River	88	84	80		**84**	**83**
O'Connell River	77	21	70		**56**	**57**
St Helens/Murray Creek	100	59	50		**69**	**66**
Vines Creek	52	57	80		**63**	**66**
Sandy Creek**	63	44	41		**49**	**45**
Plane Creek	92	60	21		**57**	**56**
Rocky Dam Creek	82	83	61		**76**	**77**
Carmila Creek	88	98	100		**95**	**96**

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

* Scores have been updated to incorporate changes associated with refinements to the source mapping used to assess vegetation (riparian and mangrove/saltmarsh) extent.

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

Key Messages:

1) The overall habitat and hydrology index grades for estuaries in the 2022 Report Card ranged from 'moderate' to 'very good' across the MWI Region.
2) There has been no change to the condition grades for the habitat and hydrology index since the 2018 Report Card (referencing 2014-15 data).

3.2.4.1 Confidence

Overall confidence for the habitat and hydrology indicator category was 'moderate' (Table 33).

Table 33. Confidence associated with habitat and hydrology index results in estuaries for the 2022 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. 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 in order to provide fish species diversity indicator.

3.4 Overall Estuary Condition

Results (Table 34, Table 35, Appendix 8.3):

Table 34. Indicator category scores alongside overall condition scores and grades of estuaries for the 2021-22 Report Card.

Estuary	2022 Report Card				
	Water Quality	Habitat and Hydrology	Fish	Estuary Score and Grade	
Gregory River	73	84		78	B
O'Connell River^	54	56		55	C
St Helens/Murray Creek	56	70		63	B
Vines Creek	47	63		55	C
Sandy Creek	57			51	C
Plane Creek	76	57		66	B
Rocky Dam Creek	52	76		64	B
Carmila Creek	64	95		79	B

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 2021–22 monitoring period were to the same as the previous year with the exception of both Gregory River and Carmila Creek Estuaries, which both declined from 'very good' (81) to 'good' (78 and 79 respectively).
2) In the Gregory River overall decline was due to minor declines in all water quality indicator categories.
3) In Carmila Creek Estuary overall decline was primarily due to a decline in Chl-*a* from 'moderate' (48) to 'very poor' (10).

Table 35. Overall condition scores and grades of estuaries for the 2022 Report Card in comparison to 2015–2021 Report Card scores.

Estuary	2022	2021	2020	2019	2018**	2017*	2016*	2015*#
	Estuary Score							
Gregory River	78	81	81	80	82	79	80	79
O'Connell River^	55	56	56	56	51	61	54	57
St Helens/Murray Creek	61	66	67	64	57	61	61	63
Vines Creek	56	60	68	57	68	64	72	73
Sandy Creek	51	49	50	51	58	52	50	52
Plane Creek	66	68	64	63	68	67	59	61
Rocky Dam Creek	62	69	67	66	76	70	73	70
Carmila Creek	79	81	82	78	67	66	73	79

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

*2017, 2016 and 2015 scores include pesticide monitoring data, but have not been back-calculated to address changes to the method of assessment and, therefore, are not directly comparable.

**2018 scores do not include pesticide monitoring data and, therefore, are not directly comparable.

Data from 2015 Report Card are repeated from the 2014 Report Card.

^ The O'Connell River estuary site is also used to monitor nutrients within freshwater basins.

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 31). All indicators reported in marine zones are updated annually.

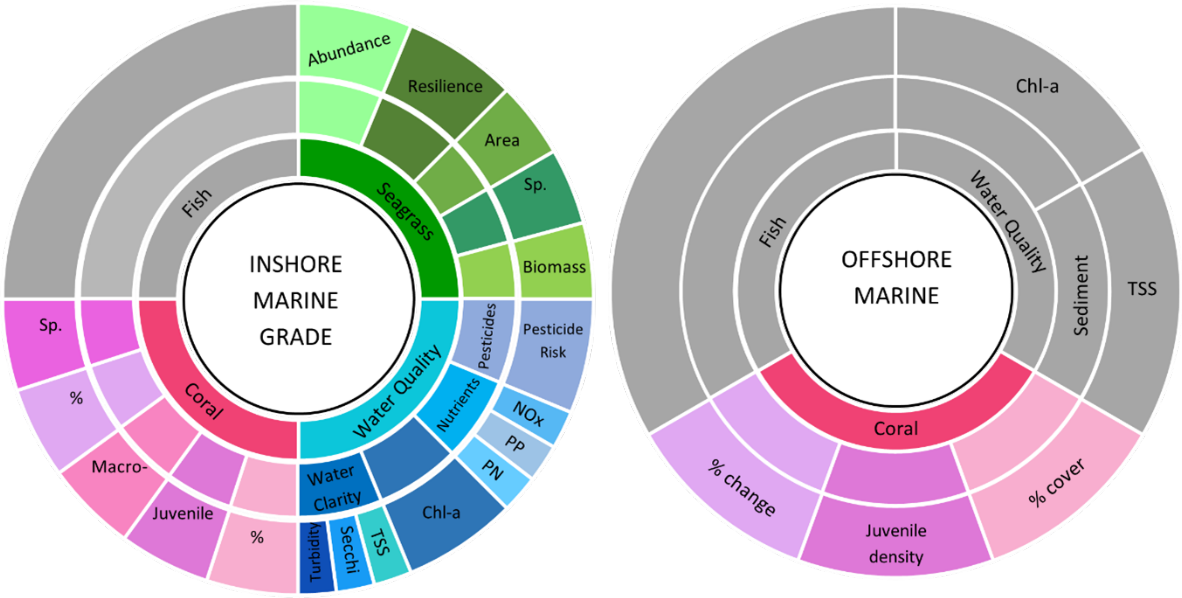


Figure 31. Indicators (outer ring), indicator categories (middle ring) and indices (inner ring) that contribute to overall inshore (A) and offshore (B) marine grades. Where no indicator category is listed, this represents that the indicator/s (e.g. juvenile density) does not fit into any category below 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[25] while the MMP annual reports can be found in the GBRMPA e-library.[26] Identifying a data gap in Southern Zone monitoring, the Partnership initiated and funded the Southern Inshore Program (SIP) in 2017.[27] 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.[28] 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.

[25] https://nqbp.com.au/sustainability/research-and-reports

[26] https://elibrary.gbrmpa.gov.au/jspui/browse?type=series&value=Marine+Monitoring+Program

[27] https://healthyriverstoreef.org.au/southern-inshore-monitoring-project/

[28] https://www.aims.gov.au/reef-monitoring/gbr-condition-summary-2020-2021

4.1 Water Quality in Marine Zones

Inshore marine water quality in the MWI Region (see sampling sites in Figure 32) is influenced by six major river basins: the Don, Proserpine, O'Connell, Pioneer, and Plane Basins in the MWI Region and the Fitzroy Basin further south. 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 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).

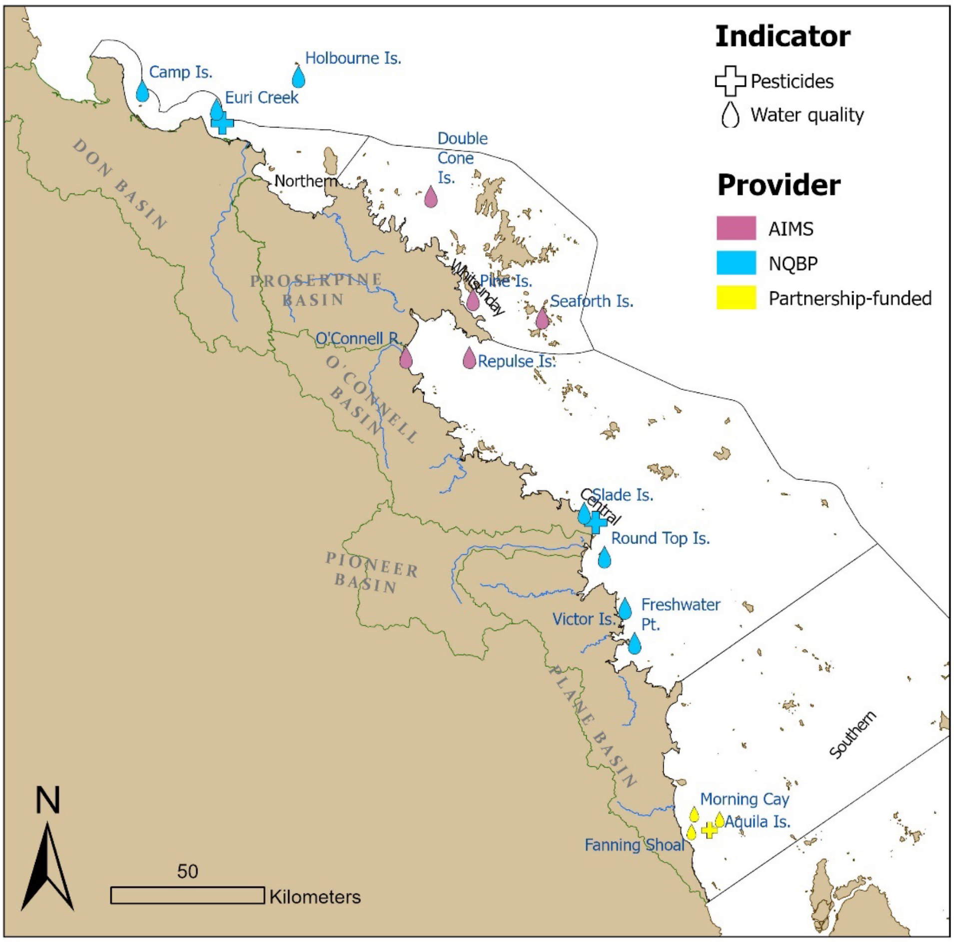


Figure 32. Water quality monitoring sites for the inshore marine zones during the 2021-22 reporting year. Sites in each zone are shown according to data provider. AIMS: Australian Institute of Marine Science; NQBP: Northern Queensland Bulk Ports, Partnership-funded refers to the Southern Inshore Program.

Condition scores are calculated by comparing annual means or medians to guideline values[29] 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 (see Methods Report). 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.

[29] 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.

4.1.1 Nutrients

Nutrient scores for inshore zones are based upon reported concentrations of oxidised nitrogen (NOx), particulate phosphorus (PP), and particulate nitrogen (PN). At the zone-level, Nutrients scores in 2021–22 remained similar to the previous year, with Northern improving to 'good' (54 to 70), Whitsunday remaining 'poor' (21 to 30), and Southern remaining 'good' (77 to 78). In the Central Zone the Nutrients score declined to 'moderate' (51), largely driven by decline in PN and PP at Round Top Island, and to a lesser extent Freshwater Point.

<u>**Results** (Figure 33, Figure 34, Appendix 8.4.1)</u>

Key Message:

1) Improvements in the Northern Zone were driven by decline in PN concentration across all sites.
2) Declines in the Central Zone were driven largely by increased concentration of PN and PP, particularly at Freshwater Point and Round Top Island.

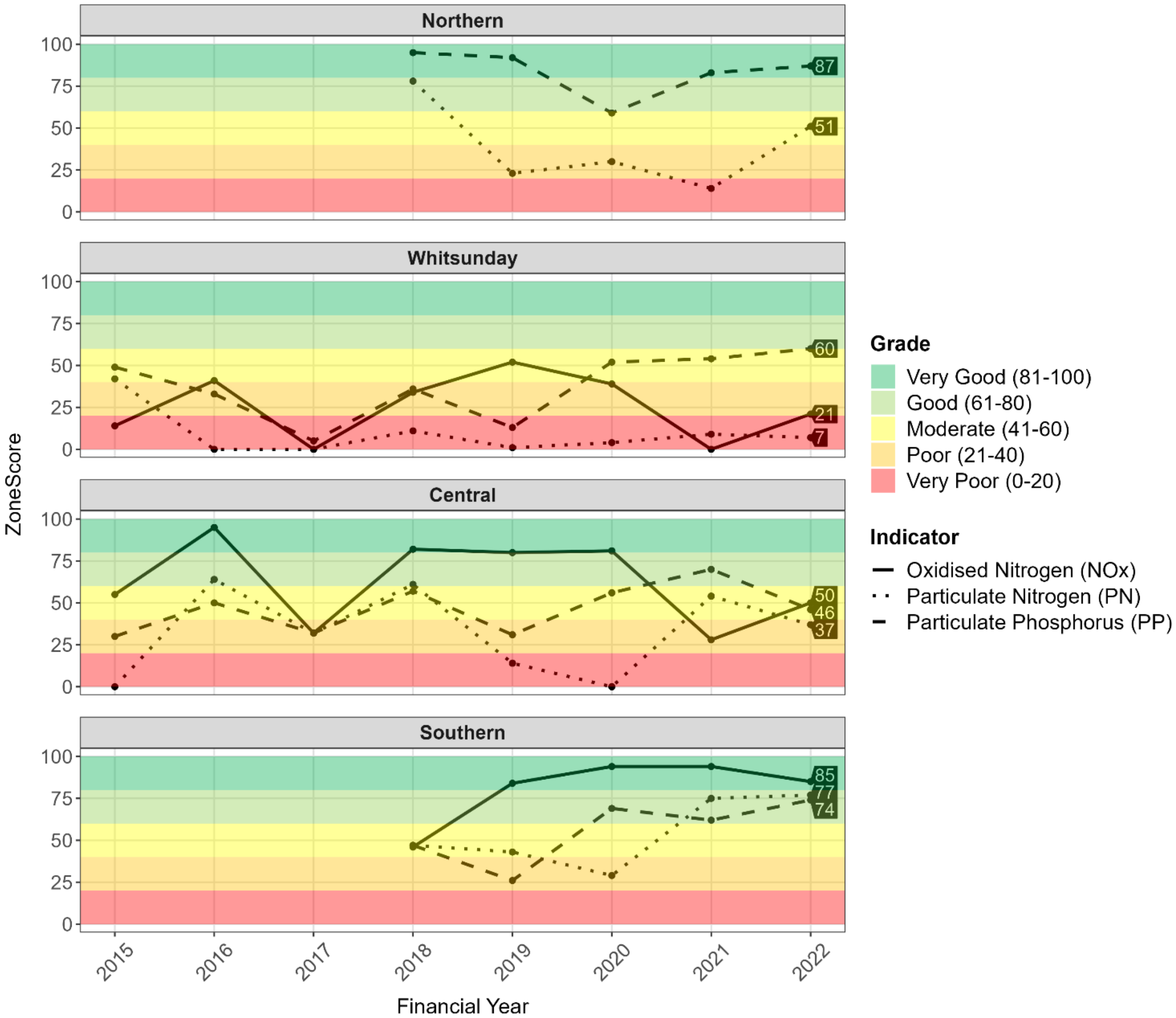


Figure 33. Marine zone nutrients indicators scores in 2022 compared to the historic record.

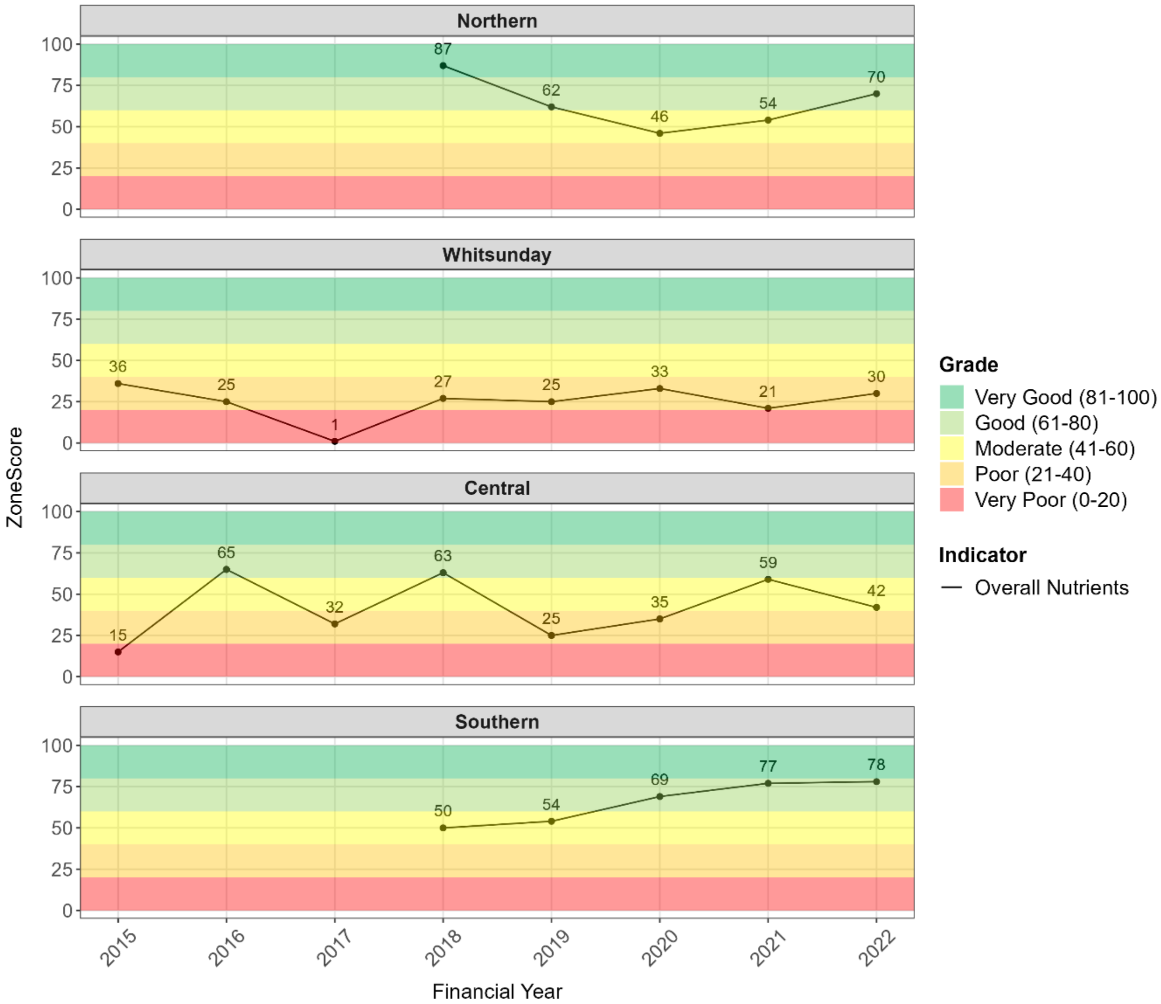


Figure 34. Marine zone nutrients scores in 2022 compared to the historic record. The annotated solid black line (overall nutrients) is an average of the other three indicators shown in the previous figure.

In the **Northern Zone**, Euri Creek remained 'good', with both PN and PP scores improving a grade (poor to moderate and good to very good respectively). Camp Island overall nutrients scores improved for the second consecutive year, from 'very poor' in 2020 to 'moderate' in the current year. Holbourne Island PN scores improved from 'very poor' to 'good', although the overall site score remained 'good'.

Improvements in nutrient scores in the **Whitsunday Zone** were largely driven by decreased concentrations of NOx at Double Cone and Seaforth Islands (both 'very poor' to 'poor') and decreased concentration of PP at all three sites.

Score changes were variable in the **Central Zone**. PN scores improved at Slade Island ('moderate' to 'good') however declined at most other sites, from 'good' to 'moderate' at Freshwater Point and Victor Island and 'good' to 'very poor' at Round Top Island. Repulse Island remained 'very poor' for the 8th consecutive year. PP scores reflected the grade decline of PN at Freshwater Point however balanced the improvement in PN at Slade by declining from 'good' to 'moderate'. Victor Island improved from ‘good’ to ‘very good’ and Repulse Island improved from ‘very poor’ to ‘poor’ for the first time since the report card’s inception.

Nutrients scores remained high in the **Southern Zone**, with overall ‘good’ or ‘very good’ scores in all three sites. These scores continue the trend of improvements each year since commencement of monitoring in 2018. The most noticeable improvements were at Aquila Island, where PN improved from ‘moderate’ to ‘very good’ and PP improved from ‘poor’ to ‘moderate’.

4.1.2 Chlorophyll-*a*

Chl-*a* grades declined in both the Whitsunday Zone ('good' (68) to 'moderate' (47)) and Central Zone ('moderate' (42) to 'poor' (27)). Northern Zone score improved yet remained 'moderate' (42 to 52), and Southern Zone improved yet remained 'poor' (31 to 37).

<u>**Results** (Figure 35, Appendix 8.4.1)</u>

Key Messages:

1) Chl-*a* scores improved in the Northern and Southern Zones but declined in the Whitsunday and Central Zones, however site level scores within zones were not consistent with overall zone scores.
2) Overall site-level declines were driven largely by increased levels of Chlorophyll-*a*, particularly at Pine Island in the Whitsunday Zone and both Freshwater Point and Round Top Island in the Central Zone.

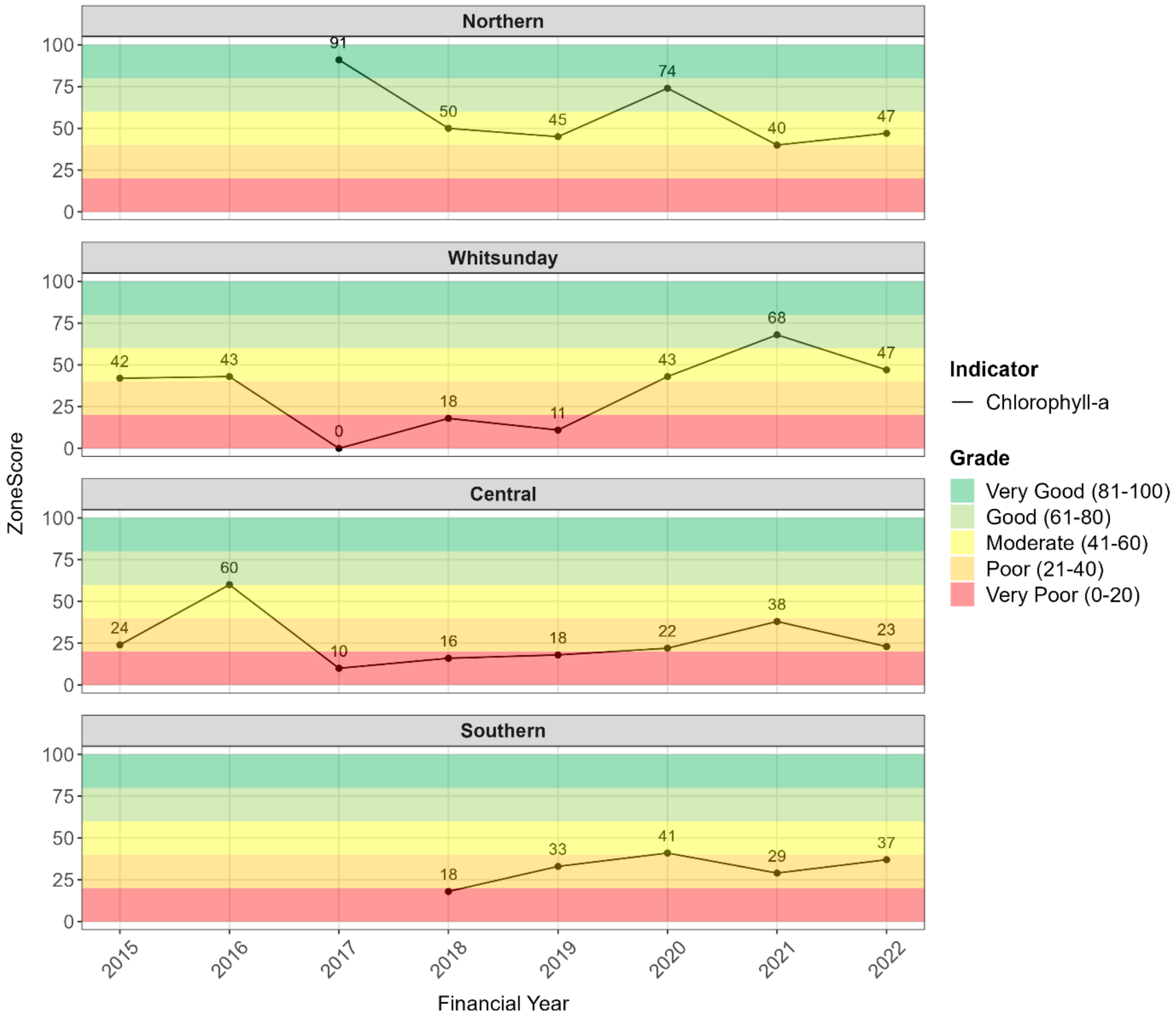


Figure 35. Marine inshore zone Chlorophyll-*a* scores in 2022 compared to the historic record.

Site level scores remained similar to the previous year in the **Northern Zone**, with Camp Island remaining 'very poor', Holbourne Island remaining 'good', and Euri Creek improving from 'moderate' to 'good'.

Chl-*a* scores declined at all sites in the **Whitsunday Zone**. Both Double Cone and Seaforth Island declined from 'good' to 'moderate', while Pine Island declined from 'good' to 'poor' respectively.

In the **Central Zone**, Chl-*a* grades remained the same at all sites except for Round Top Island which declined from 'good' to 'very poor'. All sites recorded 'poor' or 'very poor' grades except for O'Connell River mouth which scored 'very good' for the second consecutive year.

The **Southern Zone** results varied across sites for Chl-*a*. Aquila Island and Fanning Shoal saw improvements from 'very poor' to 'poor' and 'moderate' respectively, while Morning Cay declined from 'good' to 'poor'.

4.1.3 Water Clarity

The water clarity indicator category is informed by secchi depth (m), total suspended solids (TSS), and turbidity (NTU) indicators. Overall Water Clarity improved in all inshore zones, with the most notable score changes in the Northern (improving to 'good' 57 to 71) and Whitsunday ('poor' 38 to 'moderate' 47) Zones. The Central Zone remained 'poor' (25 to 31), and the Southern Zone remained 'very poor' (0 to 1) although this marks the first year that the Southern Zone clarity has scored above 0 since monitoring began.

Notes on data interpretation for 2022 Report Card results

Water Clarity: 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).

Water quality grades in the freshwater basins and estuaries are often better than those in the receiving inshore marine zone due to more stringent guideline values and the cumulative impacts of multiple riverine sources converging.

Results (Figure 36, Figure 37)

Key Messages:

1) Water Clarity scores improved in every zone during the 2021-22 reporting period, and this was consistent across all sites.
2) The Southern Zone recorded a 'very poor' grade in Water Clarity every year since monitoring began in 2018, however at many other sites throughout the region there was a trend in improved TSS scores accompanied by a decline in Turbidity 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.

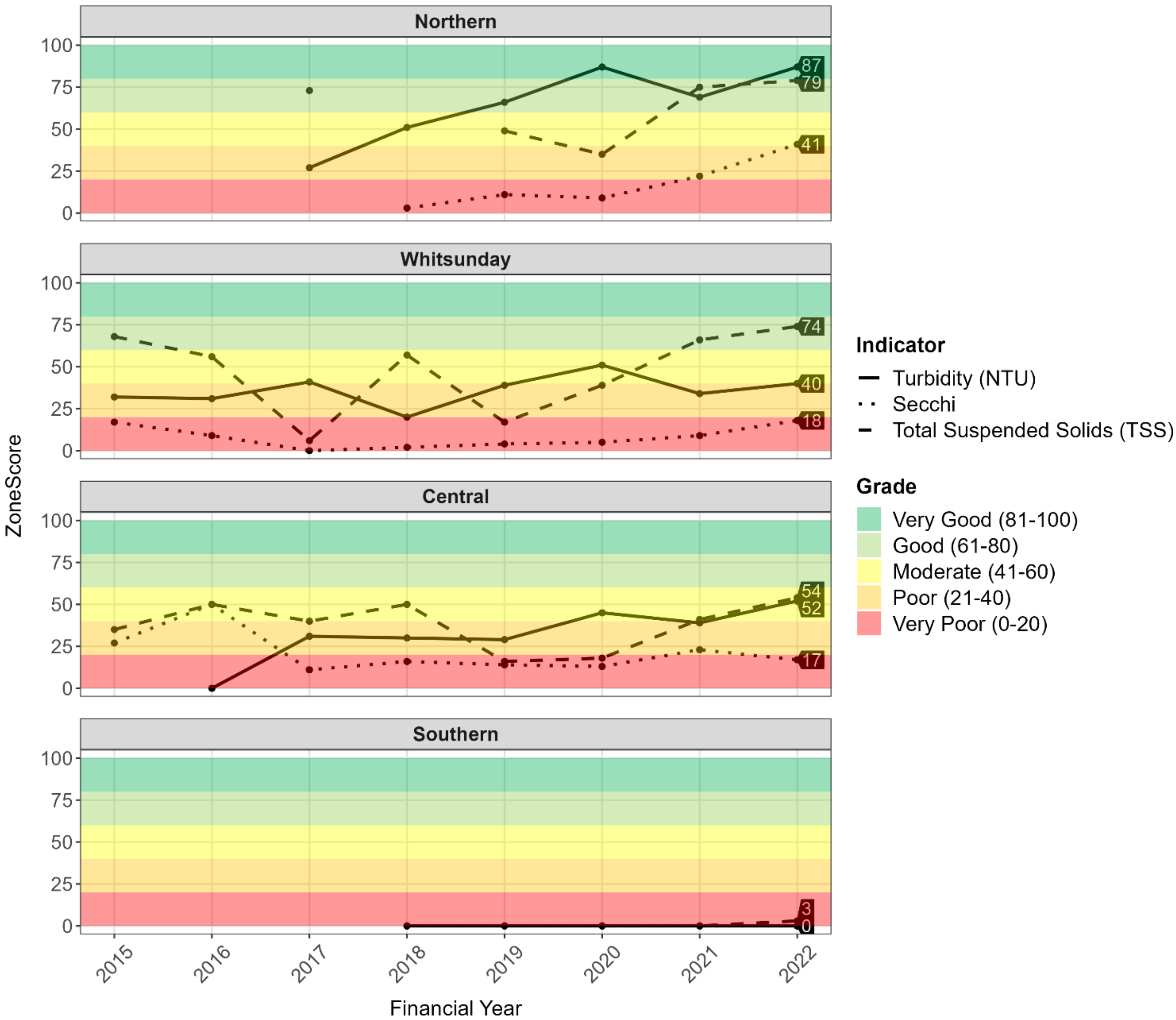


Figure 36. Marine inshore zone water clarity indicator scores in 2022 compared to the historic record.

Clarity scores in the **Northern Zone** improved at all sites, including grade changes from 'moderate' to 'good' at the inshore sites of Camp Island and Euri Creek.

In the **Whitsunday Zone**, clarity scores improved at all sites, including grade changes from 'poor' to 'moderate' at both Pine and Seaforth Islands.

Central Zone sites generally scored 'poor' or 'very poor' with exceptions at Round Top and Slade Islands where water clarity scores were 'good' and improved for the second consecutive year. These improvements were driven in part by improvements in TSS and Turbidity despite declines in Secchi.

In the **Southern Zone**, scores remained 'very poor' for the fifth 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).

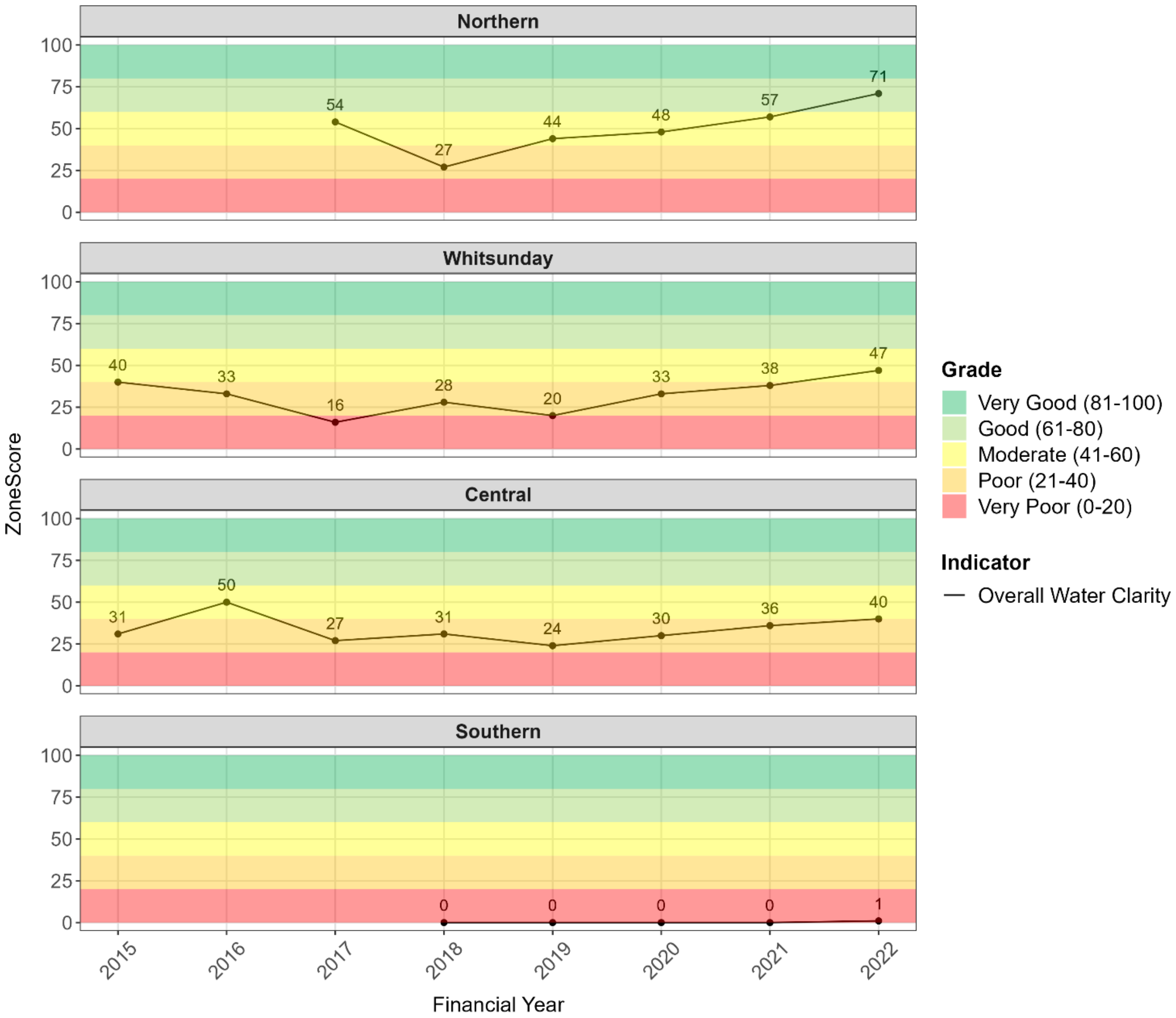


Figure 37. Marine zone water clarity scores in 2022 compared to the historic record. The annotated solid black line (overall water clarity) is an average of the three indicators shown in the previous figure.

4.1.4 Pesticides

Pesticides in the Inshore Zones are reported using the PRM. This approach considers pesticides with multiple Modes of Action (MoA) that exert their toxicity by different means. As a result, the impacts to the marine environment through land-based run-off are assessed for a greater number of chemicals than when previously using the PSll-HEq (PSll Herbicide Equivalent Concentration) method (2017 and prior).

In the 2022 Report Card, 14 pesticides were measured in the Northern and Central Zones, and 12 in the Southern Zone. 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 2022 Report Card results

Sampling methods: Pesticides data were collected using passive polar samples with up to four deployments at each site throughout the wet season. The specific pesticides included in the analysis have changed since previous years. Pesticide sampling no longer includes the use of PDSM passive samplers and now relies exclusively on Empore® disks. Therefore, pesticide reporting is restricted to the following 16 pesticides: 2,4-D, ametryn, atrazine, diuron, haloxyfop, hexazinone, imazapic, imidacloprid, MCPA, metsulfuron-methyl, metolachlor, metribuzin, prometryn, simazine, tebuthiuron, and terbuthylazine.

Reporting: Passive sampler deployments record a time-averaged estimate of pesticide concentrations (and may not capture event spikes in concentration) 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 data gap: Pesticides are not monitored in the Whitsunday Zone as previous investigations by MMP have determined that, with no major creeks or rivers flowing into this Zone, pesticide risk is very low. With risk being low, we have established that it would be poor value for the Partnership to contract a field team to undertake this work.

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 at Sandy Creek, Flat Top Island, and Repulse Bay. It was thought that these sites may be 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. New sites have been chosen and MMP pesticides monitoring will occur for the 2022-2023 wet season. This impacts spatial and temporal coverage of the Central Zone and is reflected in the confidence score in Representativeness.

Timing of the first flush: The first Euri Creek deployment (17/11/2021 - 13/12/2021) was removed before the first flush in the Don Basin (determined to be 1/1/2022), while the second deployment (30/03/2022 - 04/05/2022) was towards the end of the wet season, in total measuring 16% of the target period. The single Slade Island deployment (15/11/2021 - 14/12/2021) captured the first flush of the Pioneer Basin (determined to be 27/11/2021) however measured only 7% of the target period. Confidence scores have been revised accordingly in Representativeness (Table 38).

Results (Table 36 and Appendix 8.4.1.6)**:**

Table 36. Standardised pesticide scores for the 2022 Report Card, compared to the historic record. 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.

2022 Report Card^				2021	2020	2019	2018	2017
	Sample Type	**Program**	**Scores**	**Pesticide Score**				
Northern	Passive Polar	NQBP	100*	100*	100**	99**		
Whitsunday								
Central	Passive Polar	MMP^^		85	74	60	54	50
	Passive Polar	NQBP	100	100	100**	99**		
Southern	Passive Polar	SIP	100	100	75	100		

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

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

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

^Scores are not directly comparable between years due to changes in the inclusion of analytes measured.

^^Redesign of the MMP inshore pesticides program resulted in a data gap during the 2021-22 reporting year.

Key Message:

1) In the 2022 Report Card the Central and Southern Zones pesticides grade remained 'very good'. Low rainfall in the MWI region reduced freshwater discharge into the marine environment (Section 1.4.4), alongside reductions in sampler deployments, sites and analytes sampled are likely to have influenced results in pesticide grades.

Pesticides in the **Northern Zone** were monitored with Passive Polar samplers instead of grab samples for the second time, an improvement in methodology due to the ability to record concentration over an increased temporal scale. Scores for the 2022 Report Card are included for reference only as the deployments did not capture the first flush onset of the wet season.[30]

In the **Central Zone**, the decommission of three MMP sites and a single deployment at the NQBP site at Slade Island contributed to a revision of confidence scoring. Slade Island, where scores remained 'very good' (100).

In the **Southern Zone**, risk remained 'very low' (100% of species protected).

Despite current scores showing 'low' or 'very low' risks from pesticides in inshore zones it is important to note that long term trends in the region suggest that concentrations of PSII herbicides are increasing at monitoring sites within the Great Barrier Reef Marine Park (Taucare et al., 2022). Pesticide management and load reduction plans may reduce the flow of pesticides into the marine environment at a site level, however there may be accumulation of PSII herbicides as they have long half lives in the marine environment (Taucare et al., 2022).

[30] These deployments were within the 1st November to 30th April target period, yet removed before the first flush of the wet season rains.

4.1.5 Overall Marine Water Quality Index

In the 2022 Report Card, nutrients, Chl-*a* and water clarity grades ranged from 'good' to 'very poor' across the MWI inshore zones. The Southern, Central, and Whitsunday Zones remained 'moderate', while the Northern Zone recorded a grade change from 'moderate' to 'good'. Appendix 8.4.1. presents boxplots along with site-level and historic (2016 to 2021) scores for individual indicators.

Results (Table 37, Figure 38)

Table 37. Water quality indicator category and overall scores and grades for the 2022 Report Card for inshore zones.

Marine Zones	2022 Report Card				
	Nutrients	Chl-*a*	Water Clarity	Pesticides	Water Quality Index
Northern	70	47	71	100^	**63**
Whitsunday	30	47	47		**41**
Central	42	23	40	100	**53**
Southern	78	37	1	100	**54**

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

^Passive Polar samples used as reference due to lack of temporal representativeness during wet season

Key Messages:

1) Similar to the previous year, below average rainfall across the region likely influenced grades, as lower freshwater inputs correspond with less nutrients, sediments, and pollutants transported from agricultural and urban areas.
2) Chlorophyll-*a* was an issue in 2021-22 as the lowest scoring indicator category in both Central and Northern Zones.
3) Improvements in the Northern Zone were driven by decline in nutrients (particularly PN) and improved Water Clarity scores across all sites.

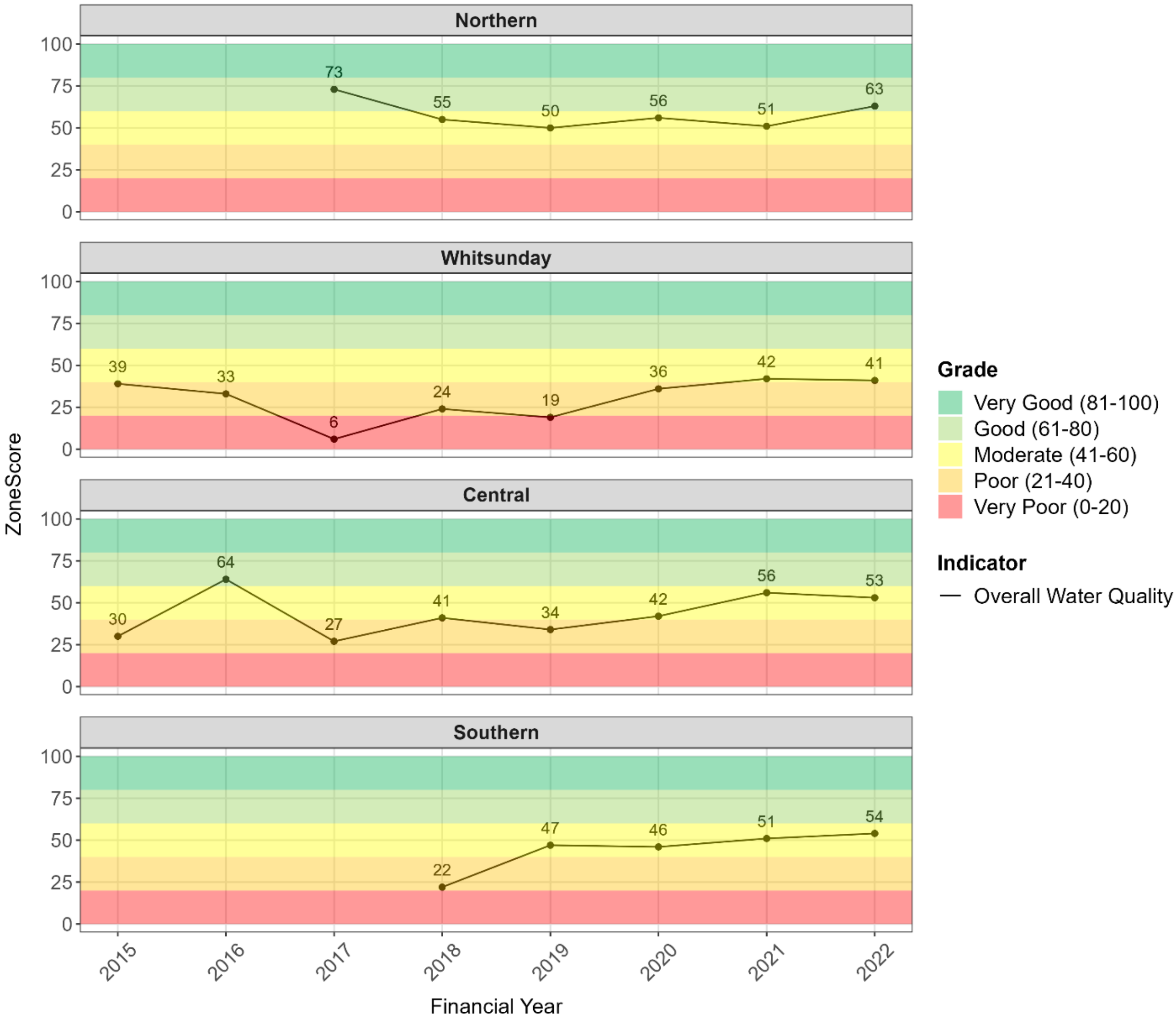


Figure 38. Water quality scores and grades for the 2022 Report Card for inshore zones compared to the historic record. Scores from the 2015 Report Card have been back-calculated to exclude pesticide scores in the Whitsunday Zone so that they are directly comparable to 2016 and 2017 scores.

4.1.6 Offshore Marine Zone

Offshore marine water quality scores were previously sourced from the BoM 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 the 2022-23 reporting year. See Appendix 8.4.1.7 for a historic record of Offshore water quality results.

4.1.6.1 Confidence

Confidence in water quality index scores in the inshore zones is 'moderate', ranging from 'moderate' to 'low' for different indicators (Table 38). Improvements to quality assurance and control of turbidity data are continuing as part of the NQBP marine monitoring program, with measured error confidence for water quality in Northern and Central Zones adjusted for the 2019 Report Card. It is expected confidence scores for measured error will change in future Report Cards to reflect these changes in QAQC measures.

Table 38. Confidence associated with water quality index results in marine zones for the 2022 Report Card. 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.

Zone	Indicator Category	Maturity of Methodology (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured Error (x0.71)	Final	Rank
Northern	Nutrients	3	3	1.5	3	3	10.5	4
	Chl-*a*	3	3	1.5	3	3	10.5	4
	Water Clarity	3	3	1	3	2	8.8	3
	Pesticides	2	2	1	2	1	6.27	1
Whitsundays	Nutrients	3	3	1	3	3	9.5	3
	Chl-*a*	3	3	1	3	3	9.5	3
	Water Clarity	3	3	1.5	3	3	10.5	4
	Pesticides							
Central	Nutrients	3	3	2	3	3	11.5	4
	Chl-*a*	3	3	2	3	3	11.5	4
	Water Clarity	3	3	2	3	2	10.8	4
	Pesticides	2	2	0.5	2	1	5.27	3
Southern	Nutrients	3	3	1.5	3	3	10.5	4
	Chl-*a*	3	3	1.5	3	3	10.5	4
	Water Clarity	3	3	1	3	3	9.5	3
	Pesticides	2	2	2	2	1	8.27	3
Inshore Water Quality Index							**9.6**	**3**

Rank based on final score: 1 (very low): 4.5–6.3; 2 (low): >6.35–8.1; 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). Reefs are assessed across four inshore and one offshore reporting zone (Figure 39).

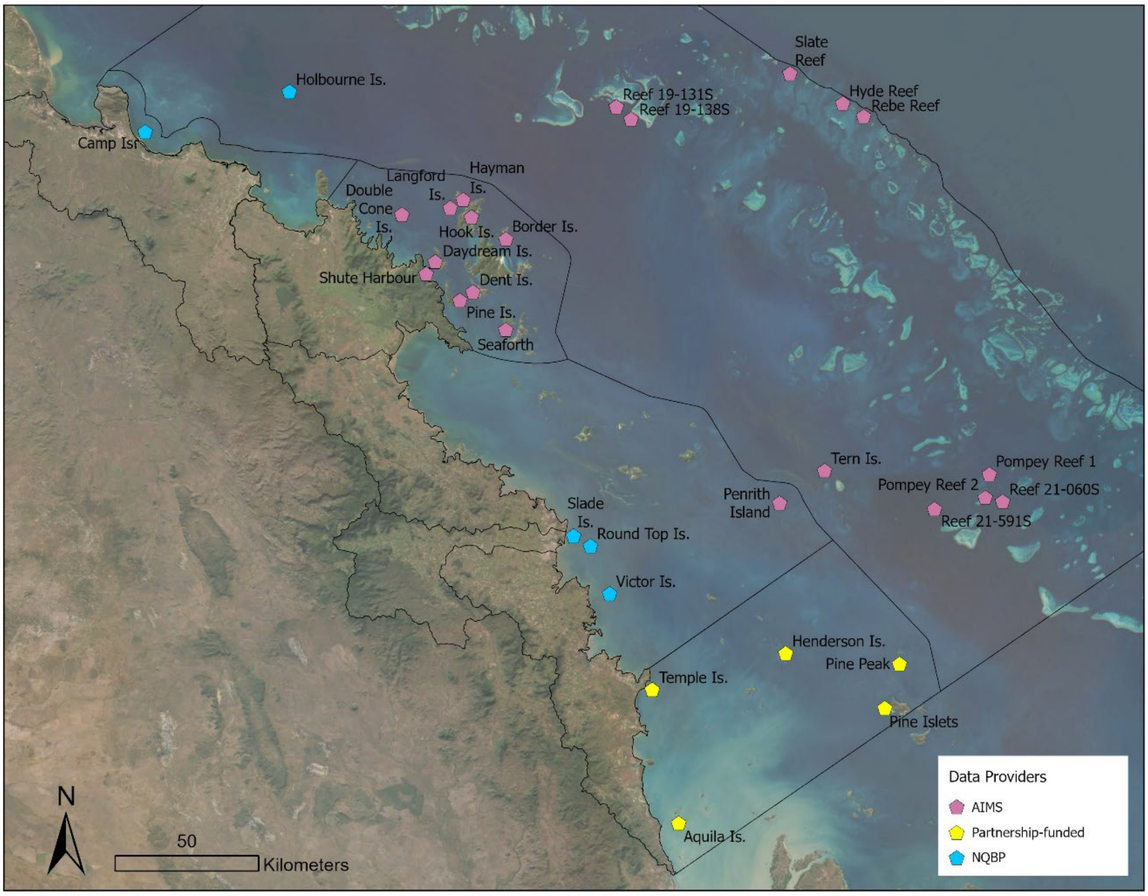


Figure 39 Coral monitoring sites for inshore and offshore zones during the 2021-22 reporting year. Sites in each zone are colour symbolised according to data provider.

4.2.1 Inshore Marine Zones

Results (Table 39, Figure 40, Figure 41, Appendix 8.4.2):

Table 39. Inshore and Offshore coral scores and grades for the 2021–22 Report Card.

Marine Zones	2022 Report Card					
	Cover	Macroalgae	Juvenile	Cover Change	Composition	Coral Index
Northern	24	50	10	12		**28**
Whitsunday	26	31	43	32	24	**33**
Central	30	57	63	35		**46**
Southern	40	0	13	46		**25**
Offshore	47		93	47		**62**

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) Although coral scores remained 'poor' across the Whitsunday Zone, there was an improvement in grade since 2020 (28 to 33) (Appendix 8.4.2). This improvement reflects the gradual recovery of coral communities following TC Debbie in 2017 (Thompson et al., 2022).

2) Recovery since TC Debbie is 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 is a continued cause for concern to coral communities in the Whitsundays. 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).

3) Inshore coral communities in the Southern Zone have shown increases in Coral Cover from 'poor' (37) to (40), showing some recovery after the severe marine heat wave in 2020 (Davidson et al., 2022) (1.4.5 Coral bleaching).

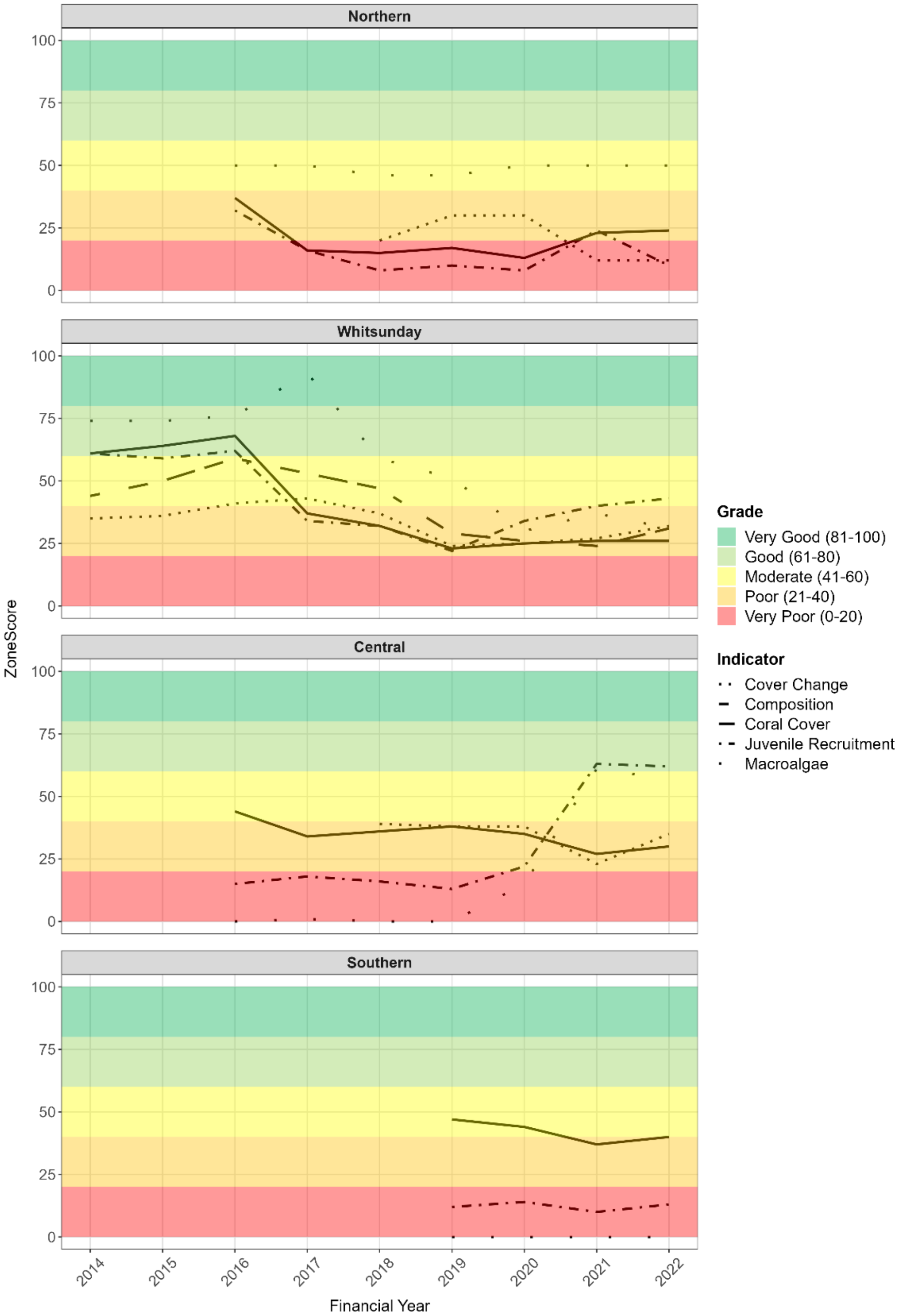


Figure 40. Inshore coral indicator scores and grades for the 2022 Report Card compared to the historic record. Scores in the **Northern Zone** before 2021 are not directly comparable to previous years due to changes in sampling design and before 2020 due to changes in reef aggregation level.

Overall scores in the **Northern Zone** remained ‘poor’ (from 32 in the previous year to 28 in 2021–2022). This is due largely to a decline in Juvenile Recruitment at both Camp and Holbourne Island sites.

Coral scores in the **Whitsunday Zone** remained poor (31 to 33). The slight increase since 2021 demonstrates the ongoing recovery of coral communities since the severe impacts of TC Debbie. The most notable improvements were at Pine, Hook, and Daydream Islands. Increased scores at Pine Island were driven by Community Composition, which increased from ‘very poor’ (0) to ‘very good’ (1). Changes in community composition scores when coral cover is low need to be treated with caution as this indicator scores relative abundance among coral taxa. Hook Island saw increases in most indicators, most notably in Macroalgae which improved from ‘poor’ (25) to ‘very good’ (83). Although Coral Cover scores remain ‘very poor’ at Daydream Island, cover increased, and this along with the increase in Cover Change score from ‘very poor’ (0) to ‘moderate’ (50) and an increase in juvenile density demonstrates that recovery is underway.

Overall scores remained moderate in the **Central Zone**, increasing from 43 to 46. Notable changes include a decline in Juvenile Recruitment at Slade Island from ‘moderate’ (51) to ‘poor’ (27), improvement in the Cover Change score at Round Top Island from ‘poor’ (25) to ‘moderate’ (43), and increase in Juvenile Recruitment at Victor Island from ‘poor’ (38) to ‘good’ (60).

Coral scores in the **Southern Zone** improved from ‘very poor’ (16) to ‘poor’ (25). Resilience of coral communities in this region continues to be challenged by high cover of macroalgae and low density of juvenile hard corals (Davidson et al., 2022), where persistent algae cover may impede hard coral recruitment. However, this is the first improvement in coral scores since the inception of the SIP monitoring. Previous years’ scores were negatively impacted by a bleaching event in 2020, however despite a subsequent, more modest, bleaching event in 2022 most reefs demonstrated increases in hard coral cover (Davidson et al., 2022).

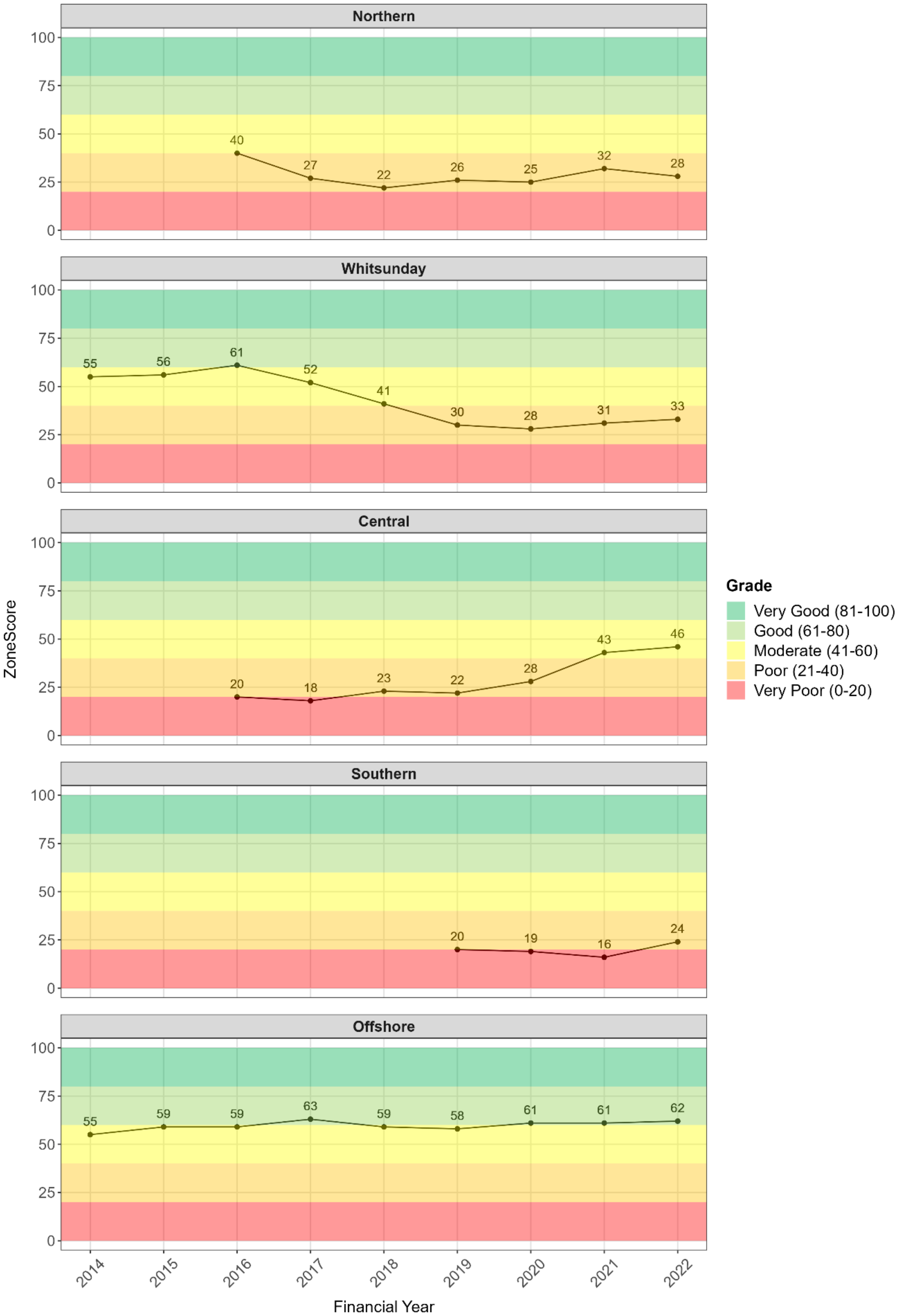


Figure 41. Inshore and Offshore overall coral index scores and grades for the 2022 Report Card compared to the historic record. Scores in the **Northern Zone** before 2021 are not directly comparable to previous years due to changes in sampling design and before 2020 due to changes in reef aggregation level. **Offshore** coral scores have been back-calculated before 2022 to account for the decommission of several sites in the current reporting cycle, and Offshore cover change scores (recording change in coral cover during periods lacking acute disturbances) have been amended in 2020 due to updates in the disturbance categorisation at AIMS.

4.2.2 Offshore Marine Zone

The Offshore Zone was less impacted by TC Debbie in 2017 and since then most reefs have shown clear improvement in coral cover. In 2020 AIMS revised their monitoring program and no longer survey several of the more southern reefs previously reported in the Offshore Zone. The improvement in coral score in 2021-22 (62) compared to that reported in 2020-21 (59) reflect both ongoing recovery of most reefs but also the change in the AIMS sampling design, as several of the reefs no longer monitored had relatively low scores in 2020-21. For comparative purposes, historic scores have been back-calculated to include only those reefs included in the 2022 Report Card scoring.

Results (Table 39, Figure 35, Figure 36, and Appendix 8.4.2)**:**

Key Messages:

1) Coral scores in the Offshore Zone remained 'good'.
2) Overall scores were driven by on-going 'very good' scores for juvenile coral densities (93) and 'moderate' but increasing scores for Coral Cover (43 to 47).

Juvenile coral density was 'good' or 'very good' at every site 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 juvenile coral density score of 42 'moderate' for **Penrith Island** may be influenced by the reef's spatial remoteness (see the Methods Report) resulting in reduced larval supply relative to the more offshore reefs (A. Thompson, pers. comm. 14/04/21).

Coral cover and cover change: Increases in coral Cover occurred at most reefs surveyed in 2022. Cover Change scores remained 'moderate', with no change since the previous year (47). In combination these results demonstrate that the recovery of these coral communities is occurring at expected rates.

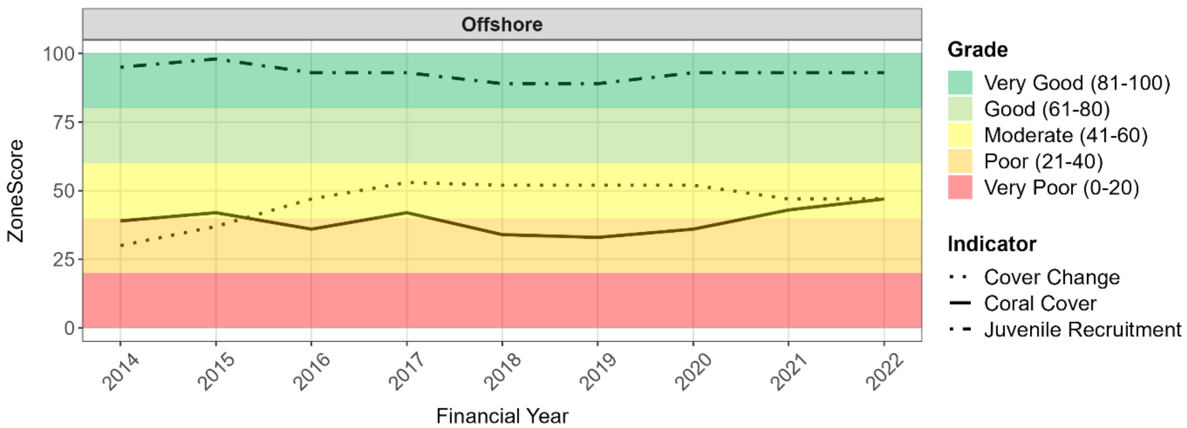


Figure 42. Offshore coral indicator scores and grades for the 2022 Report Card compared to the historic record. **Offshore** coral scores have been back-calculated before 2022 to account for the decommission of several sites in the current reporting cycle, and Offshore cover change scores (recording change in coral cover during periods lacking acute disturbances) have been amended in 2020 due to updates in the disturbance categorisation at AIMS.

4.2.3 Confidence

Confidence in scores for coral indicators is ‘high’ (Table 40).

Table 40. Confidence associated with coral index results in marine zones for the 2020 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	4
	Change	3	3	1	3	2	8.8	4
	Juvenile	3	3	1	3	2	8.8	4
	Offshore Coral Index						**8.8**	**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.

4.3 Seagrass Index

Seagrass data for the 2022 Report Card were sourced from either the AIMS MMP, the Queensland Ports Seagrass Monitoring Program (QPSMP), or the Partnership-funded Southern Inshore Program (SIP) (Figure 43). The MMP measures abundance (percent cover) and resilience, while the QPSMP and SIP condition indicators are area, biomass, and species composition. Following a period of baseline data collection, the 2021 Report Card was the first to report on seagrass condition in the Southern Zone.

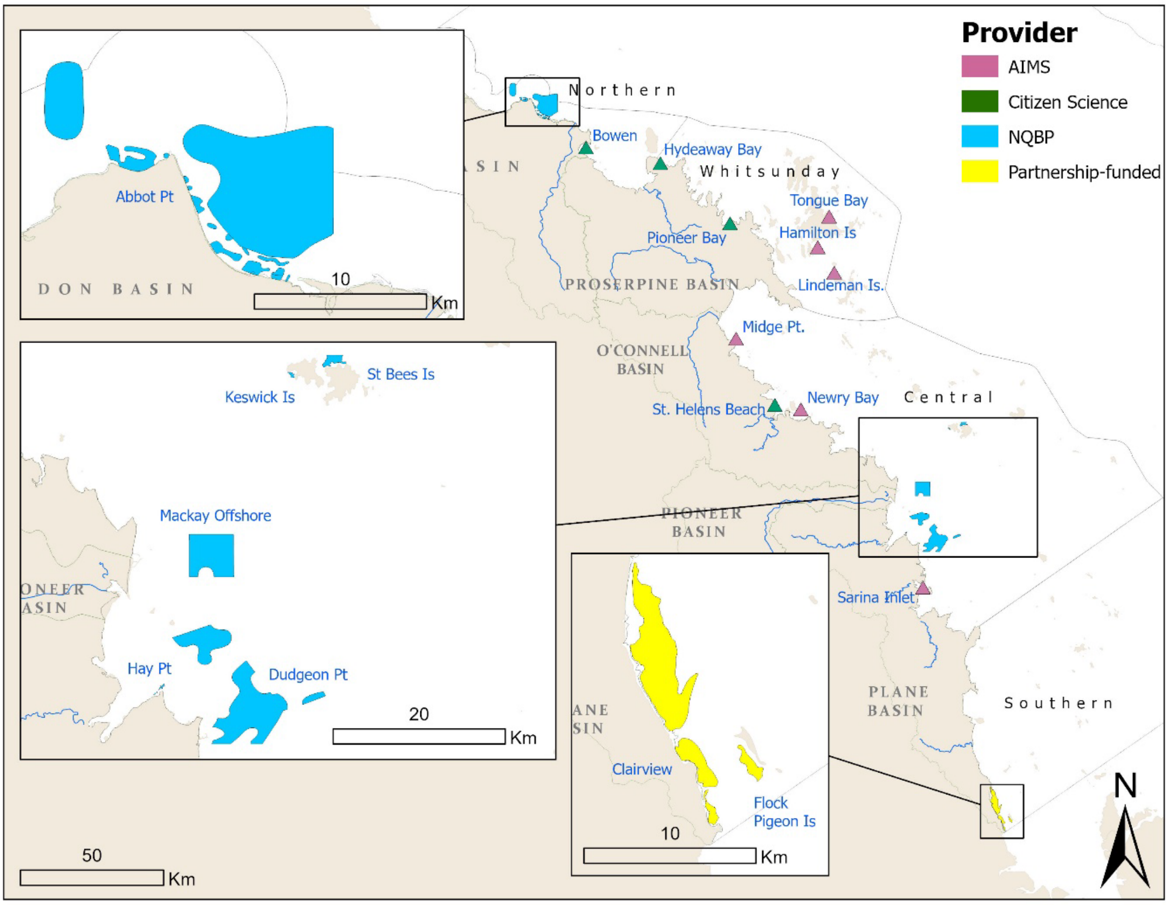


Figure 43. Seagrass monitoring sites for the inshore zones. Colours represent each data provider with MMP data from AIMS shown as pink, NQBP as blue, Seagrass Watch citizen science data as green, and Partnership-funded data from the SIP as yellow. Sites following the QPSMS methodology are shown as polygon extents of the meadow survey area, while sites following the MMP methodology are shown as a triangle point feature. Seagrass is not currently reported on in the Offshore Zone.

Notes on data interpretation for 2022 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 41, Table 42, and Appendix 8.4.3.)**:**

Table 41. Results for seagrass indicators for inshore zones for the 2021–22 reporting year. 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.

2022 Report Card						
Zones	MMP		NQBP			Seagrass Index^
	Abundance	Resilience	Biomass	Area	Species Comp.	
Northern	75		86	85	86	**78**
Whitsunday	29	53				**38**
Central	57	54	70	91	91	**64**
Southern			78	89	86	**76**

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) Improvements in seagrass scores demonstrate continued recovery after impacts from TC Debbie in 2017.
2) The Northern Zone continued to show improvement after seagrass loss from TC Debbie, moving from 'poor' (25) in 2017–18 to 'moderate' (52) in 2018–19 to a score of 'good' for the past three consecutive years (currently 78).
3) Seagrass grades in the Whitsunday Zone have been poor for four consecutive years, however improvement was seen at Lindeman Island and Hideaway Bay.
4) The shift in Central Zone grade from 'moderate' (58) to 'good' (64) was driven in part by the inclusion of a new meadow offshore from Mackay Harbour, where surveys have shown a general increasing trend across all indicators since monitoring began in 2017.
5) Seagrass condition is reported in the Southern Zone for the second time, improving from 'moderate' (60) to 'good' (76), with all indicators meeting guideline values in all three monitored meadows.

Seagrass meadows across the region have been in a period of recovery since the devastating impacts of TC Debbie in March 2017 (Table 42). During TC Debbie, meadows sustained high rainfall, flood plumes, increased wave height, and strong winds, which severely impacted seagrass in the region. Overall condition scores improved in all zones during the 2021-22 reporting period, although the

Northern Zone remained 'good' and the Whitsunday Zone remained 'poor'. Grades in the Central and Southern Zones improved from 'moderate' to 'good'.

Table 42. Results for seagrass indicators for inshore zones for the 2021–22 reporting year, compared to previous Report Cards (2017–2021). 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).

Marine Zones	2022	2021	2020	2019	2018*	2017*
	Seagrass Index					
Northern	78	70	63	52	25	58
Whitsunday	38	29	33	27	13	24
Central	64	58	65	56	45	30
Southern	76	60	64	82		

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
*2017–2018 scores have not been back-calculated with the MMP Resilience metric and are therefore not directly comparable to current scores.

Northern Zone: Scores improved yet remained 'good'. Improvements occurred primarily in Abbott Point and Bowen monitoring meadows, where all indicators improved from 'moderate' to 'good'.

Whitsunday Zone: Overall grade improved in the Whitsunday Zone yet remained 'poor'. Improvements were seen in the scores at Hydeaway Bay, scoring 'very good' and reversing a three-year decline. Lindeman Island sites showed improvement, with both subtidal and intertidal sites scoring within guideline values for the Resilience metric. Pioneer Bay, Tongue Bay, and Hamilton Island remained poor. Resilience scores in the Whitsundays reached their highest level since TC Debbie. However, 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).

Central Zone: There was an overall improvement from 'moderate' to 'good' across the Central Zone, and scores were variable between sites. Hay Point Biomass declined, yet all NQBP sites scored 'very good' for Area. Newry Bay, which declined dramatically in the previous Report Card, improved from 'very poor' to 'poor', yet Sarina Inlet seagrass remained in 'poor' condition for the third year in a row.

Southern Zone: Overall condition in this zone improved in 2021-22, with all three monitored meadows scoring 'good' or 'very good' for all three indicators. The two large coastal meadows were in a similar condition to the previous year, however the smaller offshore meadow adjacent to Flock Pigeon Island showed recovery from the substantial decline in area recorded in 2020-2021 (Rasheed et al., 2022). Dugong feeding trails were recorded in all meadows, as was the presence of numerous green turtles during the survey.

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 43).

Table 43. 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 no score for marine fish condition for the 2022 Report Card. Identification of appropriate indicators and methodology development is currently underway for progressing fish assessment indicators in inshore and offshore zones. Development of this index using citizen science and/or engagement of recreational fishers is currently being investigated by the TWG, Wet Tropics, Dry Tropics, and MWI Partnerships.

4.5 Overall Marine Zone Condition

Results (Table 44, Table 45)**:**

Table 44. Overall inshore and offshore marine scores for the 2021–22 Report Card.

2022 Report Card						
Marine Zones	**Water Quality**	**Coral**	**Seagrass**	**Fish**	**Total Score and Grade**	
Northern	63	28	78		**56**	**C**
Whitsunday	41	33	38		**37**	**D**
Central	53	46	64		**54**	**C**
Southern	54	25	76		**51**	**C**
Offshore		62				

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) Scores remained similar to the previous two years and are likely tied to similar patterns of rainfall across the region.
2) In the Southern Zone improvements in score reflect improvements in the condition of coral and seagrass.

Overall, condition grades for inshore zones in the 2022 Report Card ranged from 'poor' (D) to 'moderate' (C). The Offshore Zone cannot be given an overall grade, as only the coral index was measured during the 2021–22 reporting cycle; however, coral scores remain for reference (Table 44).

While scores remained 'moderate' in the **Northern and Central Zones**, changes were driven by a decline in coral condition that balanced an improvement in seagrass condition. The **Whitsunday Zone** remained 'poor' for the sixth consecutive year.

The partnership-funded **Southern Inshore Program** is now well-established, with water quality (including pesticides) and coral indicators now assessed across multiple years. The addition of condition assessment for seagrass meadows in the current Report Card is particularly relevant for dugong protection in the region (Coles et al., 2002; Van De Wetering et al., 2021).

Table 45. Overall inshore and offshore marine scores for the current reporting year, compared to the historic record. Scores incorporate back-calculations in the year prior to methods changes.

Marine Zones	2022	2021	2020^^	2019^	2018	2017*
	Total Score					
Northern	56	51	50	43	35	44
Whitsunday	37	34	32	25	27	27
Central	54	52	44	36	37	31
Southern	51	42	43	34	22	
Offshore			77	77	77	76

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

^^2020 scores adjusted to refer to back-calculated results due to changes in water quality and seagrass methods applied in the 2021 Report Card.

^2019 scores adjusted to refer to back-calculated results due to changes in seagrass methods applied in the 2021 Report Card.

*2017 scores adjusted to refer to back-calculated results due to changes in pesticide and seagrass methods applied in the 2018 Report Card.

5 Urban Water Stewardship Framework

Urban Water Stewardship Framework (UWSF) assessments are implemented every two years, and results below represent the most current data available, from the first round of assessments undertaken in 2020-21. The second round of assessments is currently underway, to be reported in the 2022-23 Report Card. UWSF is assessed according to three indices: Developing Urban, Established Urban, and Point Source.

Results (Figure 44, Table 46 – Table 48):

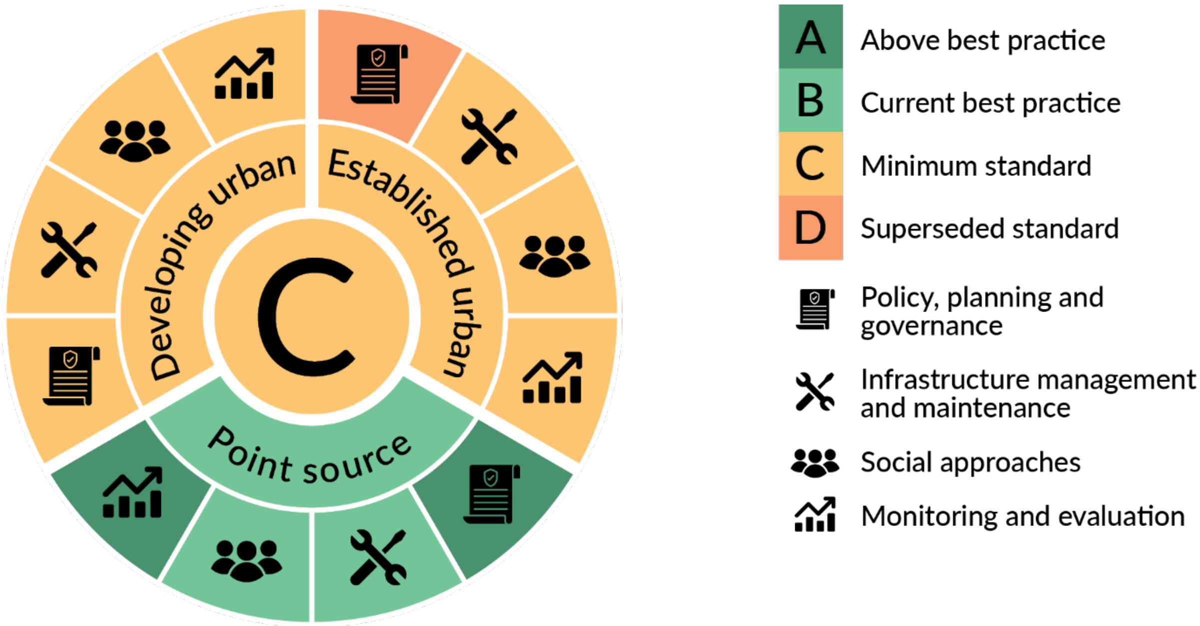


Figure 44. Indicator categories (outer ring), indicators (middle ring), and overall index grade (inner ring) that contribute to the overall UWSF score. The indicator categories (clockwise) for each indicator are 'policy, planning, and governance' symbolised by a scroll, 'infrastructure, management, and 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) The Developing Urban and Established Urban components of the framework received an overall rating of C, while the Point Source component received an overall rating of B. The latter represents management considered in line with current industry best management practice. It means going above and beyond minimum standards to protect or improve urban water quality.

3) For the Developing Urban and Established Urban components, elements received either a C or D grade. This suggests that all elements relating to pre- and post-development activities are at either a moderate or high risk of negatively influencing water quality.

4) Regionally, the poorest-scoring indicators related to policy, planning, and governance for the Developing and Established Urban categories, receiving either moderate or high-risk grades for all councils. This indicates that improved erosion and sediment control (ESC) and Stormwater Planning in our region could significantly reduce the risk to water quality.

5.1.1 Developing Urban

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

- One element of Policy, Planning, and Governing (site-based and ESC plans) was the poorest-scoring element in the Developing Urban component, with all LGAs receiving a 'high risk' grade (Table 46). This suggests 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.

- Regional grades for the Developing Urban indicator category (component) were either 'moderate' (C) or 'high risk' (D) for all indicators (elements).

Table 46. Scores and grades for Management Activity Groups for the Developing Urban indicator category. 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)	10.00	9.75	10.00	9.92
DU 2	Policy, planning, and governance (development assessment and approvals)	7.00	8.75	8.75	8.17
DU 3	Policy, planning, and governance (Site-based and ESC plans)	0.00	2.00	9.50	3.83
DU 4	Infrastructure management & maintenance (Site-based USM and ESC)	3.00	5.00	11.00	6.33
DU 5	Social approaches (Collaboration, partnerships, capacity building, and learning)	6.00	15.50	7.50	9.67
DU 6	Monitoring, evaluation, reporting & improvement	6.00	12.75	9.43	9.39

5.1.2 Established Urban

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

- Similar to the Developing Urban component, all indicators scored as 'high risk' (D) or 'moderate risk' (C) for the Established Urban indicator category (Table 47). This indicates regional room for improvement across various post-development activities, including 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.

- Both of the policy, planning, and governance indicators (elements) graded as high risk (D) at the regional level. This indicates a gap in policy and planning for both urban stormwater systems (USS) and the incorporation of total water cycle management and catchment-based principles in informing decision-making urban water processes.

Table 47. Scores and grades for Management Activity Groups for the Established Urban indicator category. 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)	10.00	4.00	0.00	4.67
EU 2	Policy, planning, and governance (Stormwater Management Plan)	7.00	1.00	0.00	2.67
EU 3	Infrastructure management and maintenance (Stormwater network)	7.00	9.00	3.33	6.44
EU 4	Social approaches (Collaboration, partnerships, capacity building, and learning)	7.50	14.25	1.00	7.58
EU 5	Monitoring, evaluation, reporting, and improvement	11.00	6.00	6.00	7.67

5.1.3 Point Source

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

- Point Source components were all rated either as A (lowest risk) or B (moderate risk) level practice (Table 48). The highest scores were regarding management practices associated with activities in the policy, planning, and governance 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.

Table 48. Scores and grades for Management Activity Groups for the Point Source indicator category. 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)	18.75	13.75	20.00	17.50
PS 2	Infrastructure management and maintenance (Sewerage network)	13.50	15.00	20.00	16.17
PS 3	Infrastructure management and maintenance (new STP and upgrades)	17.50	15.00	15.00	15.83
PS 4	Social approaches (Collaboration, partnerships, capacity building, and learning)	17.00	14.50	19.00	16.83
PS 5	Monitoring, evaluation, reporting, and improvement	19.00	18.50	18.00	18.50

5.1.4 Confidence

Overall confidence for the Urban Water Stewardship indicator was ‘poor’ (Table 49).

Table 49. Confidence associated with Urban Water Stewardship Results for the 2021–22 monitoring period (2020-21 data). Confidence criteria are scored 1 to 3 and then weighted by the value identified in parentheses as per the UWSF implementation manual (DES, 2020). Final scores (6–18) are additive across weighted confidence criteria. Summary rationales are given below each criterion.

	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). The assessments took place on the traditional country of 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.

Results (Figure 45, Table 50):

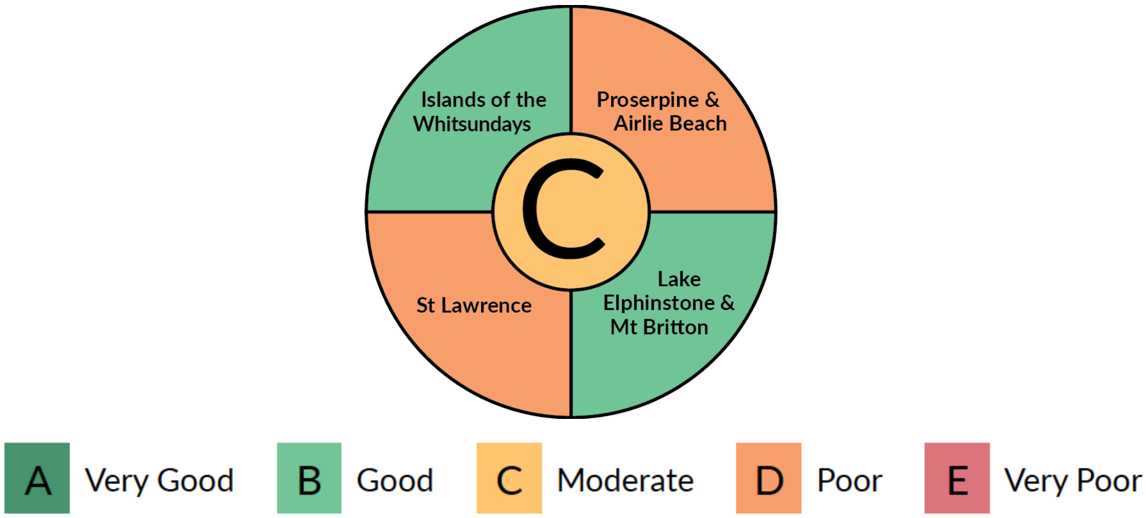


Figure 45. The overall grade for the MWI Region based on the 2020-21 Cultural Heritage results.

Table 50. Scores and grades for the 2015, 2018 and 2021 Cultural Heritage Assessments. Sites not visited during an assessment are shaded in grey.

ZONE		2021	2018	2015
St Helens	Average Score	-	2.5	1.1
	Grade	-	D	E
Islands of the Whitsundays	Average Score	3.9	3.6	3.7
	Grade	B	B	B
Cape Hillsborough	Average Score	-	2.7	2.6
	Grade	-	C	C
Cape Palmerston	Average Score	-	2.5	-
	Grade	-	D	-
Proserpine-Airlie Beach	Average Score	2.15	-	-
	Grade	D	-	-
Lake Elphinstone-Mount Britton	Average Score	3.6	-	-
	Grade	B	-	-
St Lawrence*	Average Score	2.1		
	Grade	D		
Average Score for Region		2.9	2.8	2.5
Average Grade for Region		C	C	D
Scoring range: Very Poor = 0 to 1.5 | Poor = 1.6 to 2.5 | Moderate = 2.6 to 3.5 | Good = 3.6 to 2.5 | Very Good = 4.6 to 5 | No score/data gap				

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8 Appendices

8.1 Climate

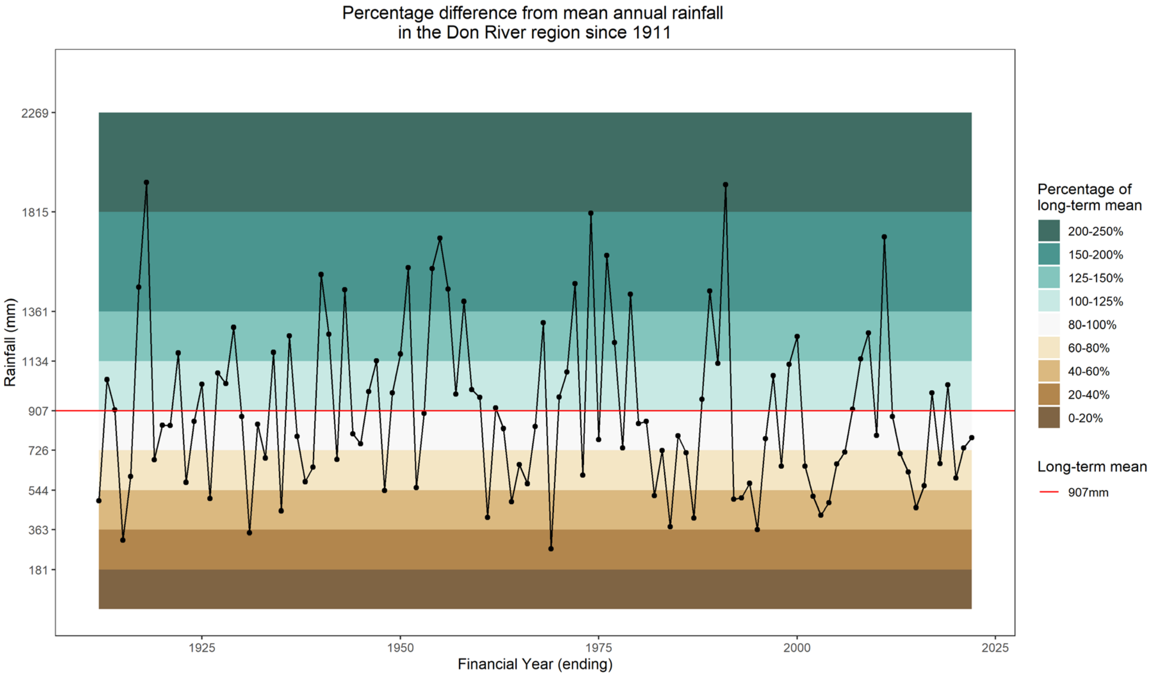

Figure 46. Annual rainfall totals for the Don Basin. Financial year on the x-axis, annual rainfall (mm) on the y-axis. Long-term mean (907 mm) red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2021-22). Long-term annual rainfall data sourced from BoM and calculated using results from 1911–2022.

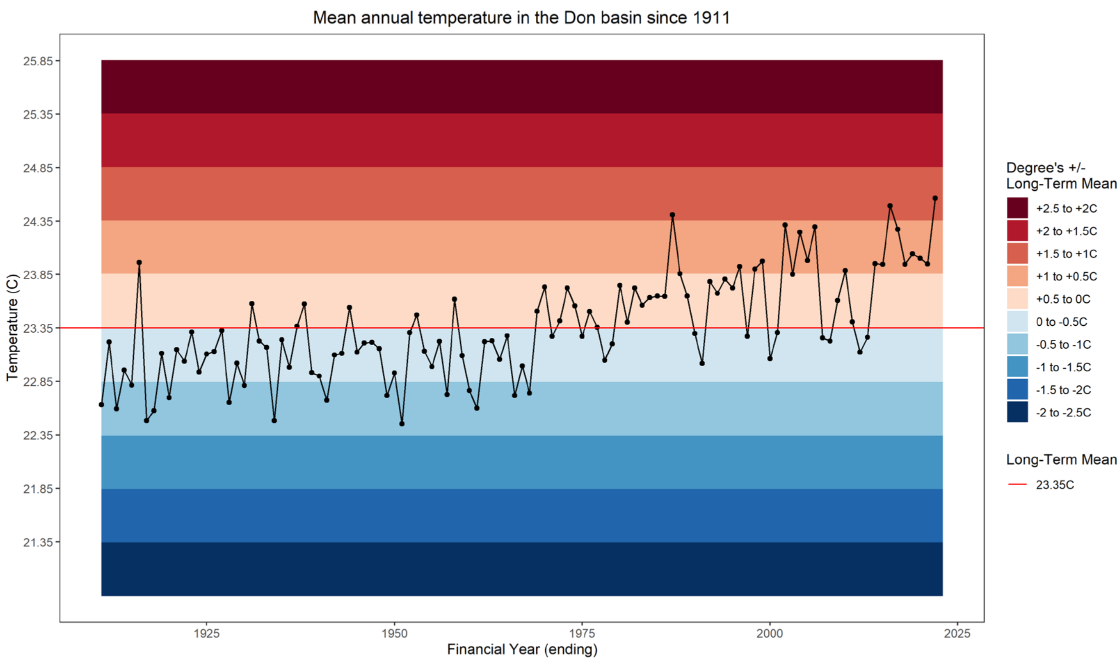

Figure 47. Annual temperature totals for the Don Basin. Financial year on the x-axis, annual temperature (C) on the y-axis. Long-term mean (23.35 C) red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2021-22). Long-term annual temperature data sourced from BoM and calculated using results from 1911–2022.

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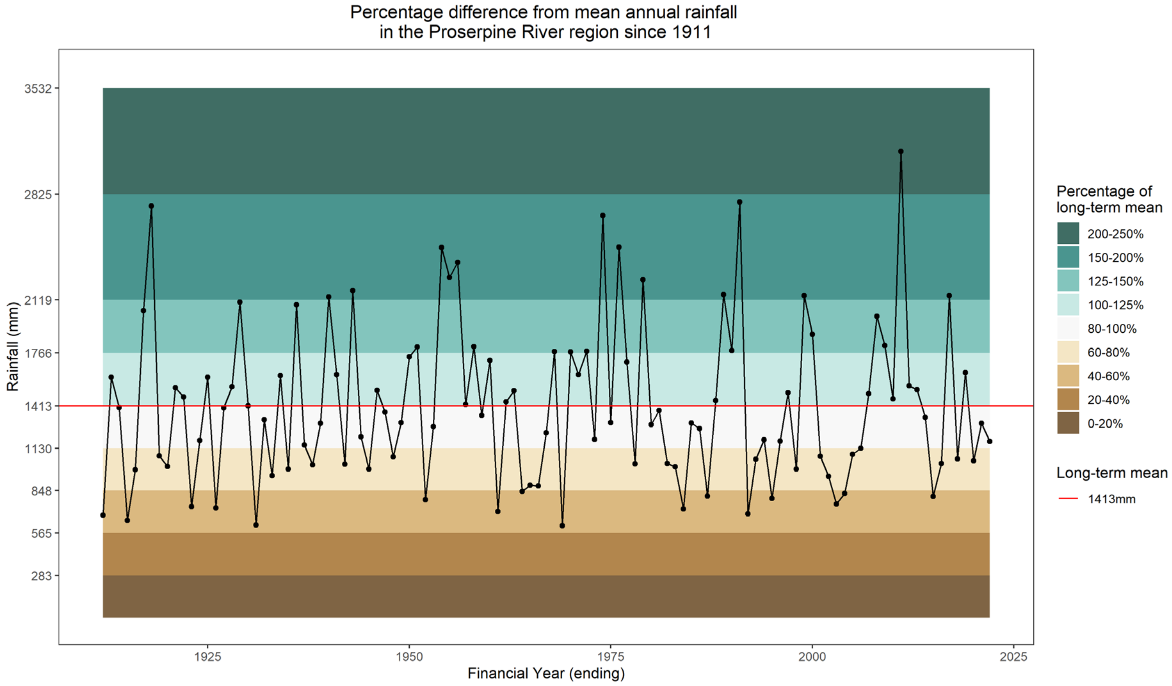

Figure 48 Annual rainfall totals for the Proserpine Basin. Financial year on the x-axis, annual rainfall (mm) on the y-axis. Long-term mean (1413 mm) represented by red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2021-22). Long-term annual rainfall data sourced from BoM and calculated using results from 1911–2022.

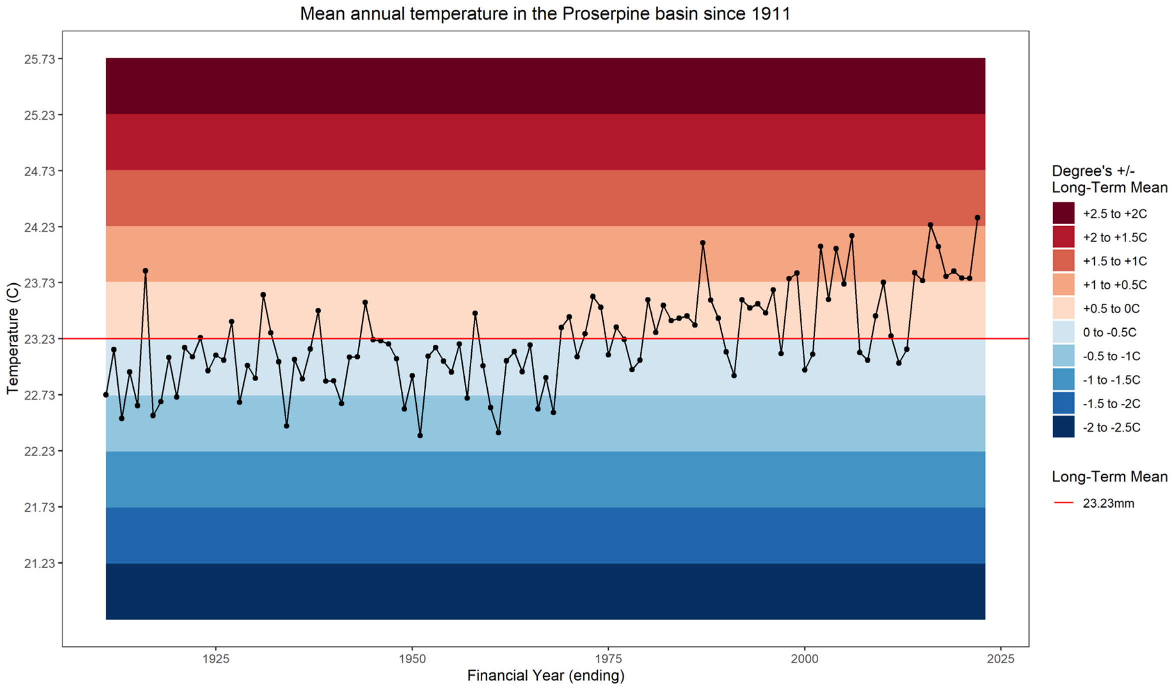

Figure 49. Annual temperature totals for the Proserpine Basin. Financial year on the x-axis, annual temperature (C) on the y-axis. Long-term mean (23.23 C) represented by red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2021-22). Long-term annual temperature data sourced from BoM and calculated using results from 1911–2022.

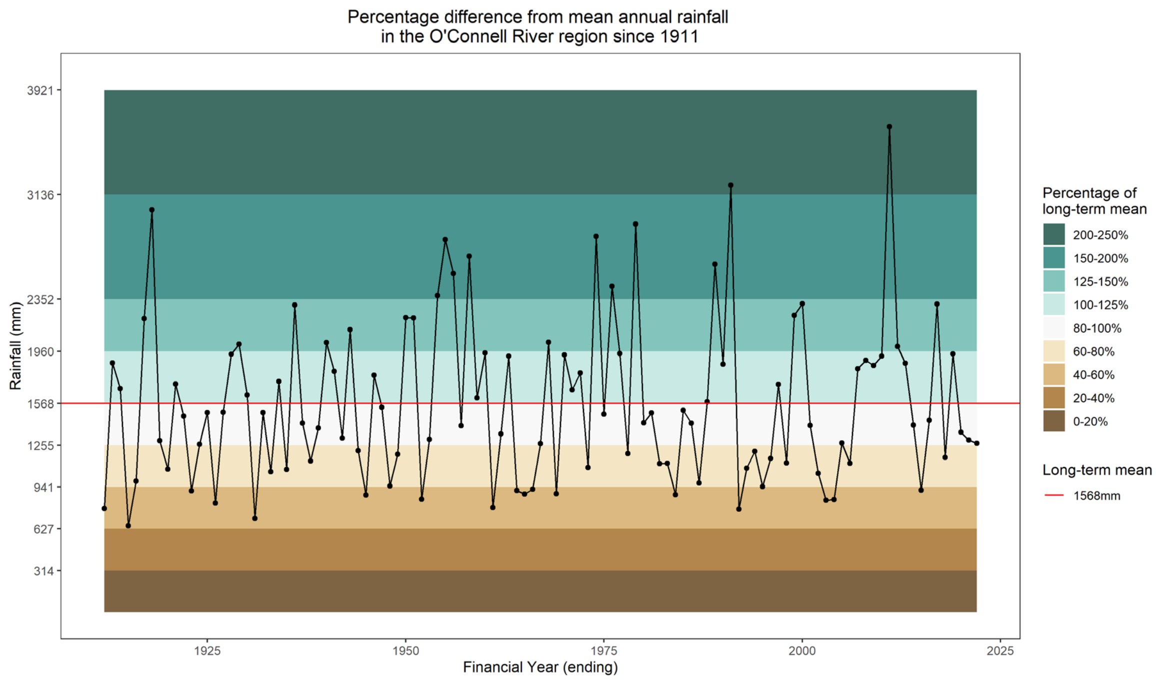

Figure 50 Annual rainfall totals for the O'Connell Basin. Financial year on the x-axis, annual rainfall (mm) on the y-axis. Long-term mean (1568 mm) represented by red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2021-22). Long-term annual rainfall data sourced from BoM and calculated using results from 1911–2022.

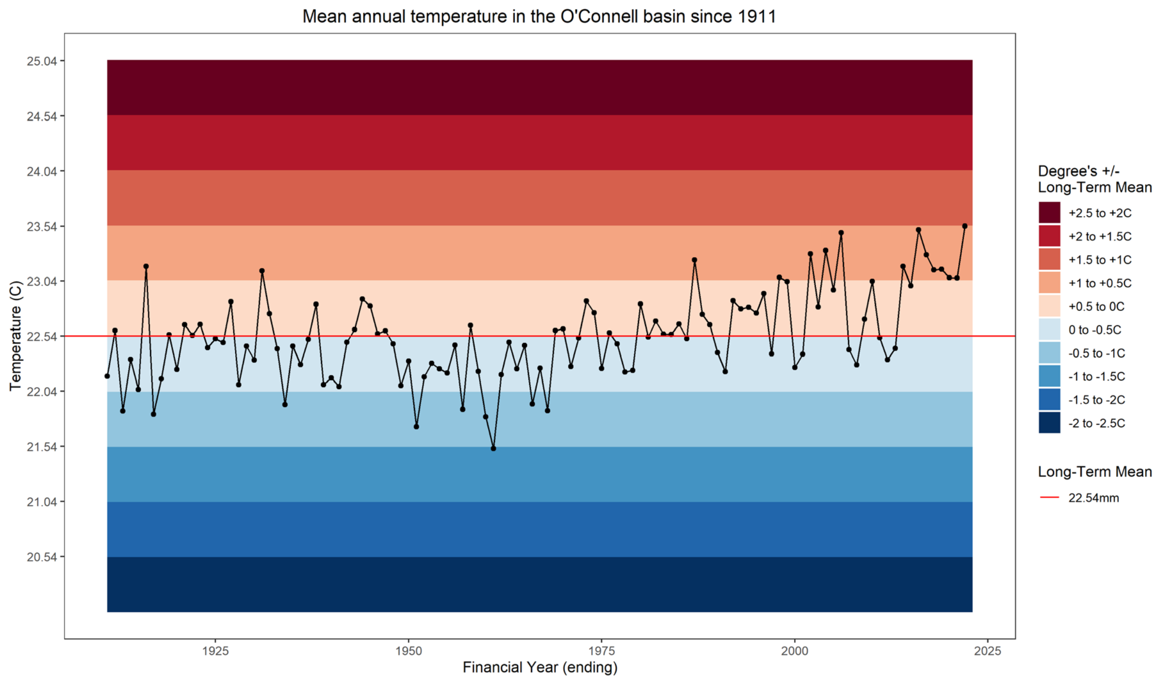

Figure 51 Annual temperature totals for the O'Connell Basin. Financial year on the x-axis, annual temperature (C) on the y-axis. Long-term mean (22.54 C) represented by red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2021-22). Long-term annual temperature data sourced from BoM and calculated using results from 1911–2022.

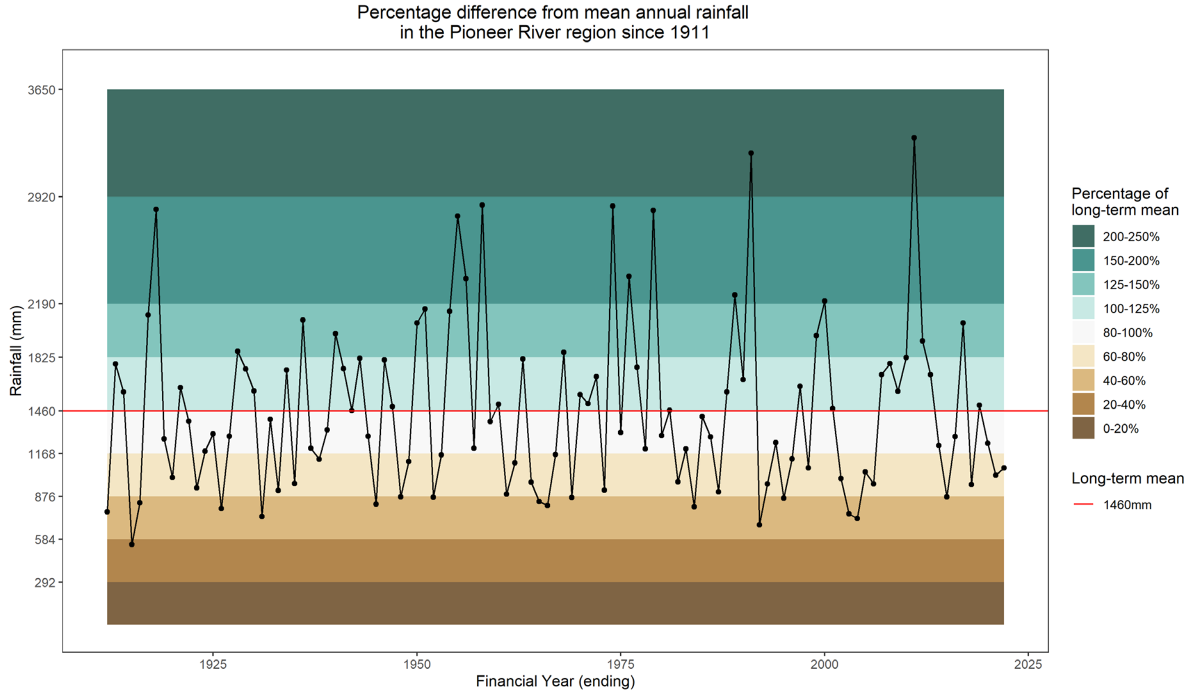

Figure 52 Annual rainfall totals for the Pioneer Basin. Financial year on the x-axis, annual rainfall (mm) on the y-axis. Long-term mean (1460 mm) represented by red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2021-22). Long-term annual rainfall data sourced from BoM and calculated using results from 1911–2022.

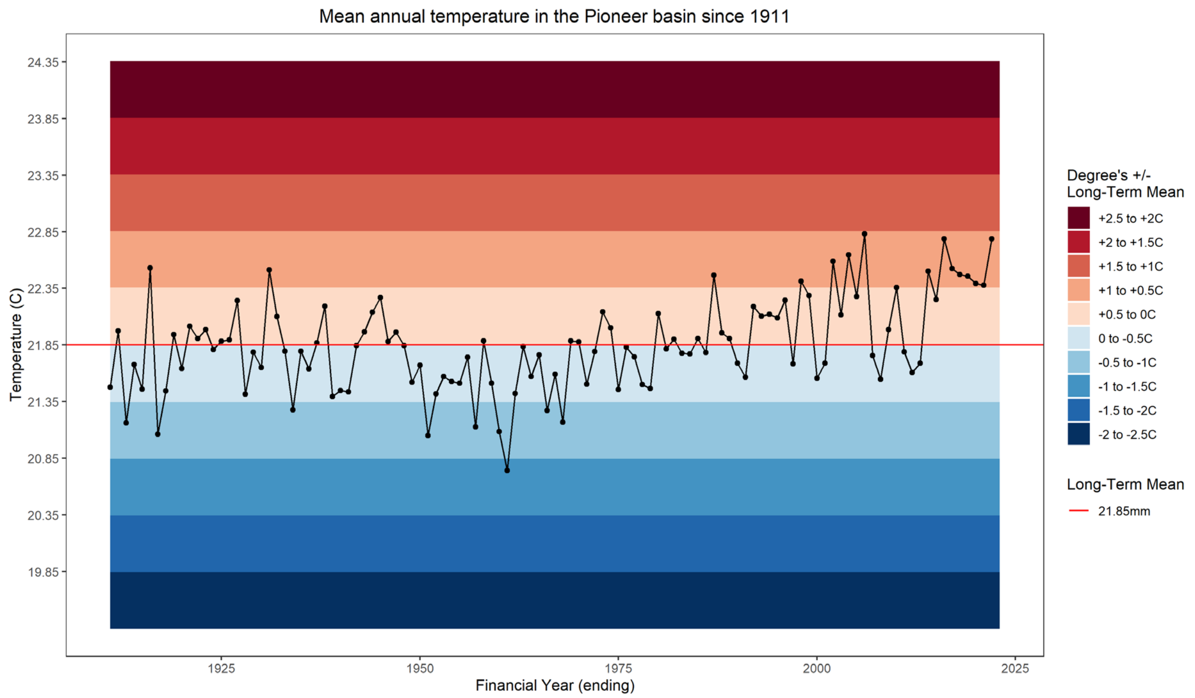

Figure 53 Annual temperature totals for the Pioneer Basin. Financial year on the x-axis, annual temperature (C) on the y-axis. Long-term mean (21.85 C) represented by red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2021-22). Long-term annual temperature data sourced from BoM and calculated using results from 1911–2022.

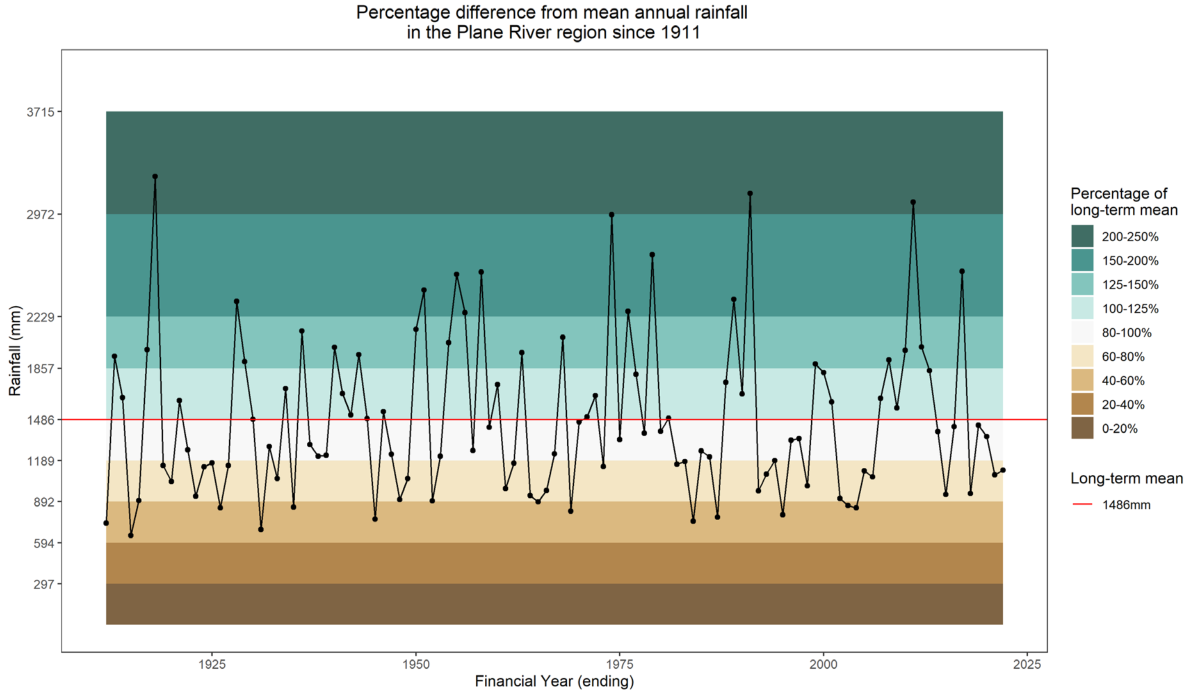

Figure 54 Annual rainfall totals for the Plane Basin. Financial year on the x-axis, annual rainfall (mm) on the y-axis. Long-term mean (1486 mm) represented by red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2021-22). Long-term annual rainfall data sourced from BoM and calculated using results from 1911–2022.

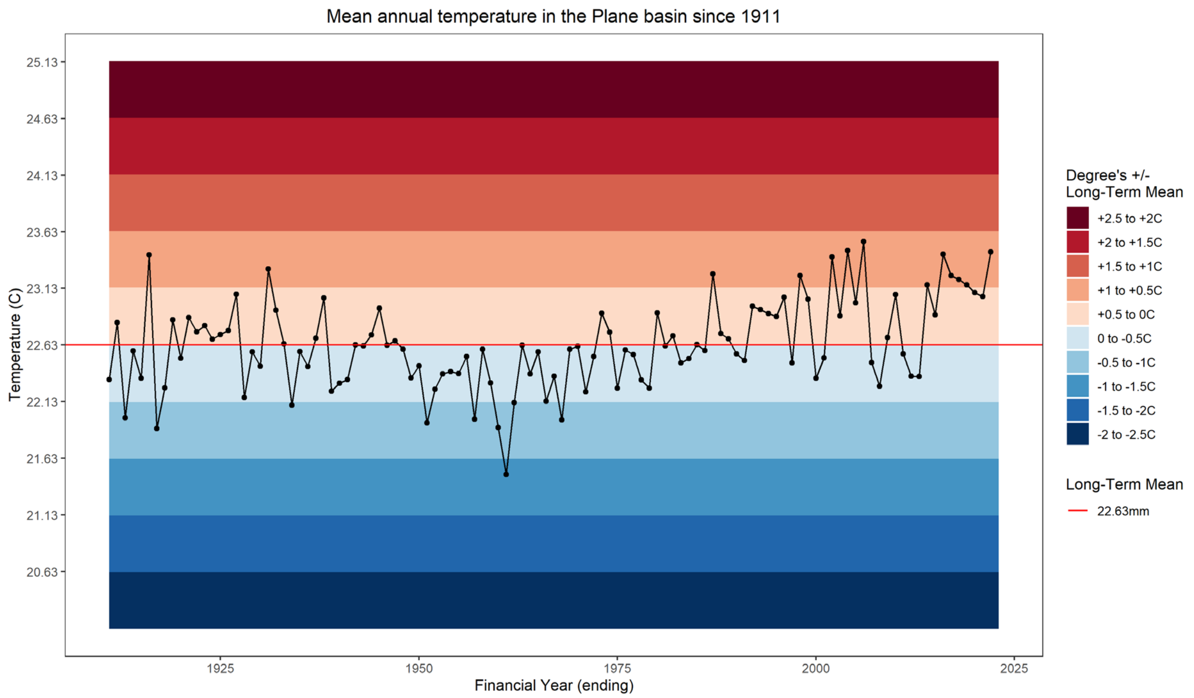

Figure 55 Annual temperature totals for the Plane Basin. Financial year on the x-axis, annual temperature (C) on the y-axis. Long-term mean (22.63 C) represented by red horizontal line. Shaded background represents the percentage of the long-term mean (1911-12 to 2021-22). Long-term annual temperature data sourced from BoM and calculated using results from 1911–2022.

8.2 Freshwater Basins

8.2.1 Basin Summary Stats and Boxplots

Table 51 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	19	205.7395	0.05	28	76	351	686	Median	5
	DIN	19	0.578474	0.146	0.3335	0.517	0.661	1.704	Median	0.03
	FRP	19	0.128316	0.004	0.0815	0.124	0.159	0.525	Median	0.045
Proserpine River at Glen Isla	TSS	59	189.4915	1	43.5	96	289.5	894	Median	5
	DIN	60	0.530483	0.029	0.1285	0.1755	0.3735	3.085	Median	0.03
	FRP	60	0.120583	0.013	0.097	0.119	0.14225	0.212	Median	0.025
O'Connell River at Caravan Park	TSS	49	61.67347	5	13	30	63	359	Median	2
	DIN	49	0.154418	0.002	0.042	0.089	0.115	1.93	Median	0.03
	FRP	49	0.037082	0.0005	0.01	0.022	0.03	0.757	Median	0.006
O'Connell River at Stafford's Crossing	TSS	84	97.05119	0.05	12.75	30	82	1150	Median	2
	DIN	94	0.123931	0.0015	0.04925	0.0835	0.13425	0.908	Median	0.03
	FRP	94	0.021979	0.0005	0.01325	0.0215	0.02775	0.111	Median	0.006
Pioneer River at Dumbleton Weir	TSS	55	8.132727	0.05	2	4	7	70	Median	5
	DIN	55	0.110364	0.0015	0.0355	0.111	0.173	0.424	Median	0.008
	FRP	54	0.026176	0.0005	0.012	0.0235	0.03275	0.091	Median	0.005
Plane Creek at Sucrogen Weir	TSS	59	38.8822	0.05	12	19	43.5	251	Median	3
	DIN	59	0.187881	0.003	0.1205	0.198	0.276	0.426	Median	0.008
	FRP	59	0.135949	0.002	0.0665	0.125	0.2055	0.432	Median	0.008
Sandy Creek at Homebush	TSS	93	53.43011	1	16	35	70	459	Median	5
	DIN	93	0.496935	0.006	0.285	0.344	0.58	1.837	Median	0.03
	FRP	92	0.173989	0.008	0.1365	0.1785	0.218	0.369	Median	0.015

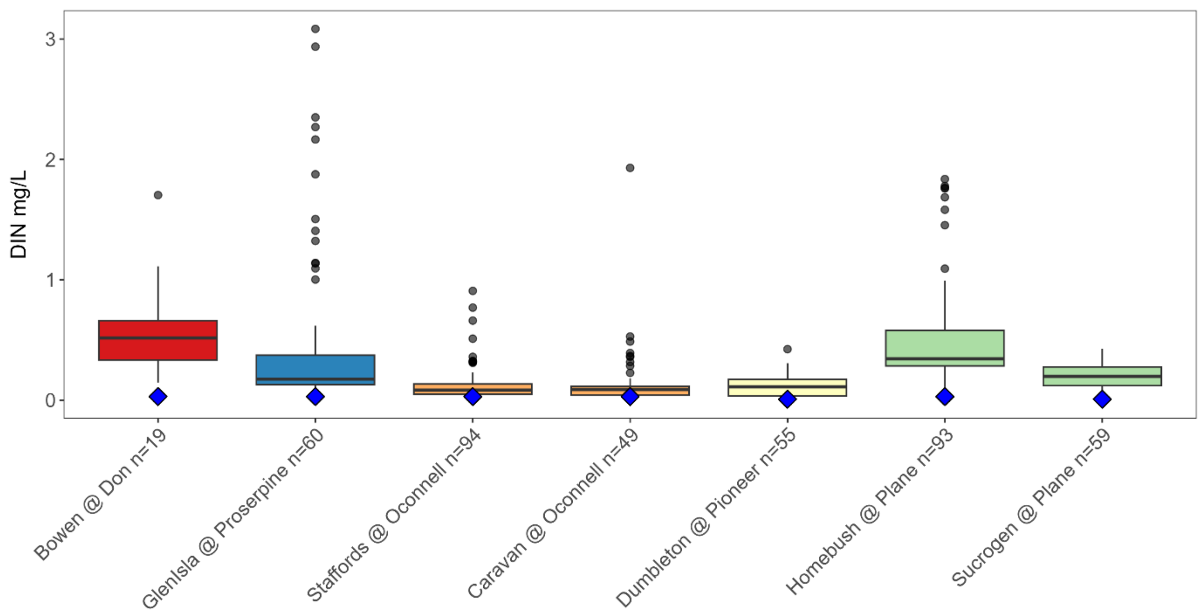

Figure 56 Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median DIN concentrations in the MWI basins. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points.

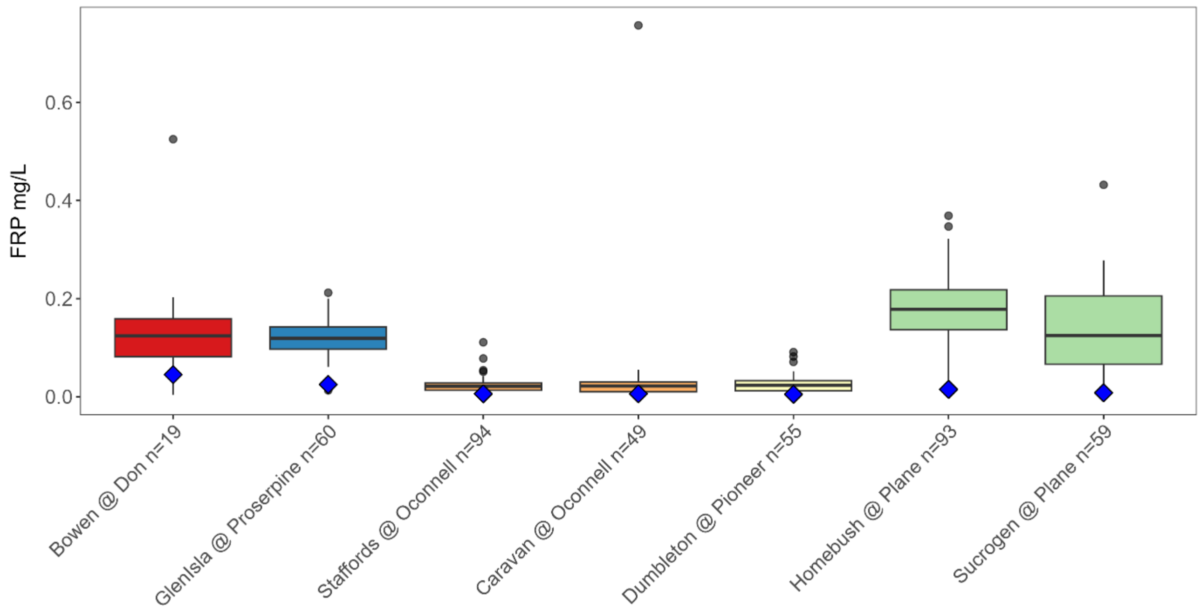

Figure 57. Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median FRP concentrations in the MWI basins. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points.

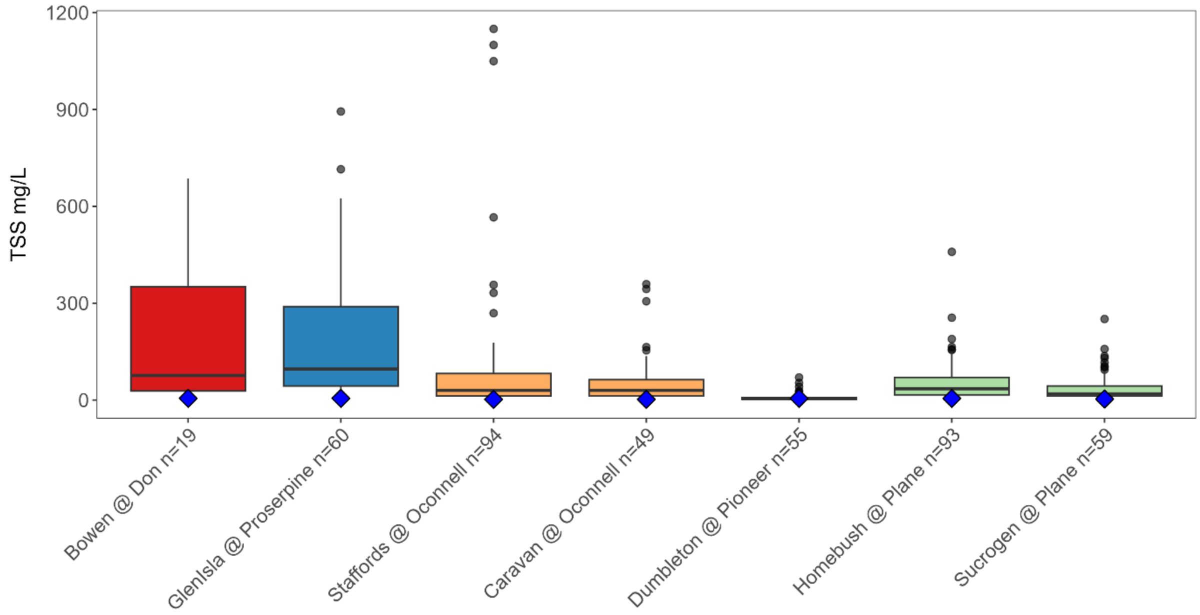

Figure 58. Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median TSS concentrations in the MWI basins. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points.

8.2.2 Freshwater Flow Indicator Tool Scores and Hydrographs

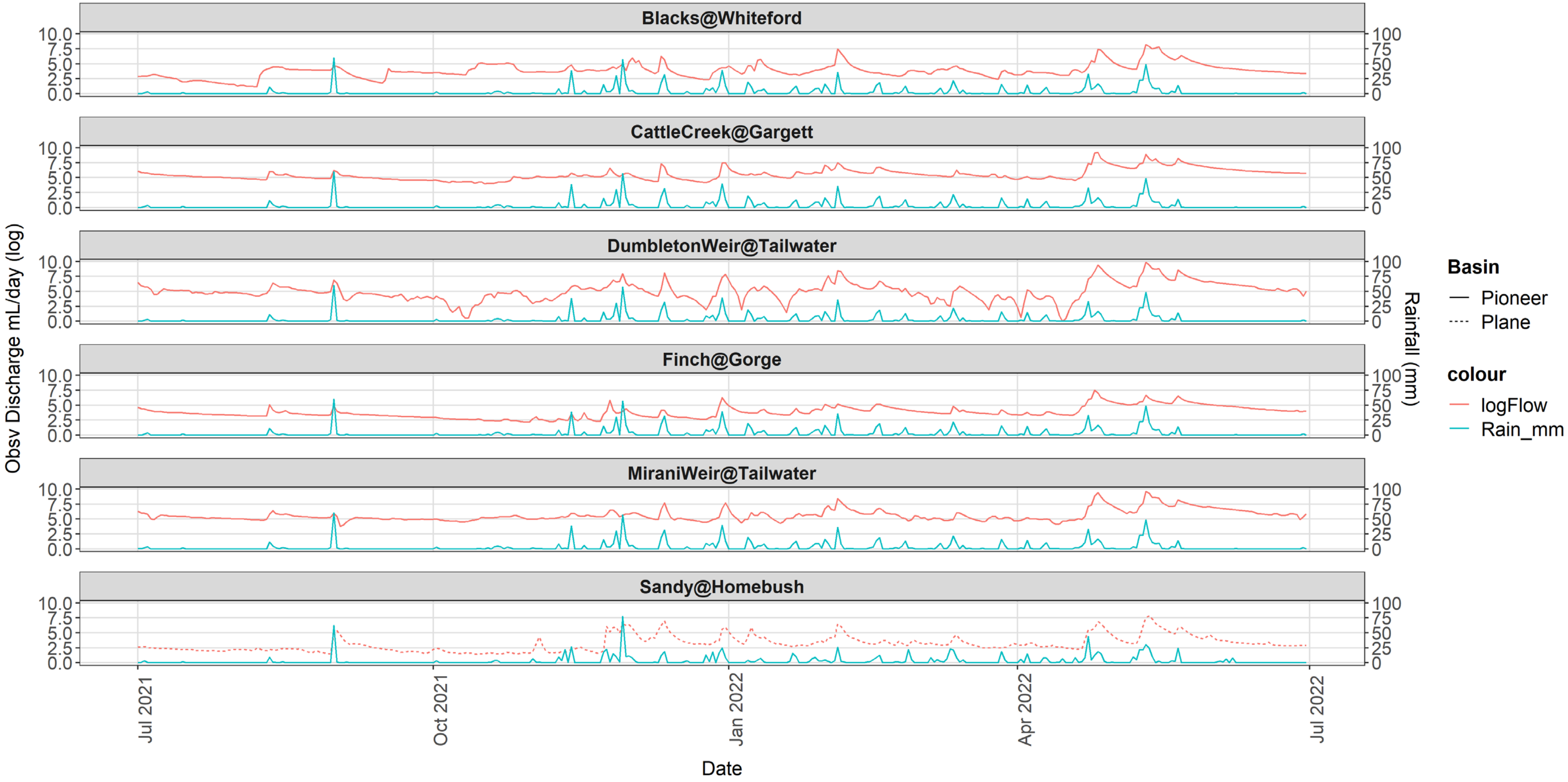

Figure 59. Hydrographs for gauging stations in the Pioneer and Plane basins. Observed discharge (ml/day) is plotted on a log scale against rainfall (mm) over the 2021–22 reporting year. Data gaps represent periods of no flow rather than missing data.

Table 52. Flow measure scores and summary scores for freshwater flow across the MWI Region, weighted by catchment area for the 2021–22 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																			**55**	**Dry**
CattleCk@Gargett	125004B	0.8	5	5	4	4	4	4	4	1	5	4	4	61	326	326	0.1	8.9		
BlacksCk@Whitefords	125005A	0.5	2	2	5	5	4	5	5	1	5	5	3.4	49	509	702	0.3	15.5		
FinchHattonCk@GorgeRd	125006A	1.2	4	4	5	5	5	5	4	5	5	5	4.7	75	35	35	0.02	1.2		
PioneerR@MiraniWeirTW	125007A	0.5	4	4	5	5	4	4	5	1	4	5	4	61	1211	885	0.4	24.3		
PioneerR@DumbletonWeirTW	125016A	0.4	1	1	5	5	4	5	4	1	5	5	3.1	43	1488	277	0.1	5.4		
Plane Basin																			**61**	**Dry**
SandyCreek@Homebush	126001A	0.3	4	4	3	5	1	4	5	5	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. In the MWI Region this occurs in both the O'Connell and the Plane River catchments. The O'Connell sites occur on the same channel, with the Staffords Crossing site located upstream of the Caravan Park site. In the Plane Basin, the Sucrogen Weir site is situated on the Plane River, while the Homebush site is situated on Sandy Creek.

Proportional contribution of each site and water quality results are presented below for O'Connell Basin (Table 55, Figure 60) and Plane Basin (Table 56 and Figure 61).

Table 53. Calculation of proportional contribution to scores for multiple monitoring sites within the O'Connell Basin based on the relative upstream catchment area. Where applicable, the adjusted area is calculated and represents the relative upstream catchment area to the next monitoring site.

Site (O'Connell Basin)	Catchment area (km^2)	Adjusted catchment area (km^2)	Proportion % (based on gauging catchment area)
Catchment upstream from O'Connell at Caravan Park	825	483	0.59
Catchment upstream from O'Connell at Stafford's	342	342	0.41
Total area measured		**825**	

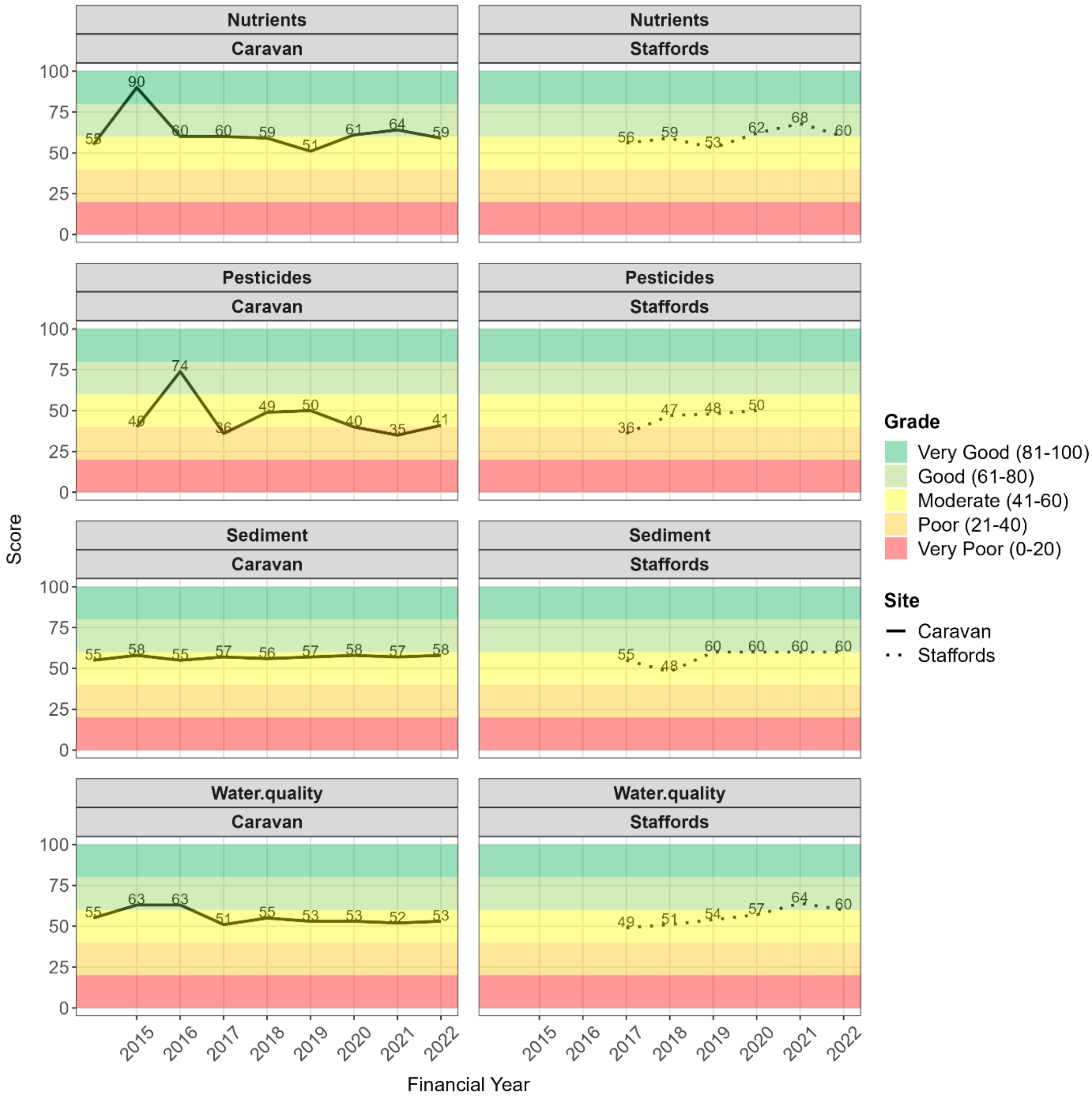

Figure 60. Results for water quality indicator categories for the 2021 22 Report Card compared to the historic record, with Stafford's Crossing represented by a dash-dot line and Caravan Park represented by a dotted line. Overall is an annotated solid line representing the adjusted basin score.

Table 54. Calculation of proportional contribution to scores for multiple monitoring sites within the Plane Basin, based on the relative upstream catchment area. Where applicable, the adjusted area is calculated and represents the relative upstream catchment area to the next monitoring site.

Site (Plane Basin)	Catchment area (km^2)	Adjusted catchment area (km^2)	Proportion % (based on gauging catchment area)
Catchment upstream from Sandy Creek at Homebush	326	326	0.78
Catchment upstream from Plane Creek	90	90	0.22
Total area measured		**416**	

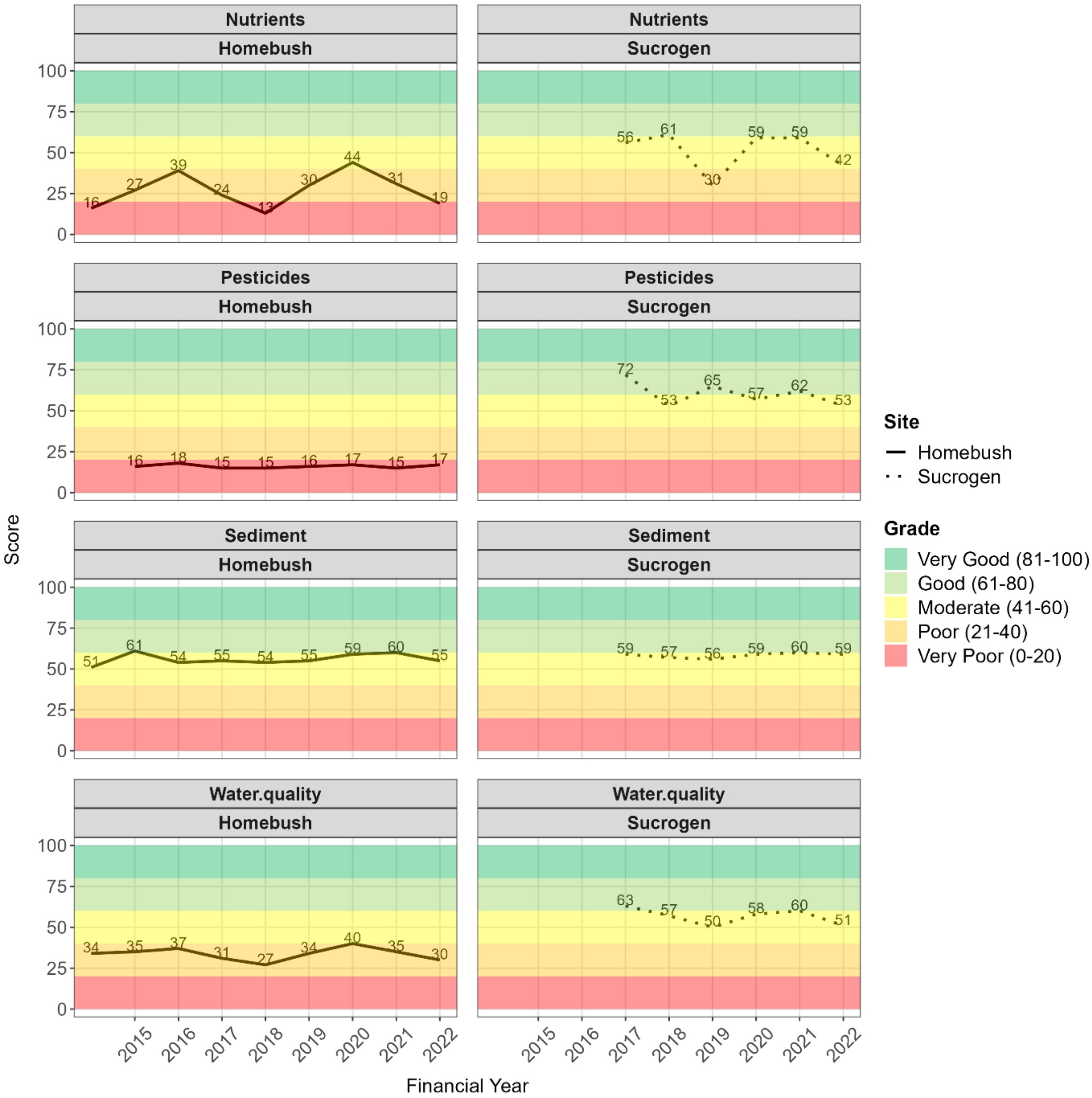

Figure 61 Results for water quality indicator categories for the 2021 22 Report Card compared to the historic record, with Plane River Sucrogen Weir represented by a dash-dot line and Sandy Creek Homebush represented by a dotted line. Overall is an annotated solid line representing the adjusted basin score.

8.2.4 Revision to Wetland Extent Scores

Based on available refinements to the wetland mapping data (version 5), the scores for wetland extent were last updated for the 2019 Report Card. Due to updates to the source mapping, including refinements such as error correction and re-mapping to a finer scale, data are not directly comparable to those previously reported, inhibiting interpretation of change observed between years. To rectify this, wetland extent scores were back calculated for the 2013 assessment, using updated maps which more accurately depict condition in 2013. The results for back calculated wetland extent scores are provided in Table 54, below. Notably, the back-calculated scores for 2013 are the same as those for the most recent 2019 assessment.

Table 55. Results showing % of wetland extent loss compared to pre-development conditions, in 2013. This assessment pertains to palustrine wetlands only.

	2013		2013
	Wetland Extent		
Basin	Hectares lost since pre-development	% loss since pre-development	Standardised Wetland Extent
Don	0*	-3*	**100**
Proserpine	848	16	**59**
O'Connell	334	66	**14**
Pioneer	1,279	71	**12**
Plane	930	47	**23**

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 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 scenarios where there has been an increase in the total wetland extent since pre-development.

8.3 Estuarine Waterways

8.3.1 Estuary Summary Stats and Boxplots

Table 56 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*	18	3.58	0.54	1.53	2.62	5.26	8.57	Median	2 µg/L
	DIN	18	0.0169	0.004	0.004	0.004	0.015	0.101	Median	0.018 mg/L
	FRP	18	0.011	0.002	0.004	0.008	0.0128	0.041	Median	0.03 mg/L
	Turbidity	18	3.55	1.07	7.07	2.82	5.063	6.8	Median	10 mg/L
	DO	18	72.85	52.8	68.73	72.95	79.2	87.3	Median	70-105 %
O'Connell River	Chl-*a*	9	3.39	0.58	2.05	3.74	4.39	5.57	Median	2 µg/L
	DIN	12	0.076	0.002	0.014	0.0325	0.095	0.341	Median	0.018 mg/L
	FRP	12	0.012	0.001	0.007	0.011	0.018	0.029	Median	0.03 mg/L
	Turbidity	10	17.92	4.5	8.21	12.82	22.98	51.7	Median	10 mg/L
	DO	10	92.7	39.9	86.93	101.6	104.8	113.9	Median	70-105 %
St Helens Creek	Chl-*a*	10	5.42	2.17	3.49	4.2	7.08	12.69	Median	2 µg/L
	DIN	10	0.049	0.004	0.026	0.036	0.06	0.136	Median	0.018 mg/L
	FRP	10	0.009	0.005	0.006	0.007	0.008	0.026	Median	0.03 mg/L

Site	Indicator	n	Mean	Minimum	25th %ile	Median	75th %ile	Maximum	Guidelines	
									Comparison Statistic	Guideline Values
	Turbidity	20	9.359	5.11	8.048	9.385	11.088	12.74	Median	10 mg/L
	DO	20	86.0	78.3	81.3	84	93.2	104.9	Median	70-105 %
Murray Creek	Chl-*a*	20	5.77	1.23	2.14	4.63	7.35	19.56	Median	2 µg/L
	DIN	20	0.144	0.004	0.055	0.136	0.24	0.302	Median	0.018 mg/L
	FRP	20	0.024	0.002	0.01	0.025	0.032	0.064	Median	0.03 mg/L
	Turbidity	30	24.71	0.07	4.278	11	37.505	119.72	Median	10 mg/L
	DO	30	84.1	55.5	73.4	84.1	91.7	127.5	Median	70-105 %
Vines Creek	Chl-*a*	10	4.49	2.11	2.78	3.92	5.64	8.7	Median	2 µg/L
	DIN	10	0.381	0.104	0.265	0.395	0.523	0.6	Median	0.018 mg/L
	FRP	10	0.031	0.002	0.004	0.01	0.031	0.16	Median	0.03 mg/L
	Turbidity	10	10.022	2	3.135	4.845	16.743	27.8	Median	10 mg/L
	DO	10	71.6	27.7	58.6	64.2	92.8	107.3	Median	70-105 %
Sandy Creek	Chl-*a*	18	4.78	0.4	3.03	4.09	6.57	9.76	Median	5 µg/L
	DIN	20	0.326	0.004	0.039	0.245	0.3978	1.207	Median	0.018 mg/L
	FRP	20	0.06	0.01	0.024	0.037	0.078	0.19	Median	0.06 mg/L
	Turbidity	20	28.062	2.5	6.908	16.525	33.213	156.87	Median	NA
	DO	20	84.5	62.6	78.9	87.8	94.3	97.2	Median	70-105%

Site	Indicator	n	Mean	Minimum	25th %ile	Median	75th %ile	Maximum	Guidelines	
									Comparison Statistic	Guideline Values
Plane Creek	Chl-*a*	18	4.55	0.67	2.32	3.06	5.09	14.28	Median	5 µg/L
	DIN	20	0.068	0.004	0.004	0.011	0.074	0.432	Median	0.018 mg/L
	FRP	20	0.035	0.002	0.002	0.016	0.051	0.2	Median	0.06 mg/L
	Turbidity	20	12.937	2.11	4.048	4.935	7.18	75.1	Median	NA
	DO	20	96.6	79.4	87.8	92.6	97.9	148.5	Median	70-105%
Rocky Dam Creek	Chl-*a*	18	7.19	1.34	6.04	7.6	8.71	10.79	Median	5 µg/L
	DIN	20	0.195	0.035	0.118	0.229	0.256	0.364	Median	0.018 mg/L
	FRP	20	0.0323	0.011	0.028	0.032	0.038	0.049	Median	0.06 mg/L
	Turbidity	20	121.27	36.96	55.75	89.15	171.25	342.94	Median	NA
	DO	20	81.1	69.6	76.5	80.7	85.4	93.2	Median	70-105%
Carmila Creek	Chl-*a*	14	7.22	3.43	4.72	7.46	9.04	12.56	Median	5 µg/L
	DIN	10	0.052	0.004	0.004	0.004	0.069	0.262	Median	0.018 mg/L
	FRP	10	0.029	0.002	0.024	0.03	0.037	0.044	Median	0.06 mg/L
	Turbidity	20	18.735	6.73	10.028	14.905	19.943	53.13	Median	NA
	DO	20	101.5	80.7	91.3	98.3	108.4	135.8	Median	70-105%

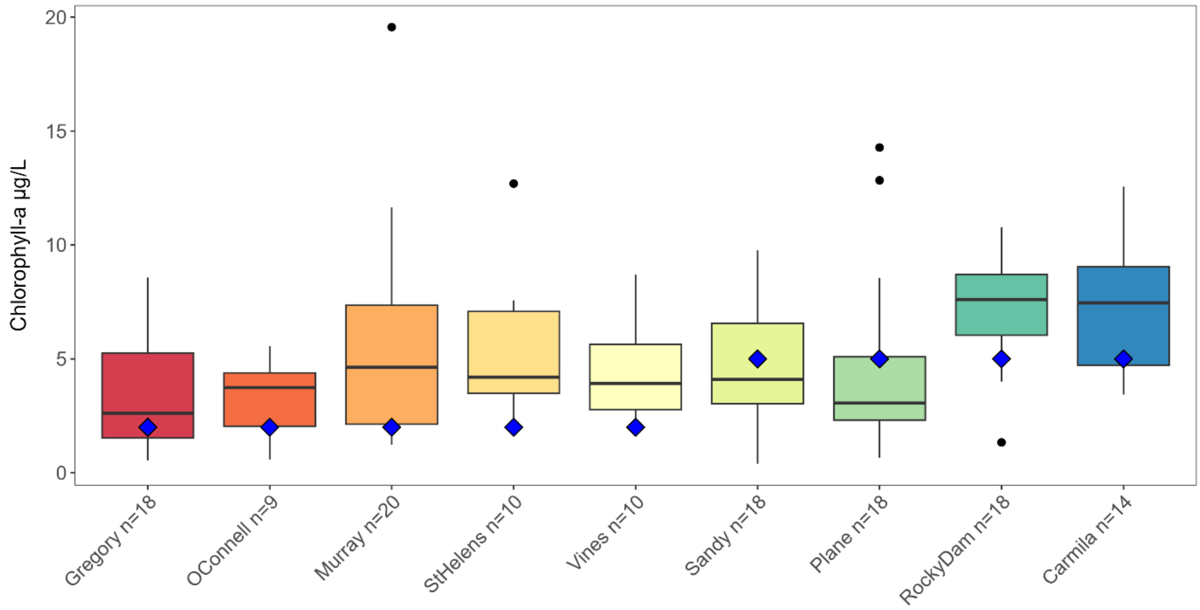

Figure 62. Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median Chlorophyll-*a* concentrations in the MWI estuaries. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per estuary is shown with the x axis labels.

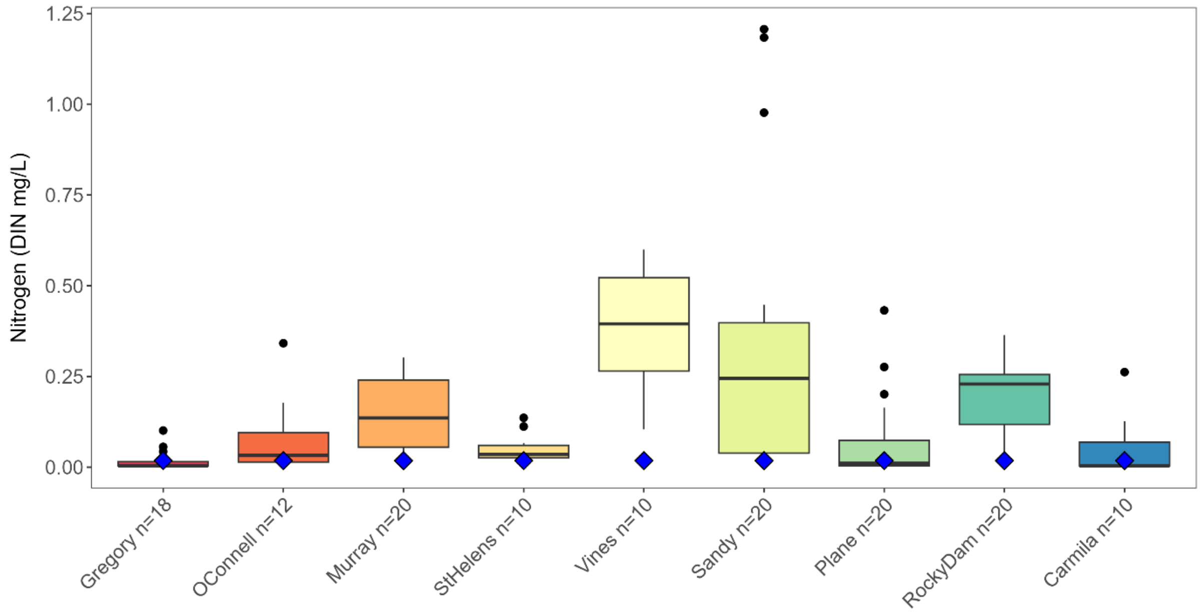

Figure 63. Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median DIN concentrations in the MWI estuaries. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per estuary is shown with the x axis labels.

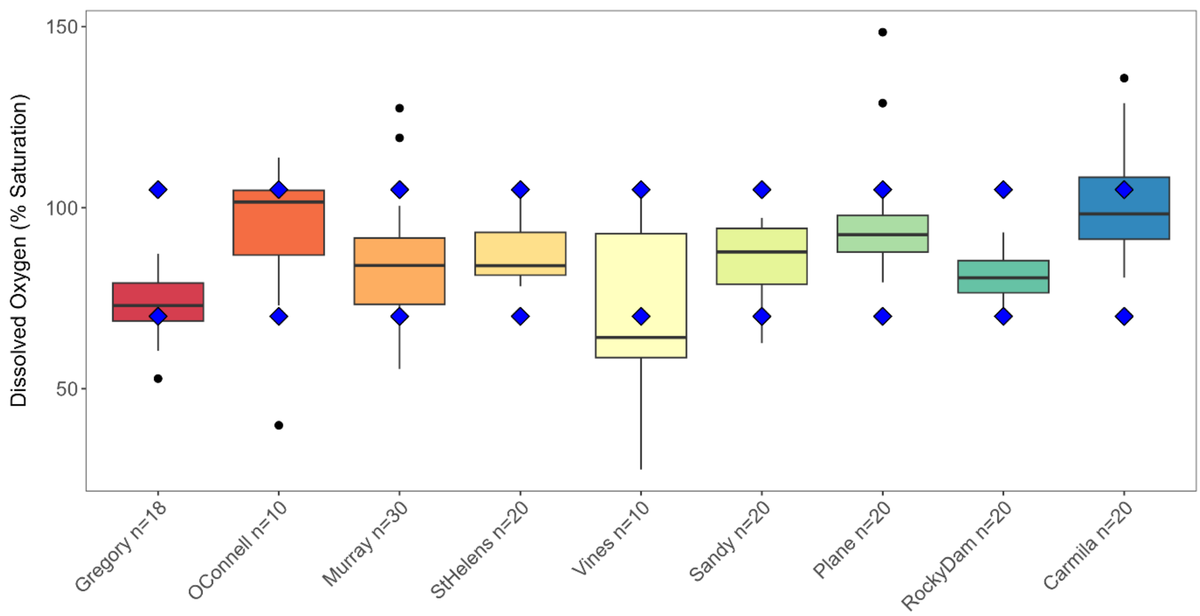

Figure 64. Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median Dissolved Oxygen (DO) concentrations in the MWI estuaries. Guideline values are represented by a blue diamond, and both lower and upper DO guideline values are presented. Outliers (>1.5 x IQR) are represented as black points. Sample size per estuary is shown with the x axis labels.

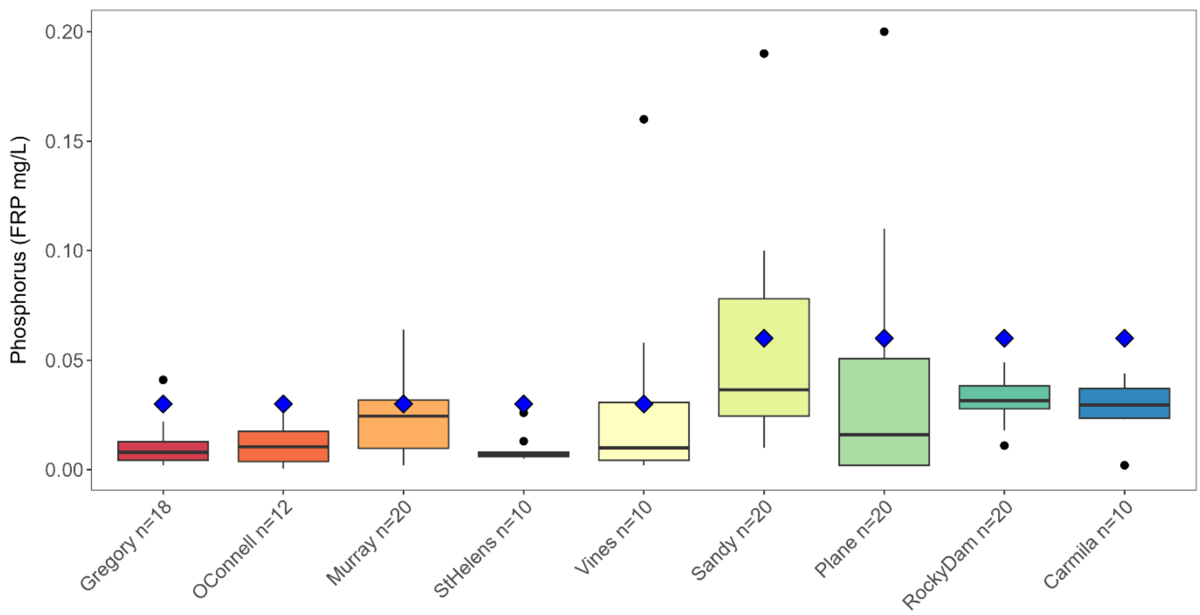

Figure 65. Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median FRP concentrations in the MWI estuaries. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per estuary is shown with the x axis labels.

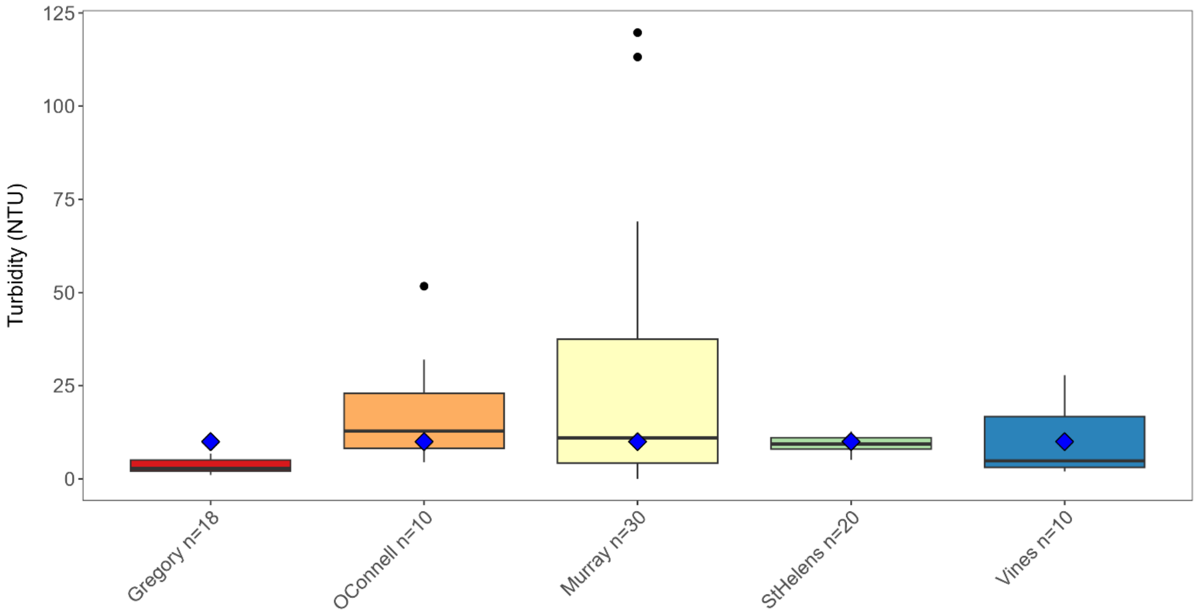

Figure 66. Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of monthly median NTU in the MWI estuaries. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per estuary is shown with the x axis labels.

8.4 Marine Environments

The scores and graphs presented below are for the inshore and offshore zones for the MWI 2022 Report Card. 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

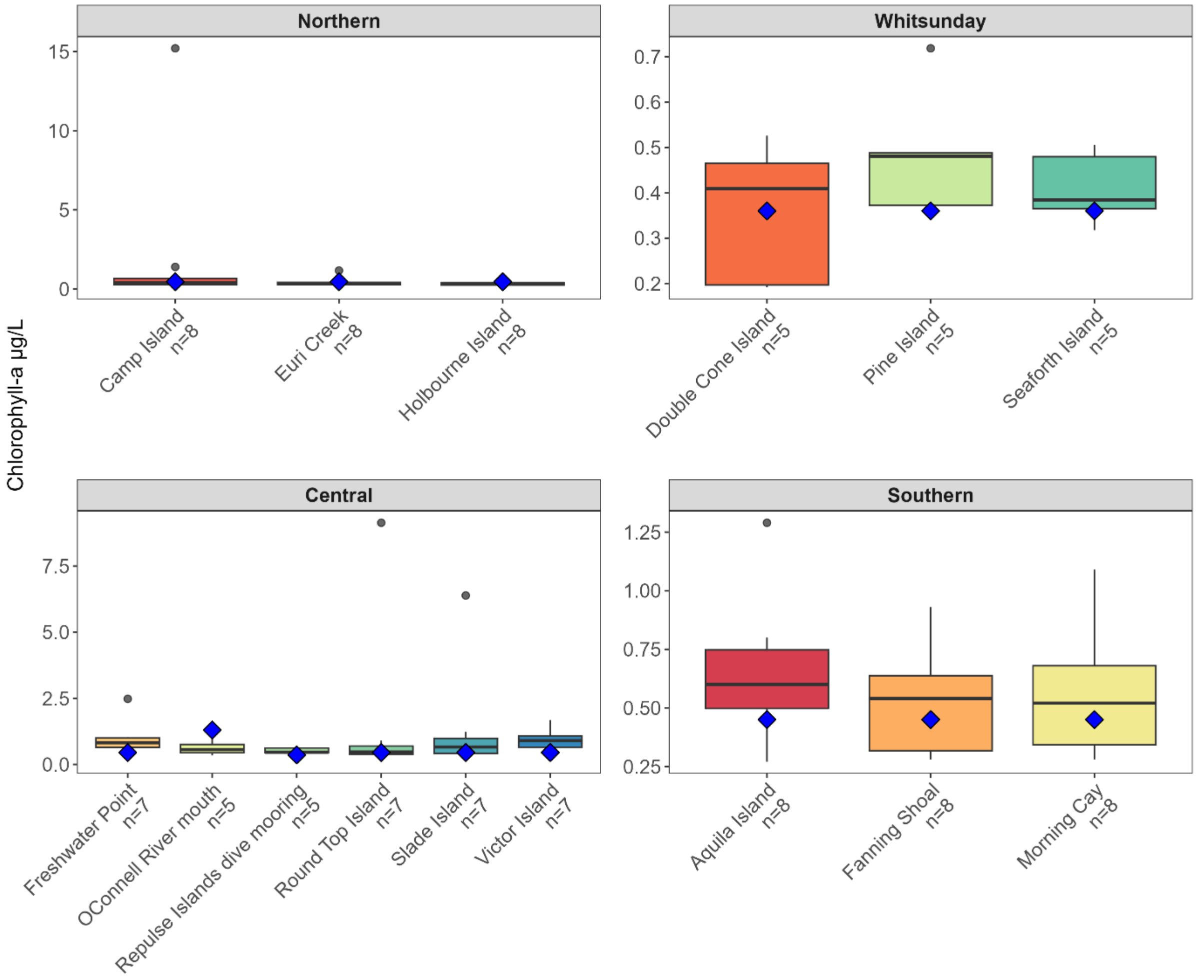

Figure 67. Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of Chlorophyll-*a* concentrations in the MWI inshore zones and sampling sites. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per site is shown with the x axis labels. Note the free scale on the y axis.

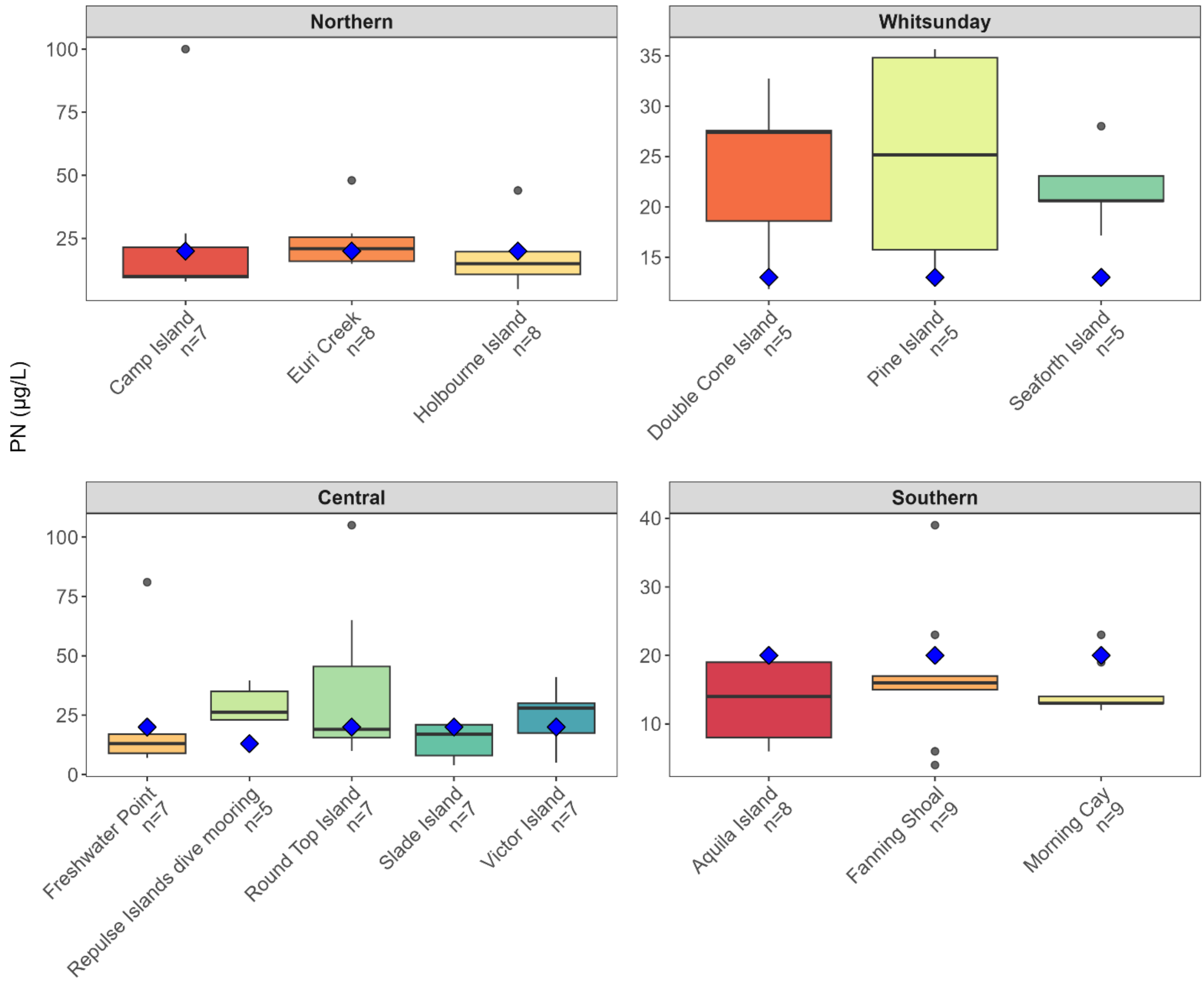

Figure 68. Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of PN concentrations in the MWI inshore zones and sampling sites. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per site is shown with the x axis labels. Note the free scale on the y axis.

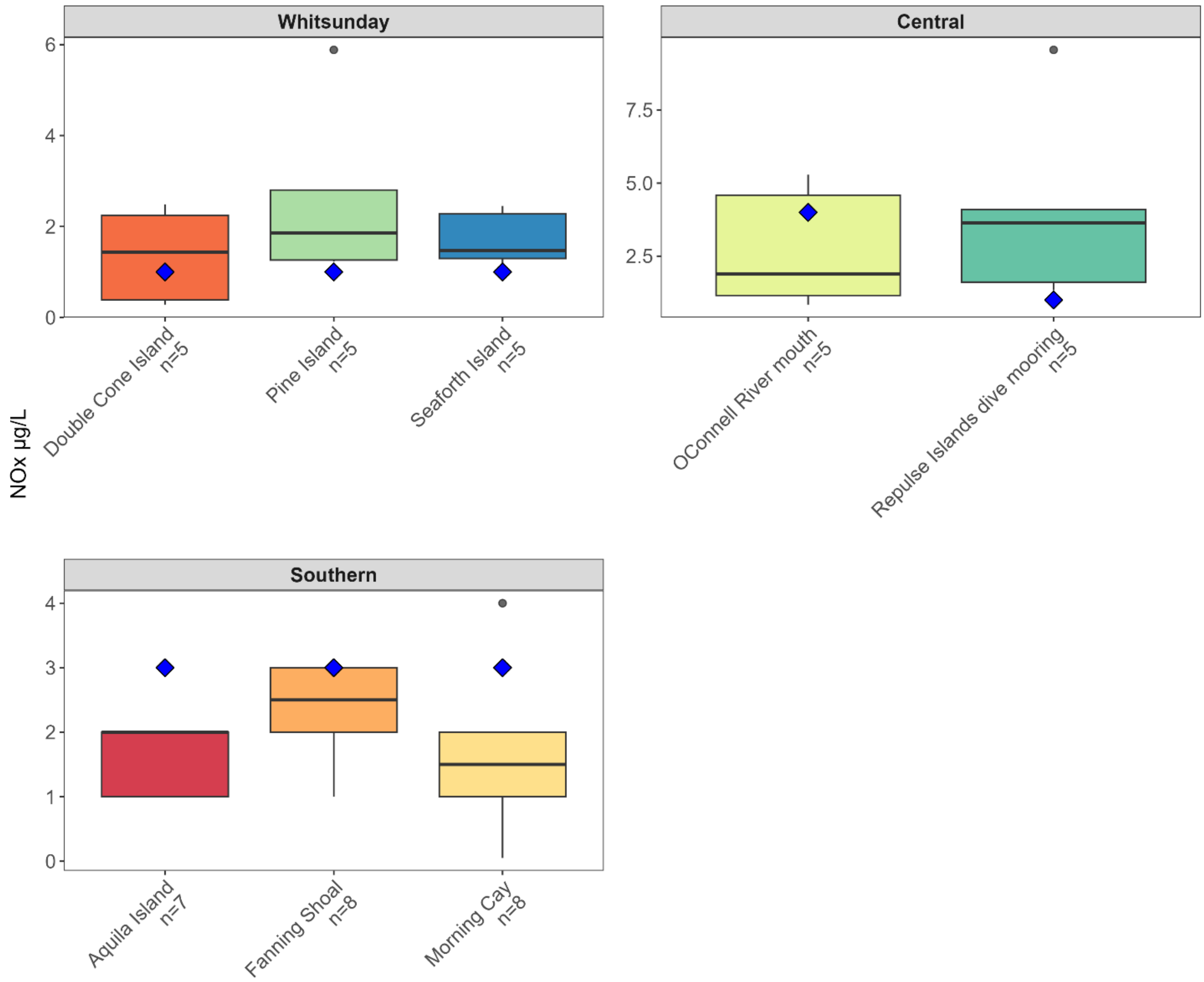

Figure 69. Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of NOx concentrations in the MWI inshore zones and sampling sites. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per site is shown with the x axis labels. Note the free scale on the y axis.

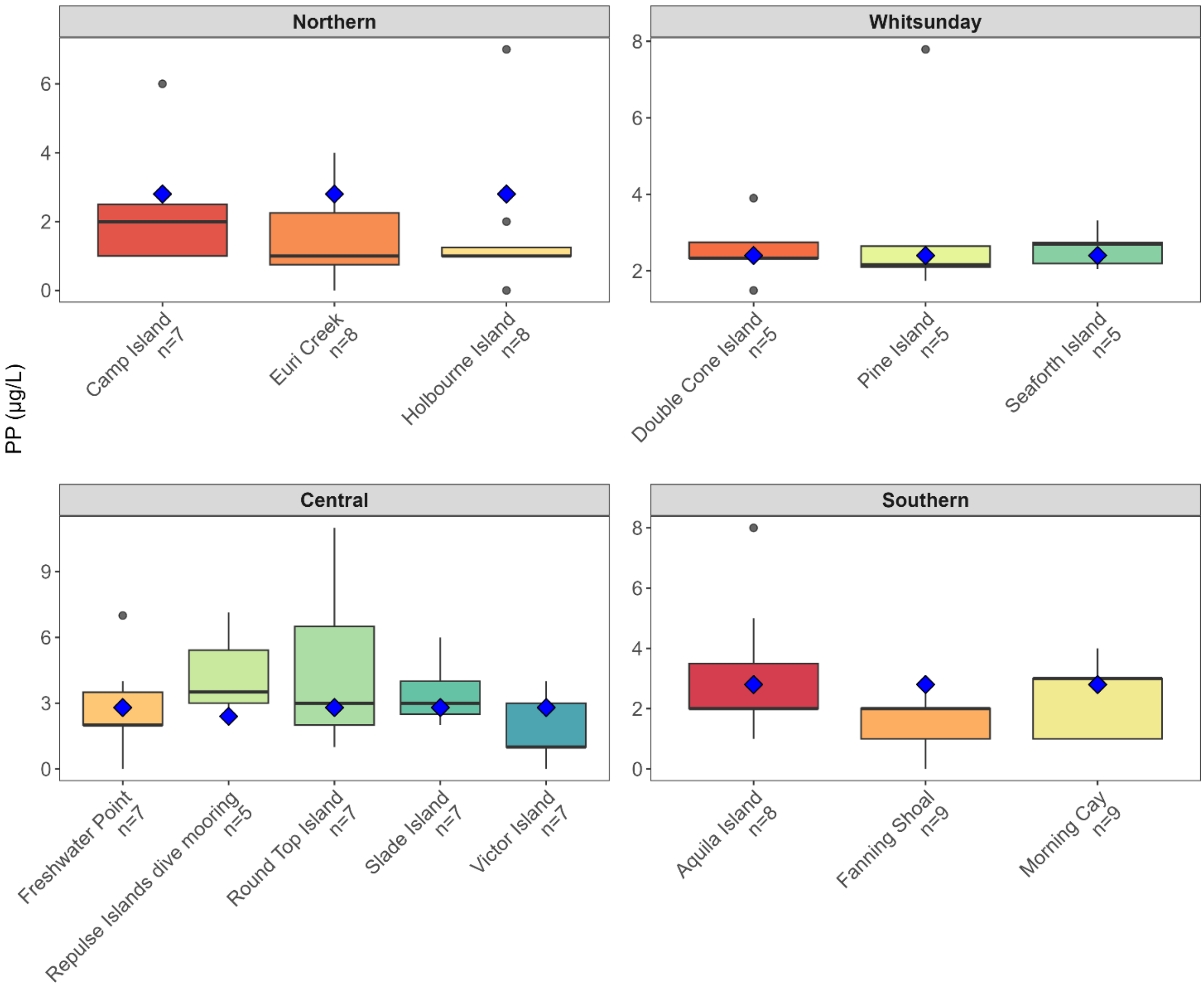

Figure 70. Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of PP concentrations in the MWI inshore zones and sampling sites. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per site is shown with the x axis labels. Note the free scale on the y axis.

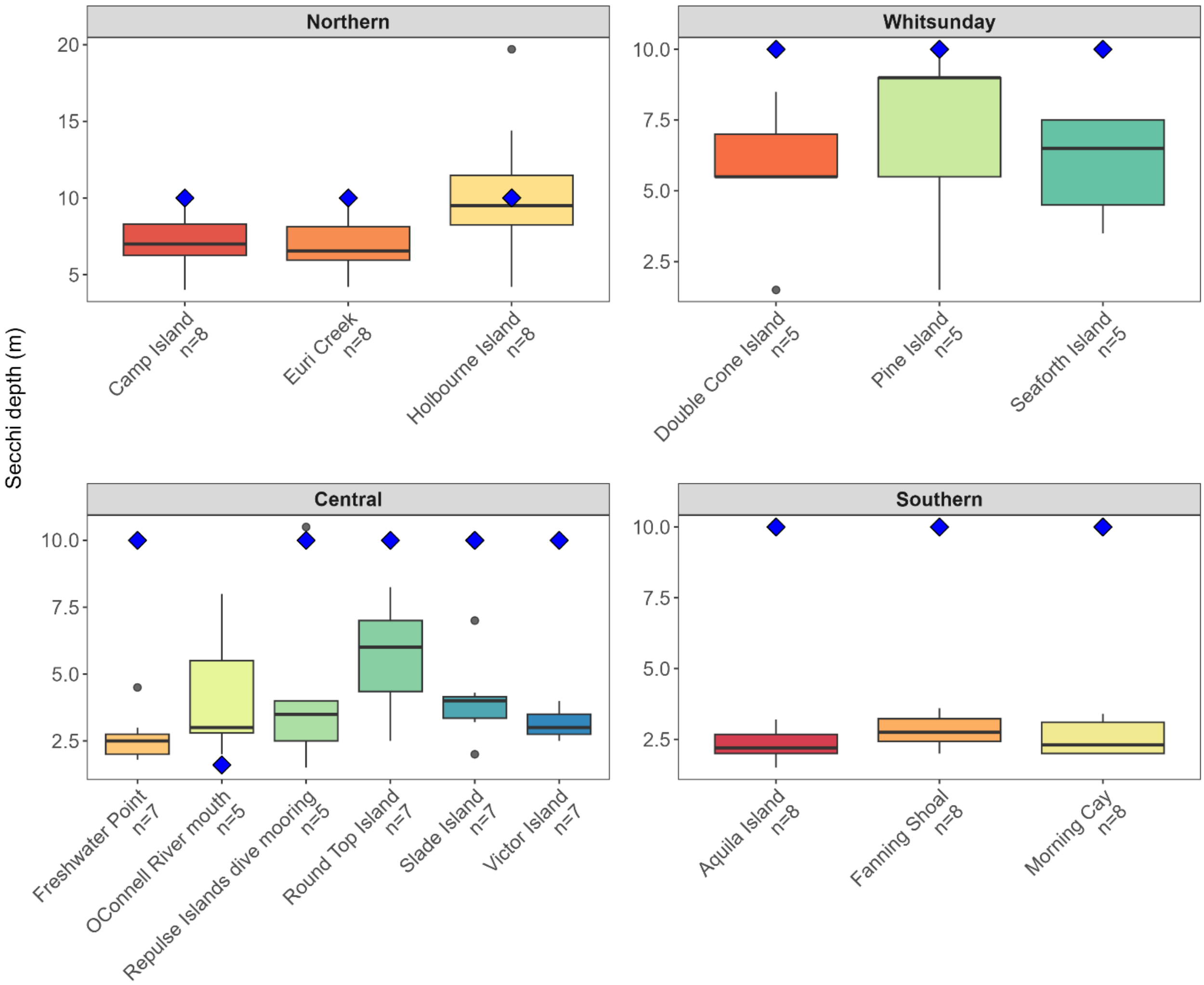

Figure 71. Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of Secchi depth (m) in the MWI inshore zones and sampling sites. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample size per site is shown with the x axis labels. Note the free scale on the y axis.

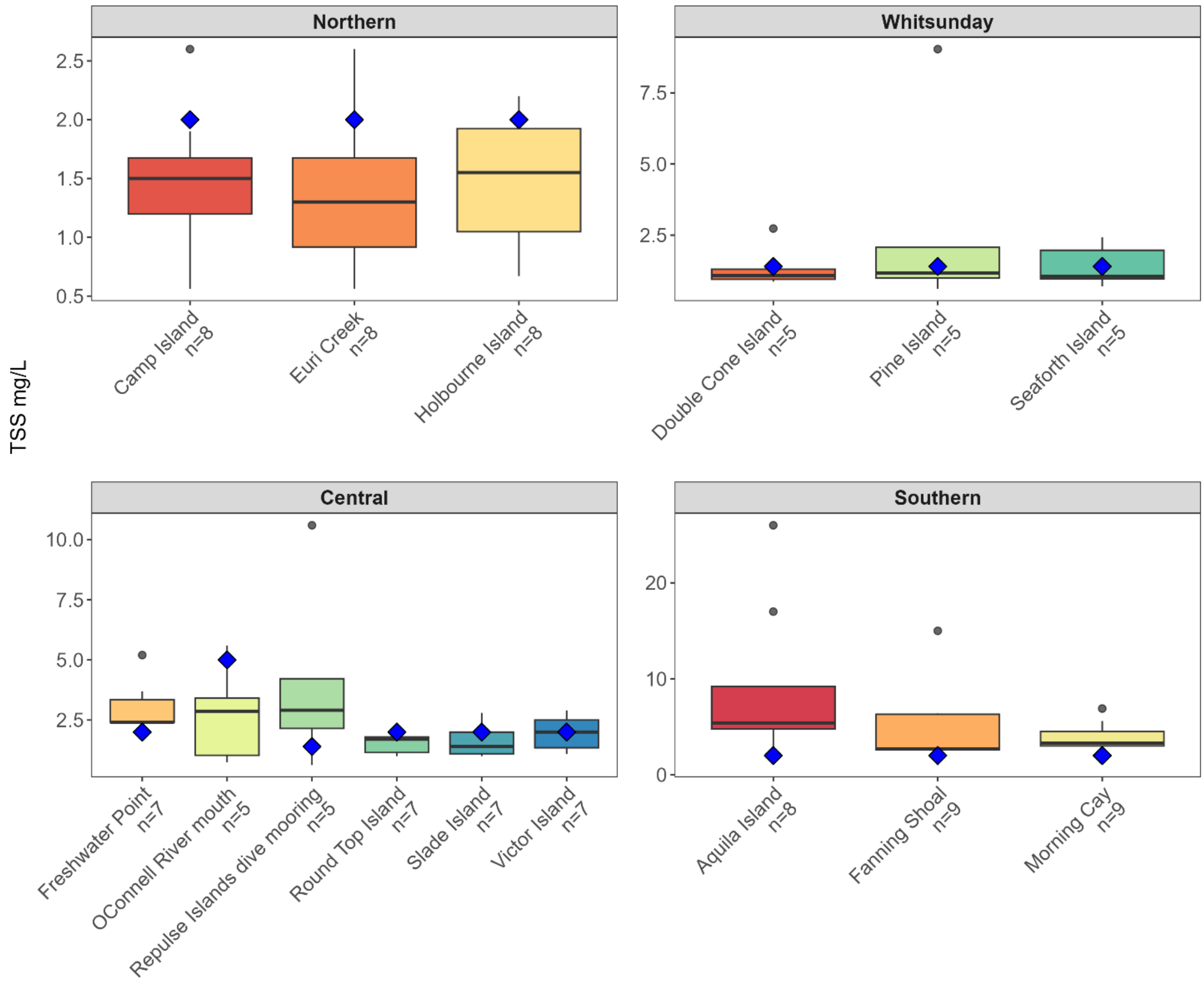

Figure 72. Box and whisker plot (box showing 25th, 50th and 75th percentiles, whiskers 1.5 x interquartile range [IQR]) of TSS concentrations in the MWI inshore zones and sampling sites. Guideline values are represented by a blue diamond. Outliers (>1.5 x IQR) are represented as black points. Sample 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

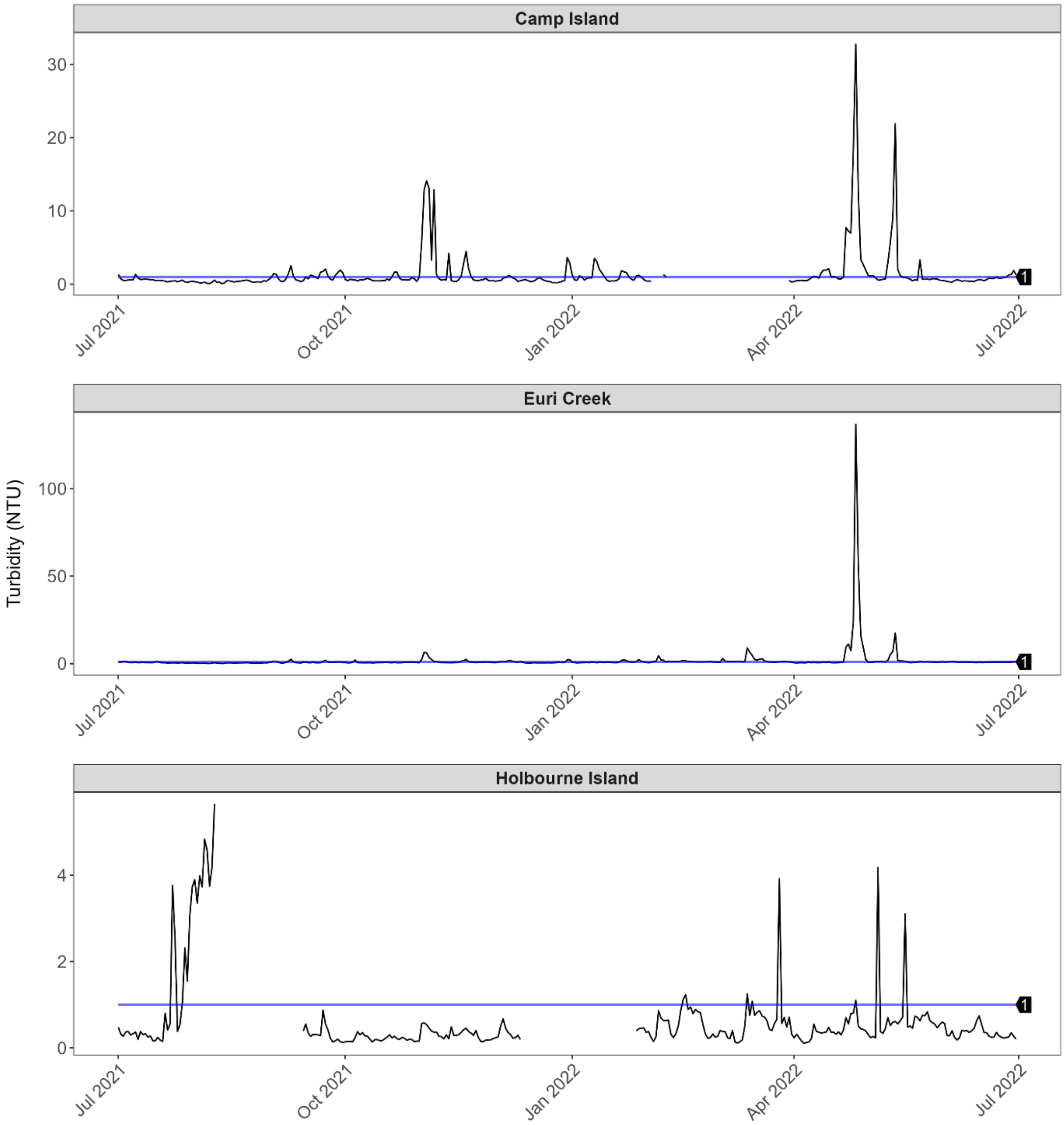

Figure 73. Linegraphs representing daily mean turbidity (NTU) at the sampling sites in the NQBP Abbot Point monitoring program in 2022. Missing data removed due to spikes and/or fouling. Guideline value represented by a blue line. Note the free scales on the y-axis.

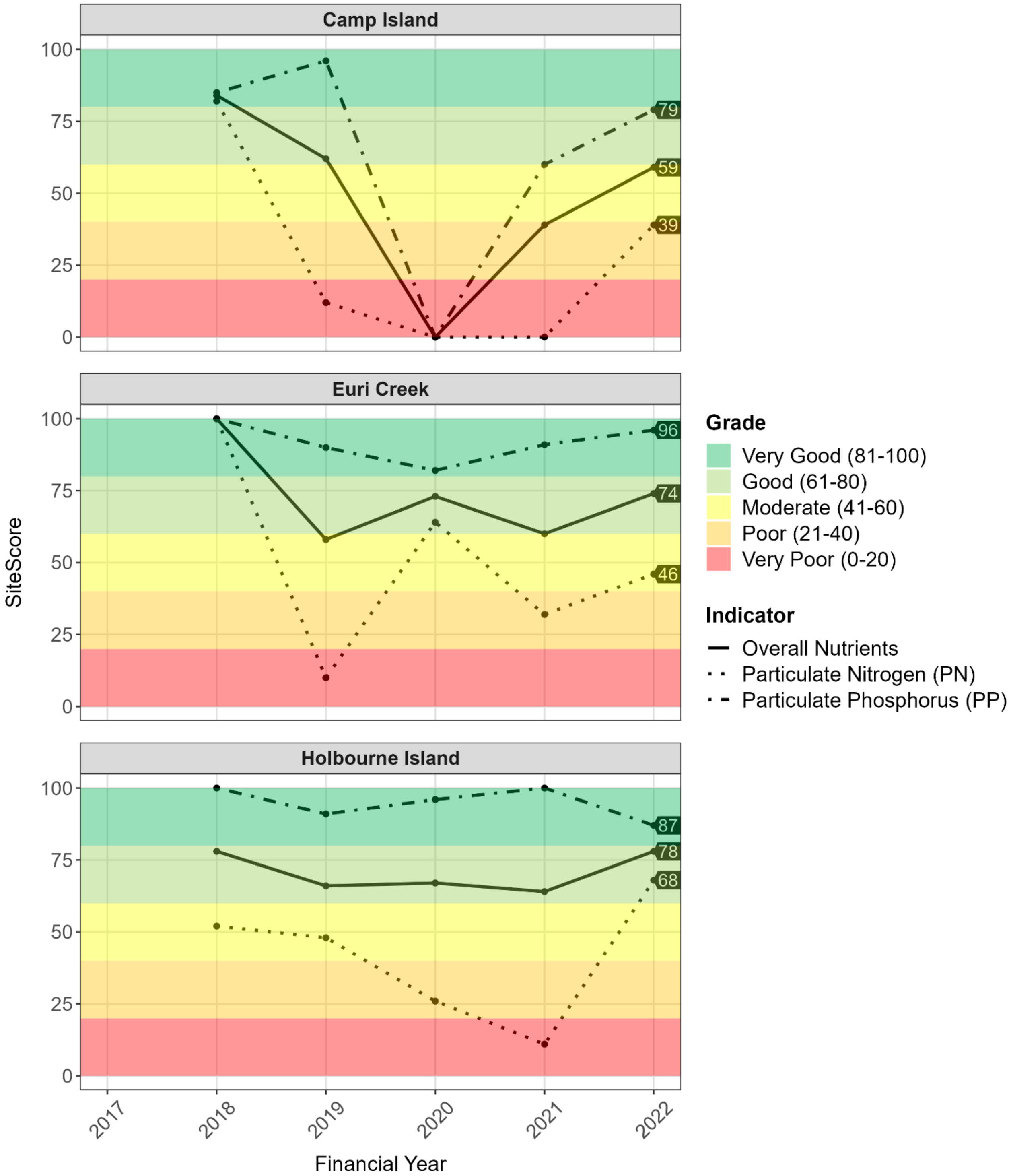

Figure 74. Site level nutrients scores in the MWI Northern Zone, 2021-22 compared to the historic record. The annotated solid black line (overall nutrients) is an average of the other indicators.

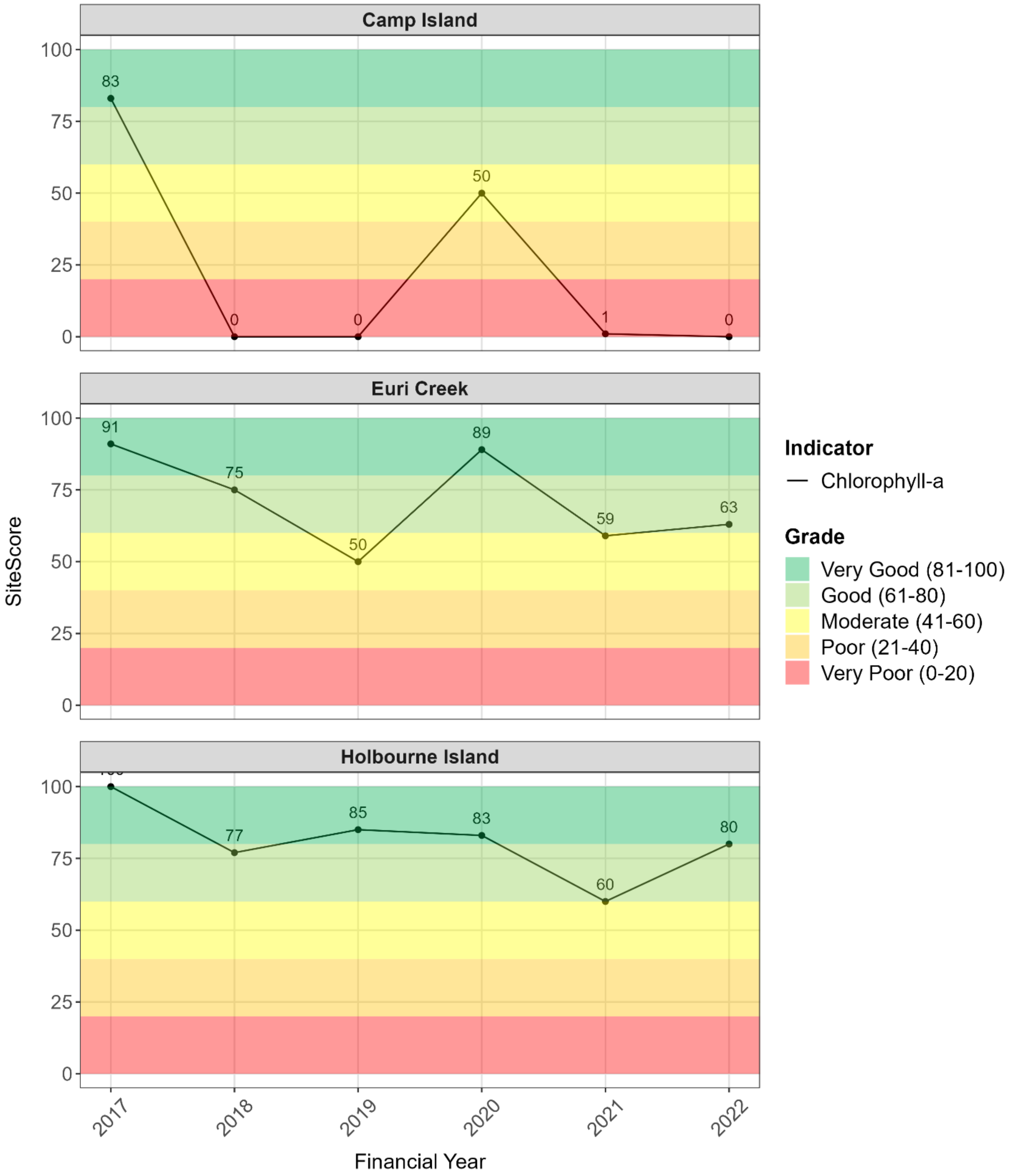

Figure 75. Site level Chlorophyll-*a* scores in the MWI Northern Zone, 2021-22 compared to the historic record.

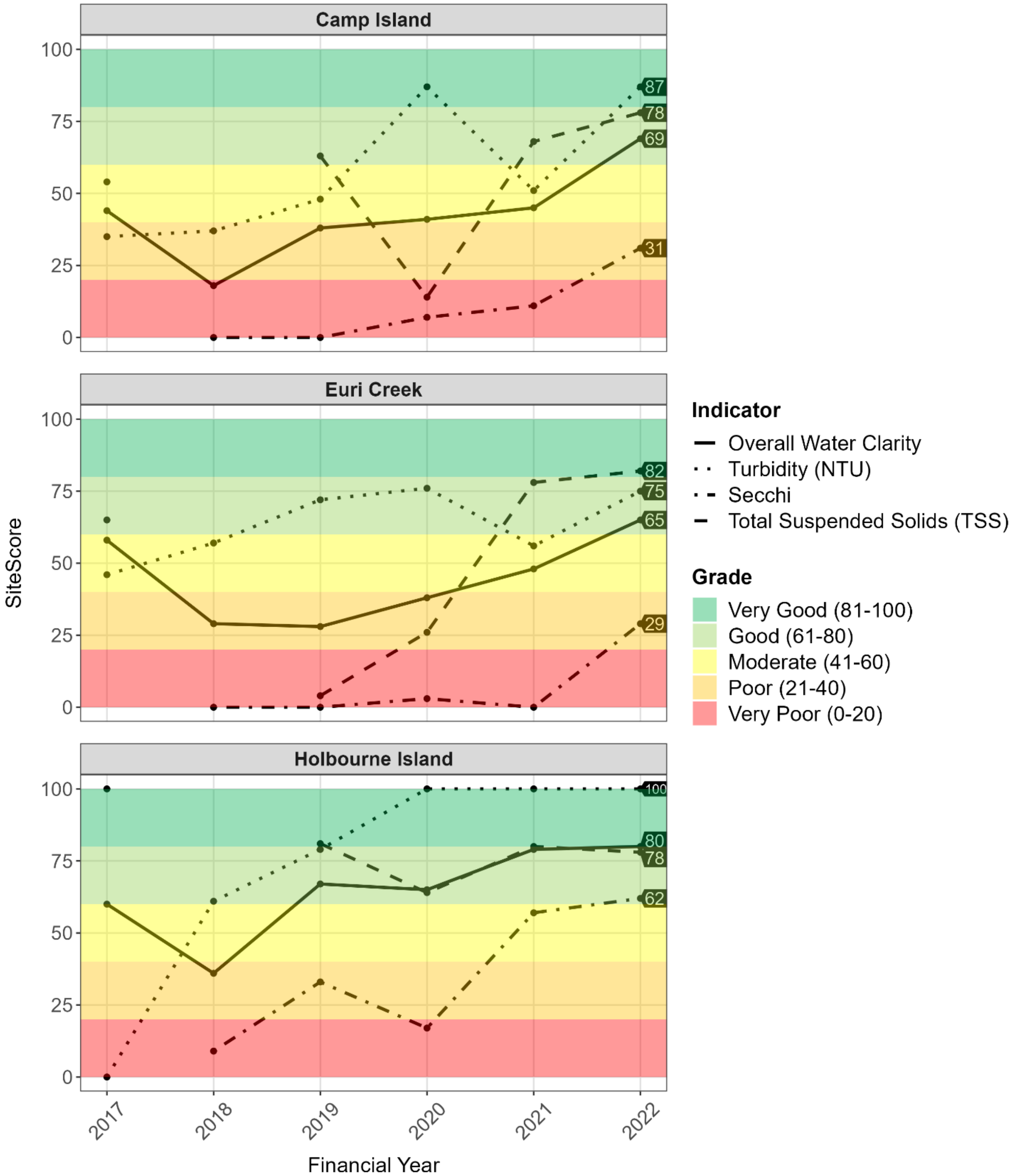

Figure 76. Site level water clarity scores in the MWI Northern Zone, 2021-22 compared to the historic record. The annotated solid black line (overall nutrients) is an average of the other indicators.

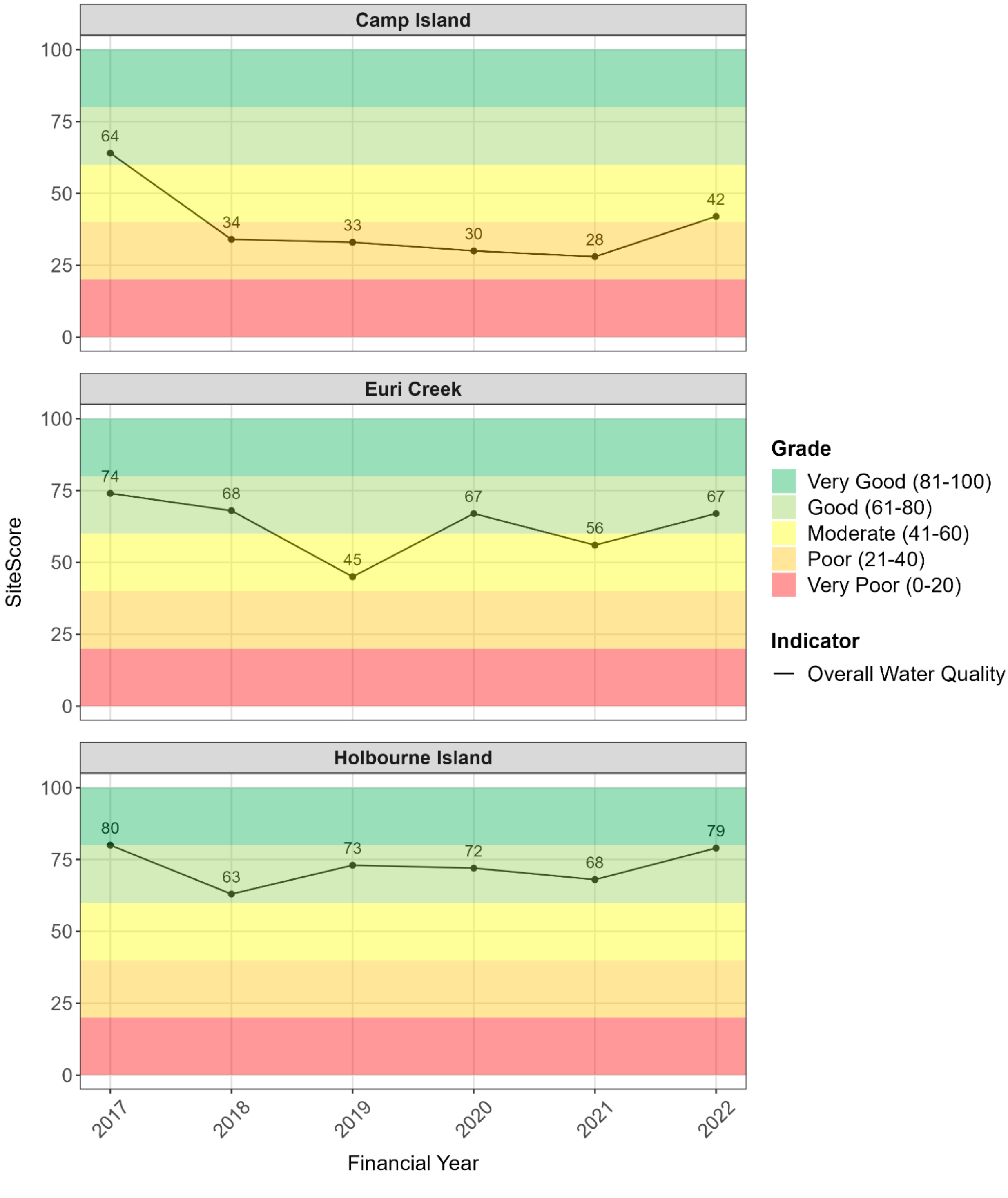

Figure 77. Site level overall water quality scores in the MWI Northern Zone, 2021-22 compared to the historic record.

Table 57. Summary statistics for water quality indicators in the Northern Zone sites from July 2021 to June 2022. 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)	NOx (µg/L)								Mean	3
	PN (µg/L)	8	23.62	15	16	21	25.5	48	Mean	20
	PP (µg/L)	8	1.5	0	0.75	1	2.25	4.0	Mean	2.8
	Chl-*a* (µg/L)	8	0.43	0.21	0.27	0.36	0.41	1.16	Mean	0.45
	TSS (mg/L)	8	1.37	0.56	0.92	1.3	1.68	2.6	Mean	2
	Secchi (m)	8	6.92	4.2	5.95	6.55	8.12	9.8	Mean	10
	Turb (NTU)	231*	1	0	0	1	1	5	Median	1
AP_AMB4 (Camp Is.)	NOx (µg/L)								Mean	3
	PN (µg/L)	7	25.71	8	9.5	10	21.5	100	Mean	20
	PP (µg/L)	7	2.29	1	1	2	2.5	6	Mean	2.8
	Chl-*a* (µg/L)	8	2.3	0.1	0.27	0.39	0.66	15.21	Mean	0.45
	TSS (mg/L)	8	1.48	0.56	1.2	1.5	1.68	2.6	Mean	2
	Secchi (m)	8	7.15	4	6.25	7	8.3	10	Mean	10
	Turb (NTU)	201*	1	0	1	1	1	11	Median	1
AP_AMB5 (Holbourne Is.)	NOx (µg/L)								Mean	3
	PN (µg/L)	8	17.62	5	10.75	15	19.75	44	Mean	20
	PP (µg/L)	8	1.75	0	1	1	1.25	7	Mean	2.8
	Chl-*a* (µg/L)	8	0.32	0.1	0.24	0.34	0.39	0.5	Mean	0.45
	TSS (mg/L)	8	1.48	0.67	1.05	1.55	1.92	2.2	Mean	2
	Secchi (m)	8	10.35	4.2	8.25	9.5	11.47	19.7	Mean	10
	Turb (NTU)	186*	0	0	0	0	1	1	Median	1

*While turbidity loggers were deployed for the entire 2021-22 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

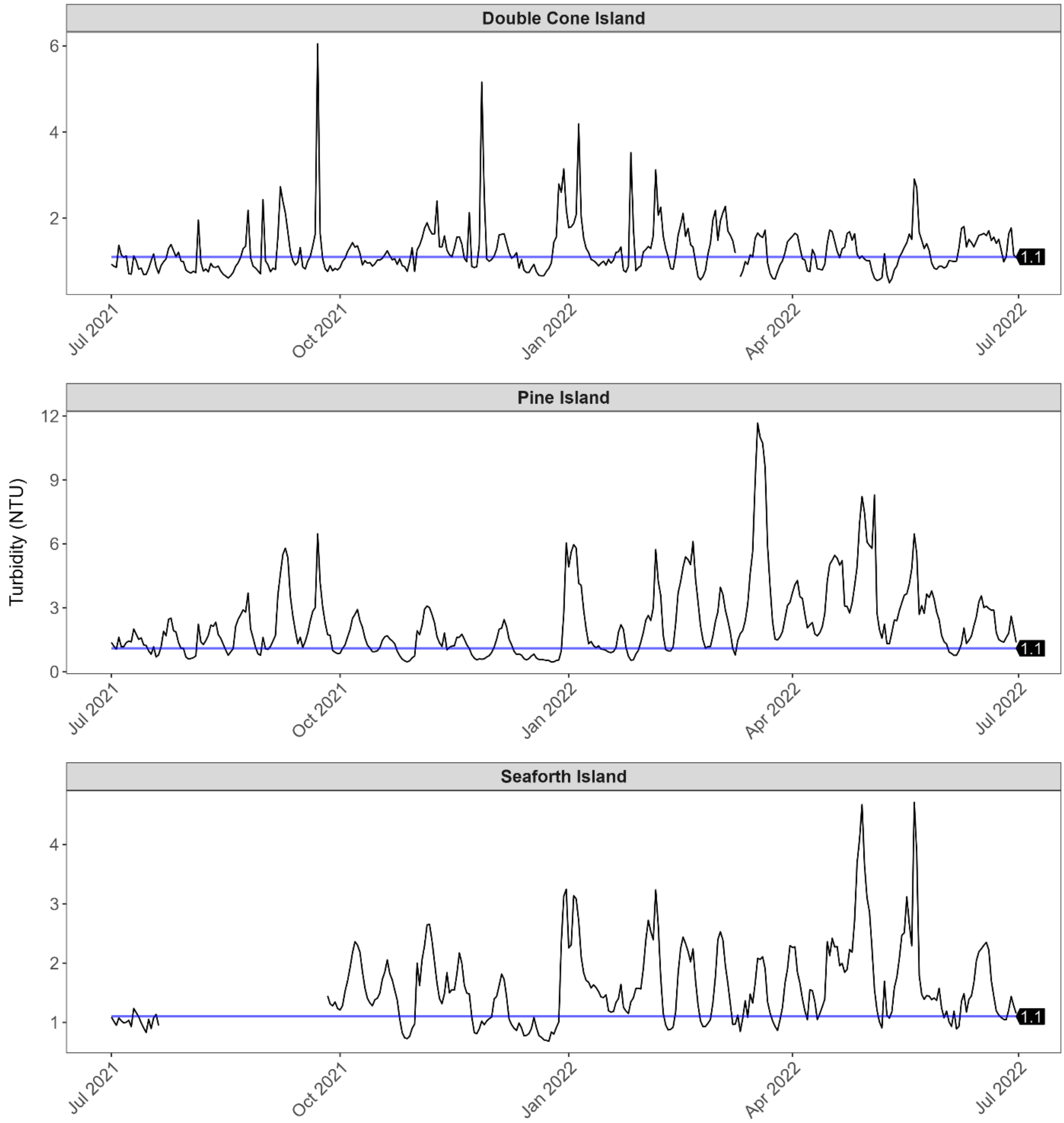

Figure 78. Linegraphs representing daily mean turbidity (NTU) at the sampling sites in the MMP monitoring program in 2022. Missing data removed due to spikes and/or fouling. Guideline value represented by a blue line. Note the free scales on the y-axis.

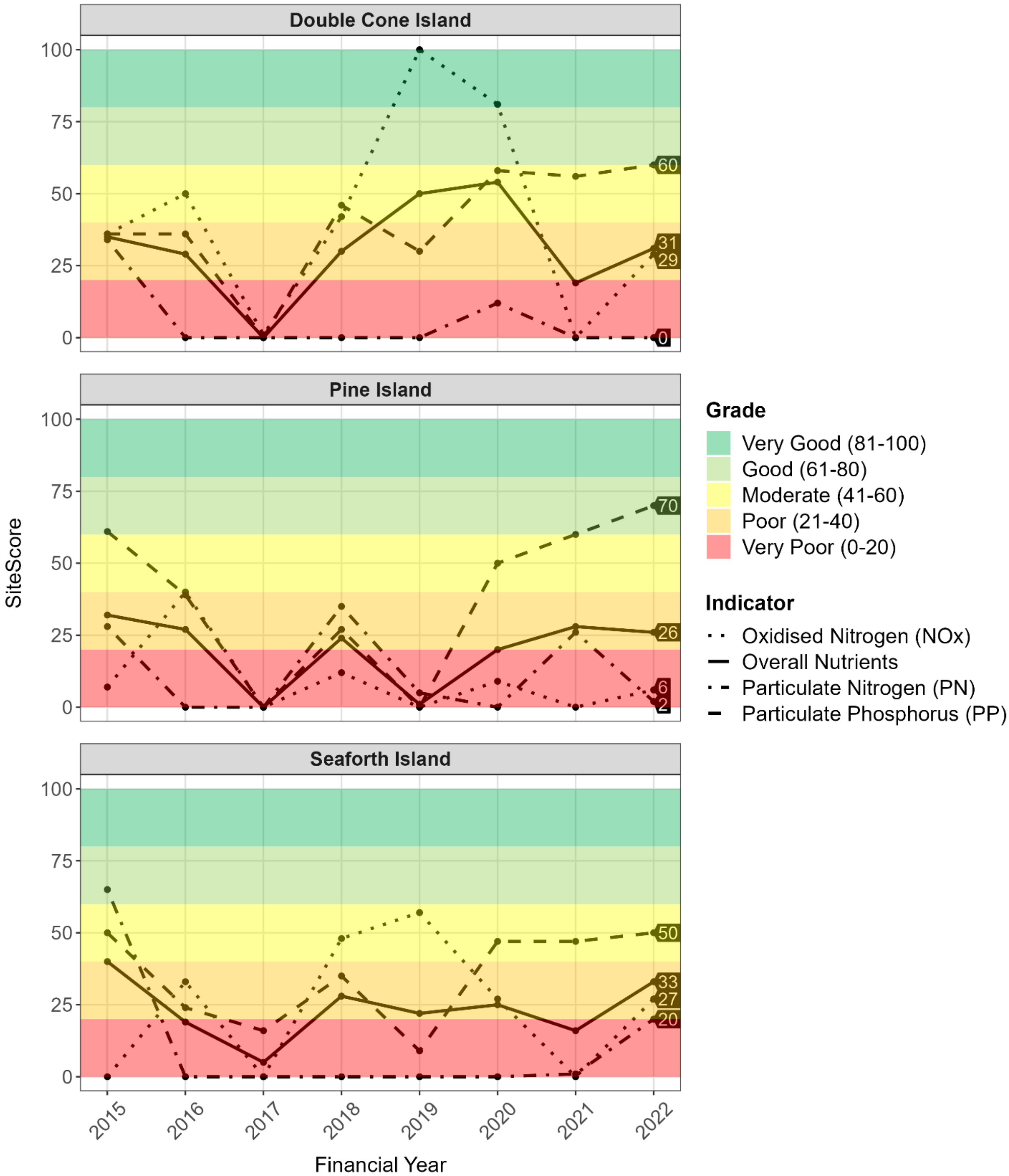

Figure 79. Site level nutrients scores in the MWI Whitsunday Zone, 2021-22 compared to the historic record. The annotated solid black line (overall nutrients) is an average of the other indicators.

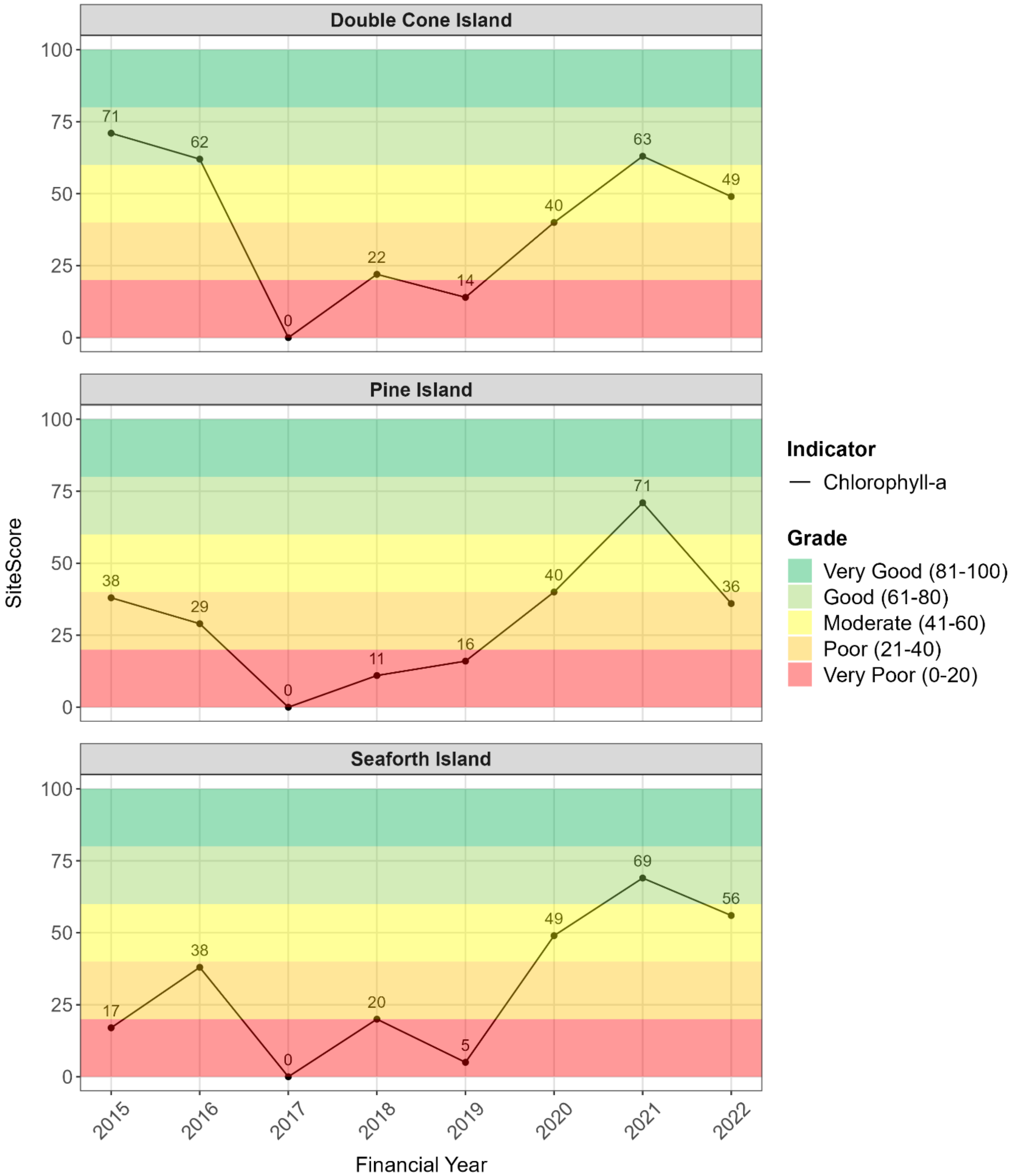

Figure 80. Site level Chl-*a* scores in the MWI Whitsunday Zone, 2021-22 compared to the historic record.

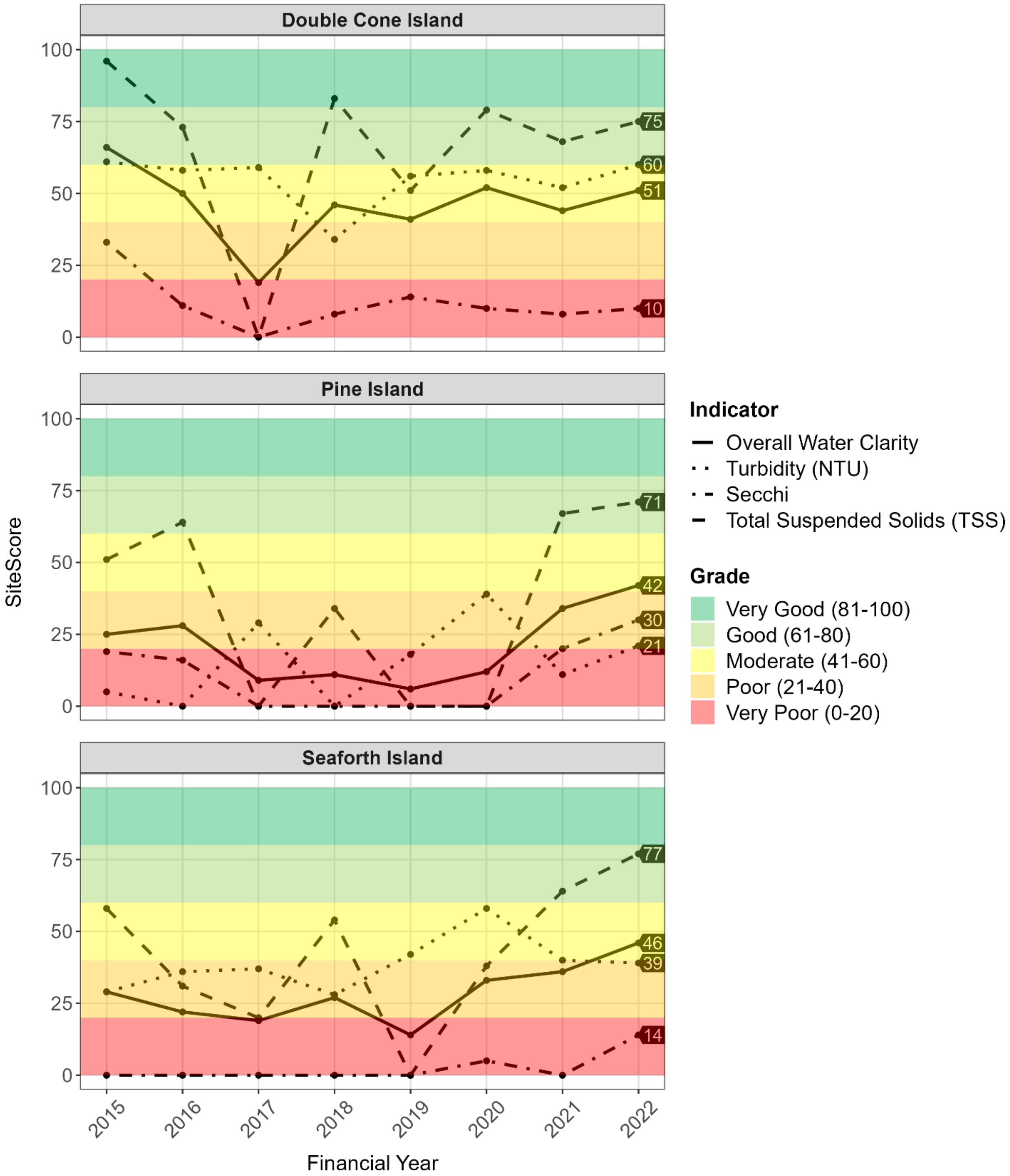

Figure 81. Site level water clarity scores in the MWI Whitsunday Zone, 2021-22 compared to the historic record. The annotated solid black line (overall nutrients) is an average of the other indicators.

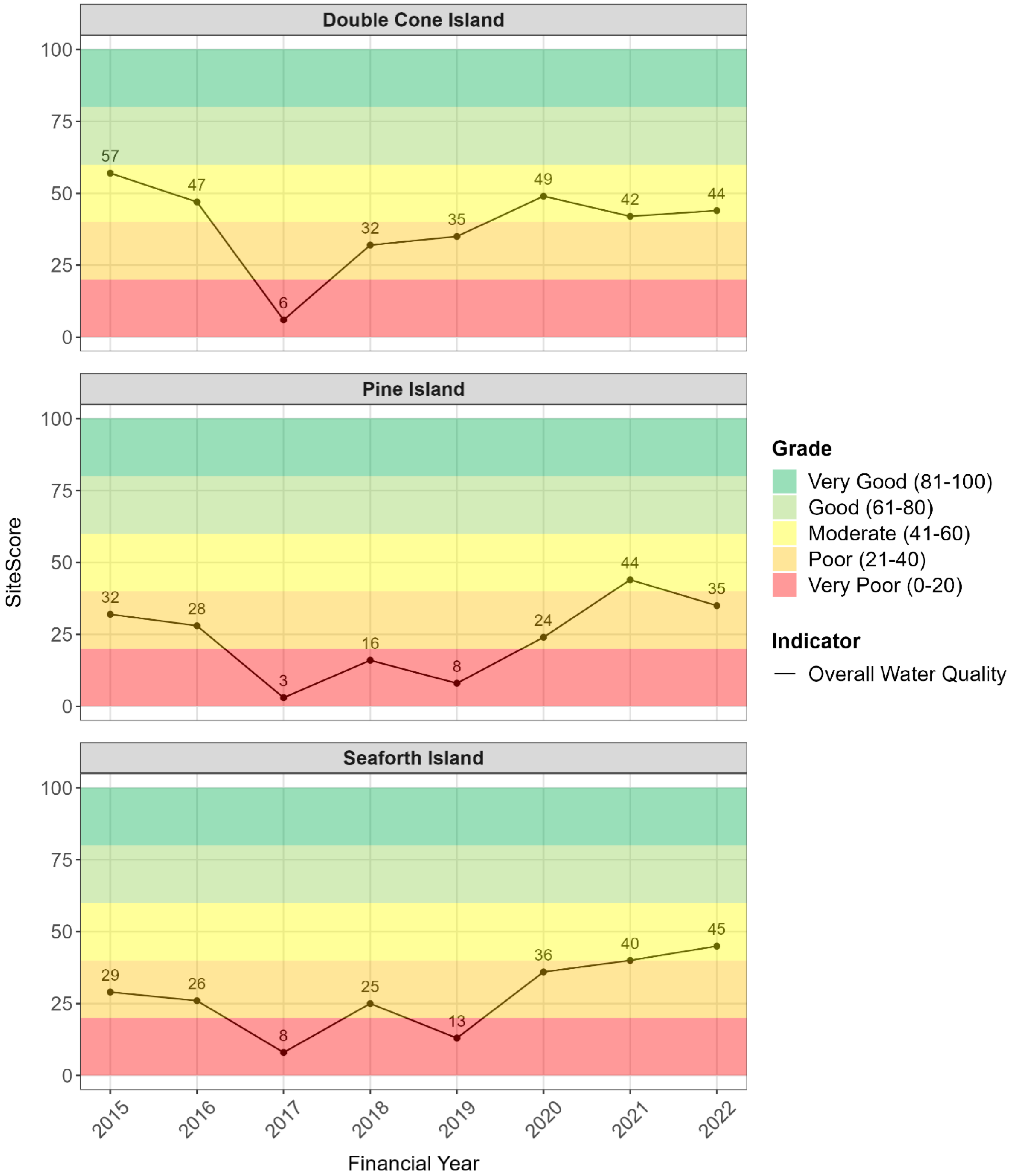

Figure 82. Site level overall water quality scores in the MWI Whitsunday Zone, 2021-22 compared to the historic record.

Table 58. Summary statistics for water quality indicators in the Whitsunday Zone sites from July 2021 to June 2022. 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 Island)	NOx (µg/L)	5	1.37	0.28	0.39	1.44	2.24	2.49	Median	1
	PN (µg/L)	5	23.63	11.85	18.6	27.4	27.56	32.76	Median	13
	PP (µg/L)	5	2.56	1.49	2.33	2.33	2.75	3.9	Median	2.4
	Chl-*a* (µg/L)	5	0.36	0.19	.2	0.41	0.47	0.53	Median	0.36
	TSS (mg/L)	5	1.39	0.87	0.95	1.08	1.3	2.73	Median	1.4
	Secchi (m)	5	5.6	1.5	5.5	5.5	7	8.5	Mean	10
	Turb (NTU)	366*	1.4	0.6	0.9	1.1	1.6	6.8	Median	1.1
WHI4 (Pine Island)	NOx (µg/L)	5	2.61	1.23	1.26	1.86	2.8	5.88	Median	1
	PN (µg/L)	5	25.01	13.65	15.75	25.16	34.81	35.67	Median	13
	PP (µg/L)	5	3.29	1.74	2.1	2.16	2.64	7.79	Median	2.4
	Chl-*a* (µg/L)	5	0.48	0.36	0.37	0.48	0.49	0.72	Median	0.36
	TSS (mg/L)	5	2.77	0.61	0.99	1.16	2.07	9.04	Median	1.4
	Secchi (m)	5	7	1.5	5.5	9	9	10	Mean	10
	Turb (NTU)	297*	2.0	0.4	0.9	1.4	2.3	11.9	Median	1.1
WHI5 (Seaforth Island)	NOx (µg/L)	5	1.67	0.84	1.3	1.47	2.28	2.45	Median	1
	PN (µg/L)	5	21.88	17.15	20.55	20.6	23.06	28.01	Median	13
	PP (µg/L)	5	2.6	2.05	2.19	2.7	2.74	3.32	Median	2.4
	Chl-*a* (µg/L)	5	0.41	0.32	0.37	0.38	0.48	0.51	Median	0.36
	TSS (mg/L)	5	1.42	0.71	0.96	1.05	1.97	2.42	Median	1.4
	Secchi (m)	5	5.9	3.5	4.5	6.5	7.5	7.5	Mean	10
	Turb (NTU)	366*	1.5	0.5	0.9	1.1	1.7	8.9	Median	1.1

*While turbidity loggers were deployed for the entire 2021-22 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

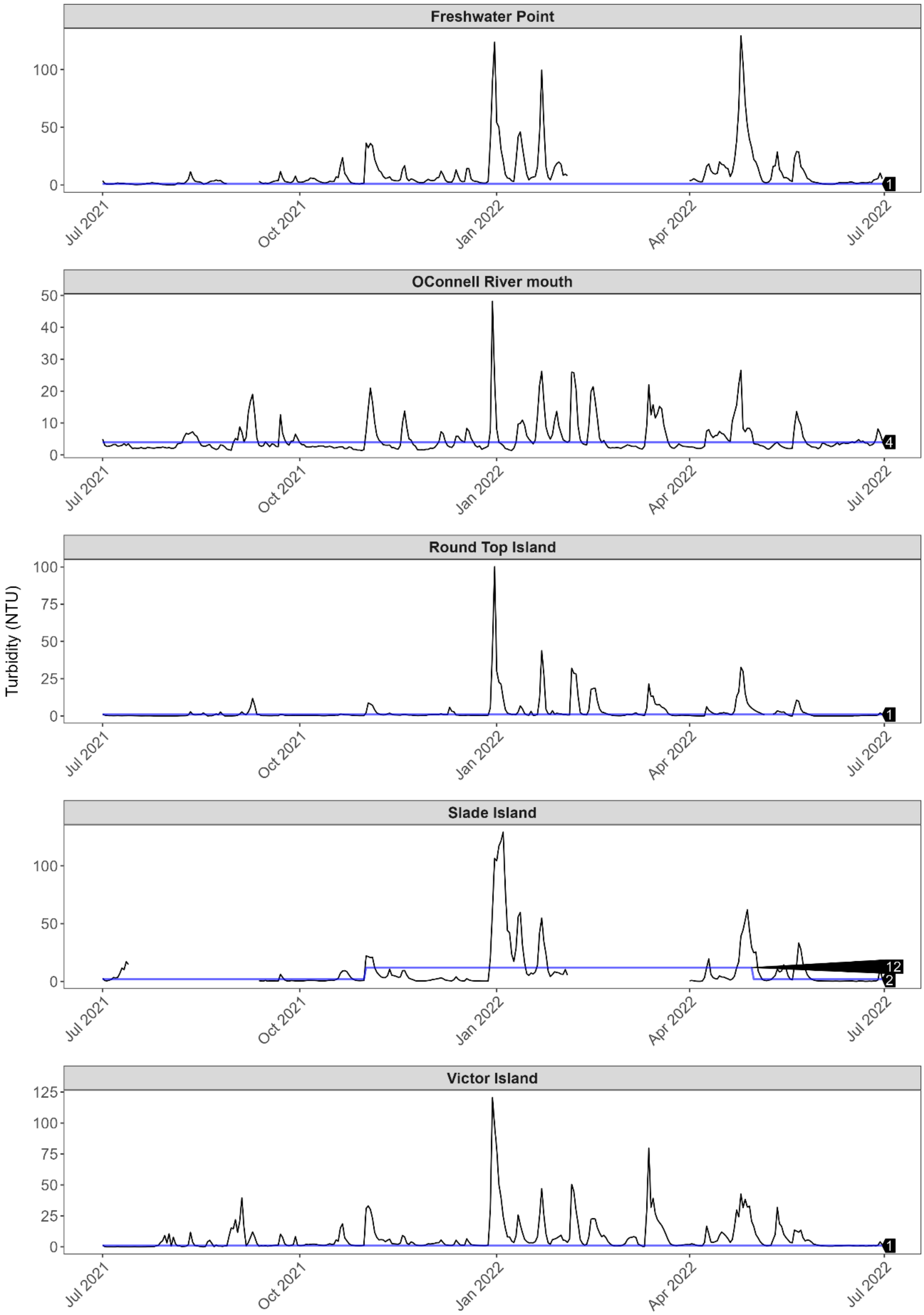

Figure 83. Linegraphs representing daily mean turbidity (NTU) at the sampling sites in the NQBP Hay Point monitoring program in 2022. Missing data removed due to spikes and/or fouling. Guideline value represented by a blue line, note the wet season / dry season GVs for the Slade Island monitoring site and the lack of GV for the O'Connell River mouth site. Note the free scales on the y-axis.

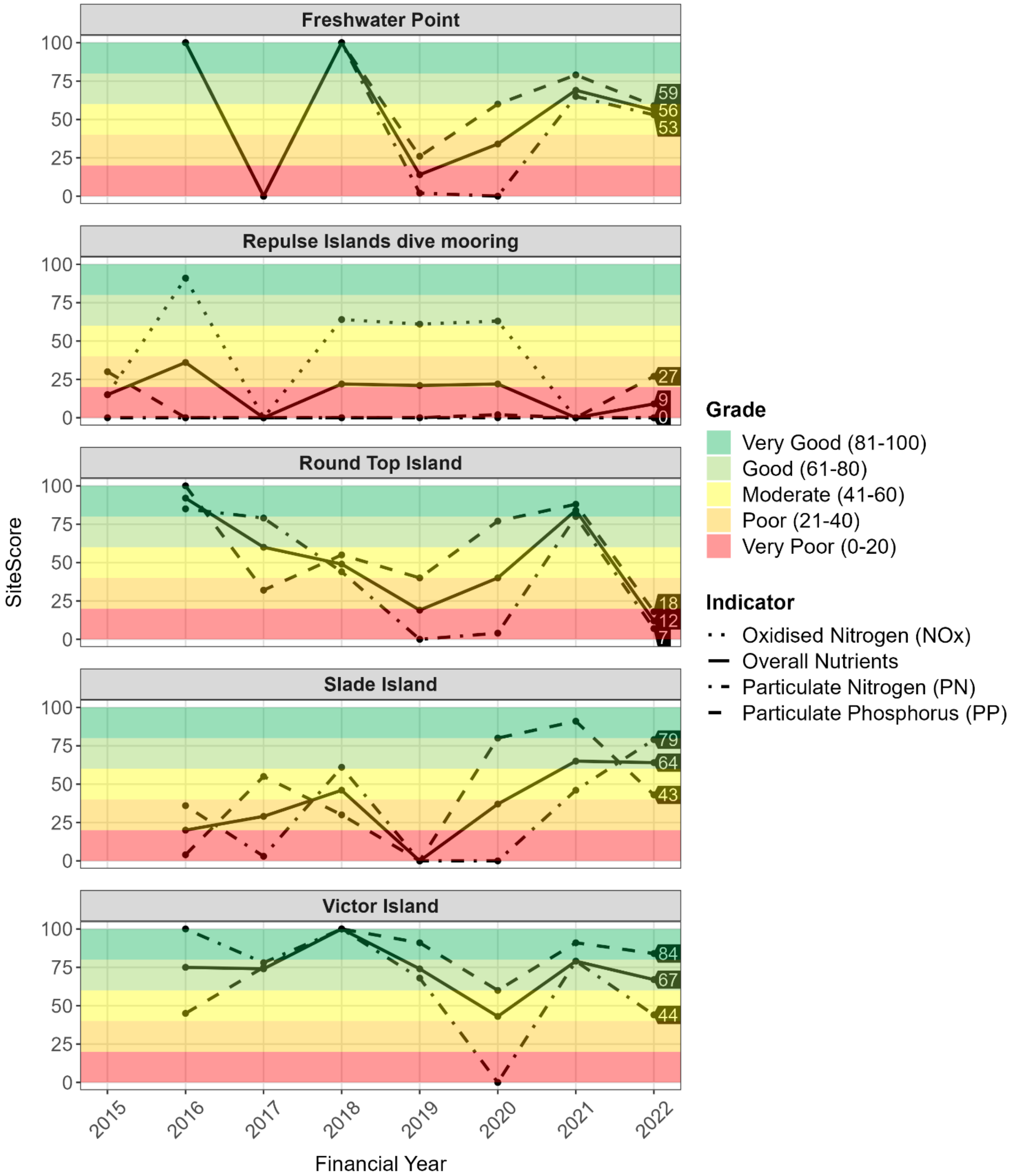

Figure 84. Site level nutrients scores in the MWI Central Zone, 2021-22 compared to the historic record. The annotated solid black line (overall nutrients) is an average of the other indicators. Scores for NOx at the NQBP monitoring sites cannot be calculated as there is no associated guideline value.

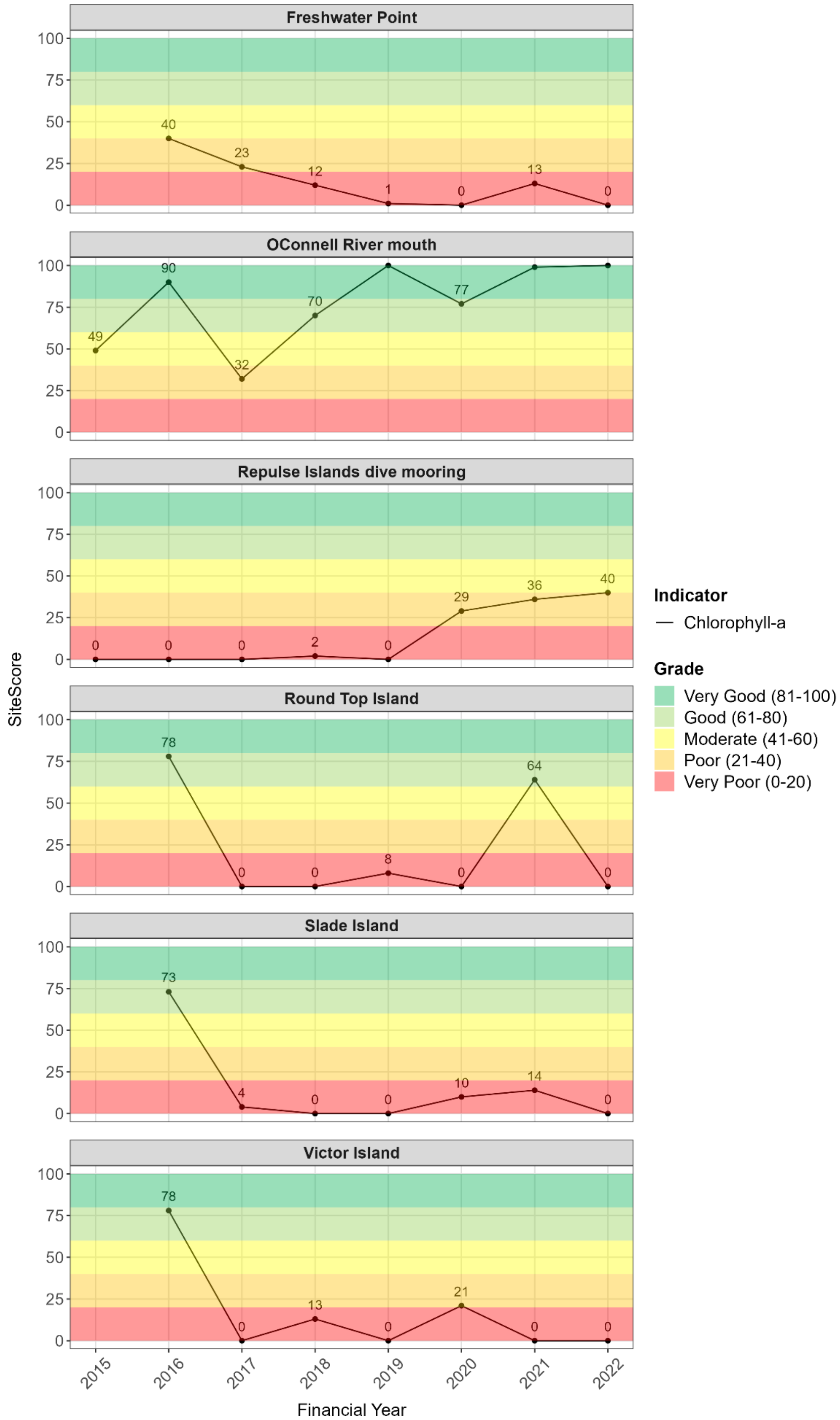

Figure 85. Site level Chlorophyll-*a* scores in the MWI Central Zone, 2021-22 compared to the historic record.

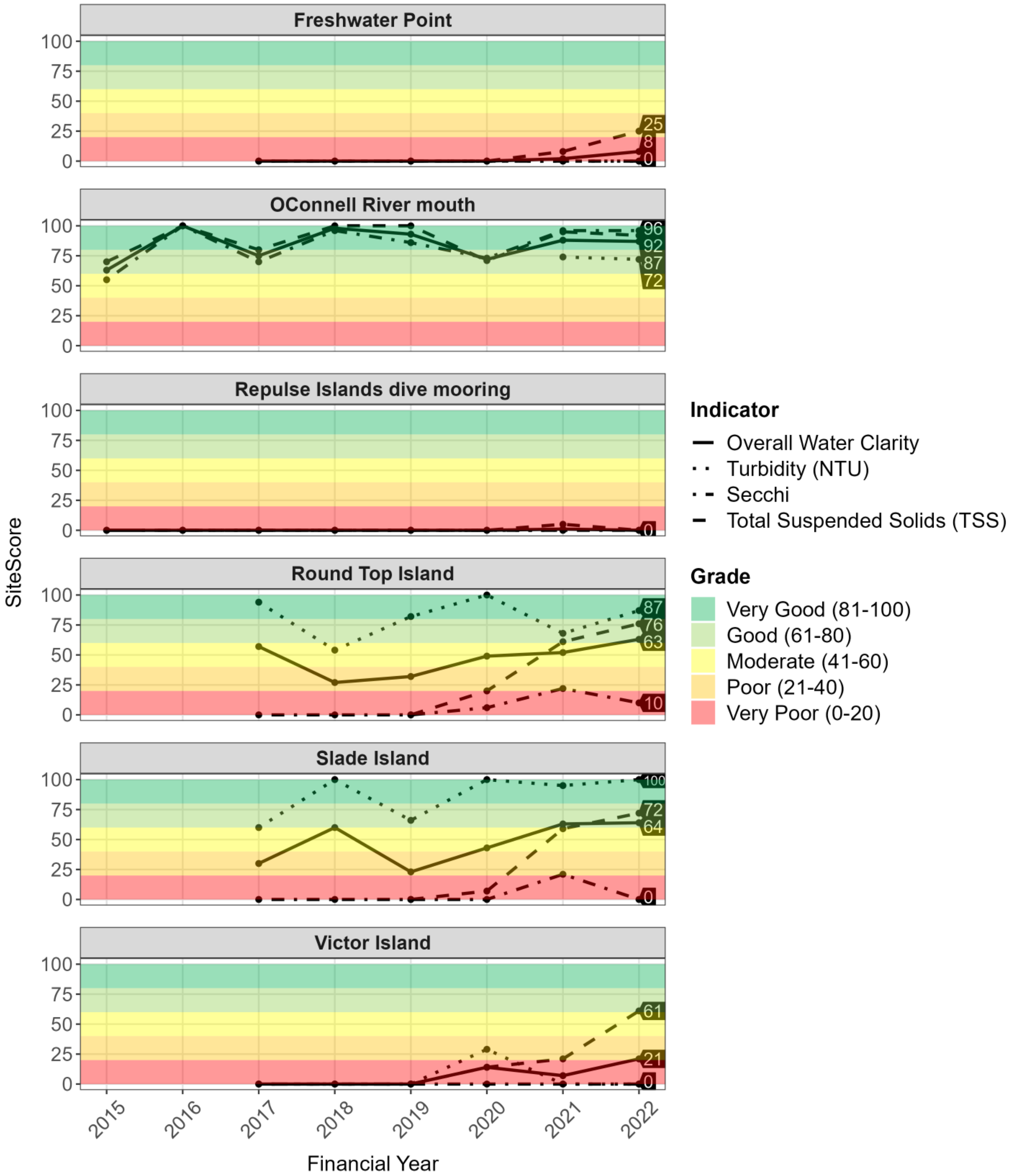

Figure 86. Site level water clarity scores in the MWI Central Zone, 2021-22 compared to the historic record. The annotated solid black line (overall clarity) is an average of the other indicators. Scores for clarity at the O'Connell River mouth site cannot be calculated as there are no associated guideline values.

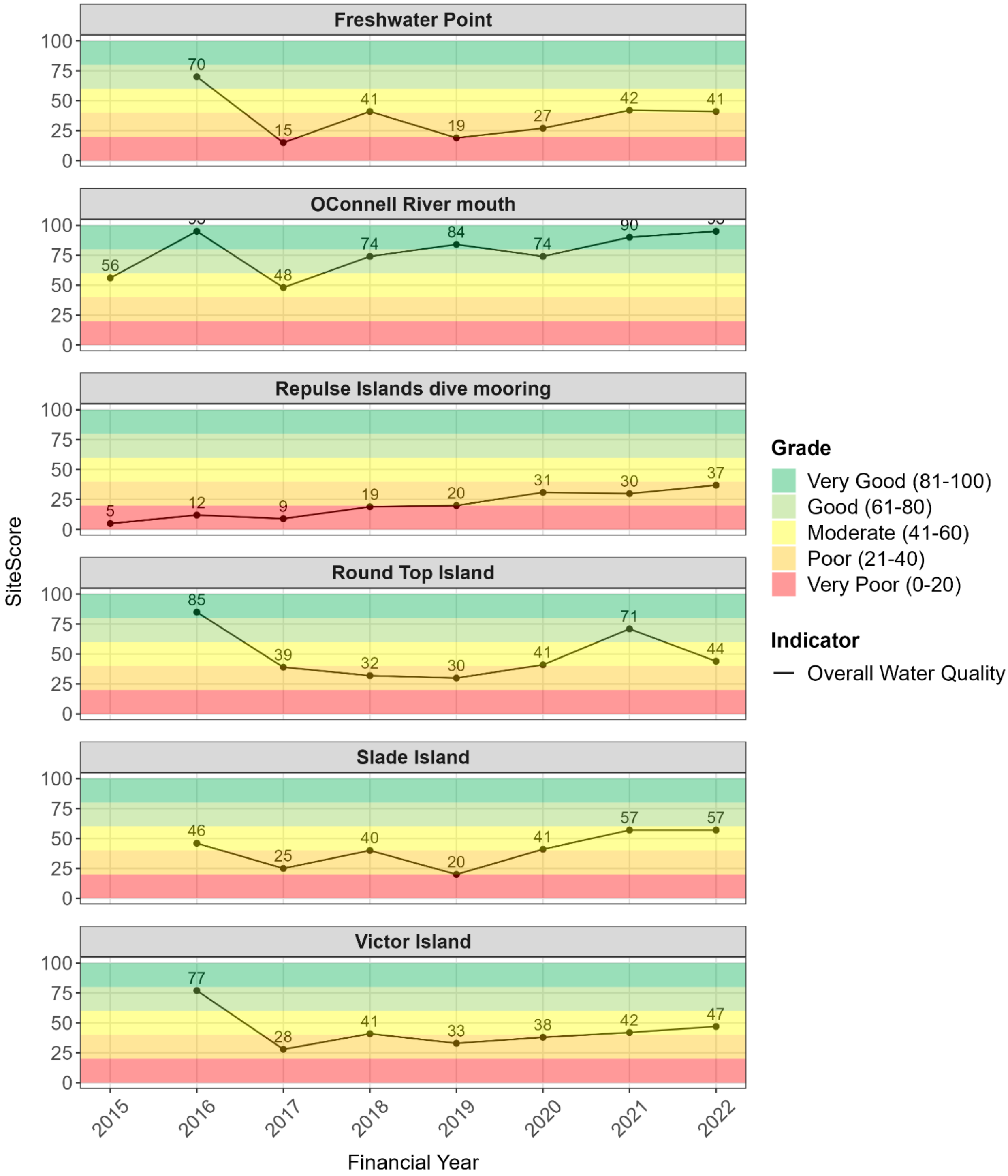

Figure 87. Site level overall water quality scores in the MWI Central Zone, 2021-22 compared to the historic record. Overall water quality scores cannot be calculated at the O'Connell River mouth site due to lack of guideline values for several indicators and minimum reporting requirements for scores calculations.

Table 59. Summary statistics for water quality indicators in the Central Zone sites from July 2021 to June 2022. 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	2.75	0.84	1.16	1.89	4.59	5.29	Median	4
	PN (µg/L)	5	69	38	59	64	75	109		
	PP (µg/L)	5	7.8	5.7	7.0	7.1	8.2	10.7		
	Chl-*a* (µg/L)	5	0.63	0.34	0.44	0.56	0.76	1.06	Median	1.3
	TSS (mg/L)	5	3.8	1.6	2.7	3.2	4.6	6.8		
	Secchi (m)	5	2	2	2	2	2	3		
	Turb (NTU)									
WHI7 (Repulse Islands dive mooring)	NOx (µg/L)	5	4.05	1.33	1.61	3.64	4.1	9.56	Median	1
	PN (µg/L)	5	29.33	22.71	23.01	26.31	35.01	39.61	Median	13
	PP (µg/L)	5	4.28	2.34	3	3.51	5.42	7.14	Median	2.4
	Chl-*a* (µg/L)	5	0.52	0.38	0.45	0.46	0.62	0.67	Median	0.36
	TSS (mg/L)	5	4.1	0.63	2.15	2.91	4.22	10.59	Median	1.4
	Secchi (m)	5	4.4	1.5	2.5	3.5	4	10.5	Mean	10
	Turb (NTU)	366*	3.6	0.6	1.5	2.6	4.4	27.7	Median	1.1
MKY_AMB1 (FW Point)	NOx (µg/L)									
	PN (µg/L)	7	21.86	7	9	13	17	81	Mean	20
	PP (µg/L)	7	2.86	0	2	2	3.5	7	Mean	2.8
	Chl-*a* (µg/L)	7	0.98	0.3	0.64	0.82	1	2.48	Mean	0.45
	TSS (mg/L)	7	2.99	1.8	2.4	2.4	3.35	5.2	Mean	2
	Secchi (m)	7	2.61	1.8	2	2.5	2.75	4.5	Mean	10
	Turb (NTU)	232*	8.2	0.2	1.4	3.2	9.8	73.1	Median	<1
MKY_AMB3B (Round Top Is.)	NOx (µg/L)									
	PN (µg/L)	7	36.57	10	15.5	19	45.5	105	Mean	20
	PP (µg/L)	7	4.57	1	2	3	6.5	11	Mean	2.8
	Chl-*a* (µg/L)	7	1.7	0.1	0.38	0.47	0.7	9.14	Mean	0.45
	TSS (mg/L)	7	1.53	1	1.15	1.7	1.8	2.1	Mean	2
	Secchi (m)	7	5.64	2.5	4.35	5.64	7	8.25	Mean	10
	Turb (NTU)	158*	0.7	0.1	0.3	0.5	0.8	7.6	Median	<1

MKY_AMB5 (Slade Is.)	NOx (µg/L)									
	PN (µg/L)	7	14.43	4	8	17	21	22	Mean	20
	PP (µg/L)	7	3.43	2	2.5	3	4	6	Mean	2.8
	Chl-*a* (µg/L)	7	1.42	0.1	0.42	0.66	0.98	6.39	Mean	0.45
	TSS (mg/L)	7	1.63	1	1.1	1.4	2	2.8	Mean	2
	Secchi (m)	7	4	2	3.35	4	4.15	7	Mean	10
	Turb (NTU)	166*	2.6	0.1	0.4	1.0	2.8	30.5	Median	D = 2; W = 12
MKY_AMB10 (Victor Is.)	NOx (µg/L)									
	PN (µg/L)	7	24.14	5	17.5	28	30	41	Mean	20
	PP (µg/L)	7	1.86	0	1	1	3	4	Mean	2.8
	Chl-*a* (µg/L)	7	0.9	0.25	0.65	0.9	1.08	1.68	Mean	0.45
	TSS (mg/L)	7	1.96	1.1	1.35	2	2.5	2.9	Mean	2
	Secchi (m)	7	3.14	2.5	2.75	3	3.5	4	Mean	10
	Turb (NTU)	195*	3.8	0.1	0.9	1.4	3.4	138.7	Median	<1

*While turbidity loggers were deployed for the entire 2021-22 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

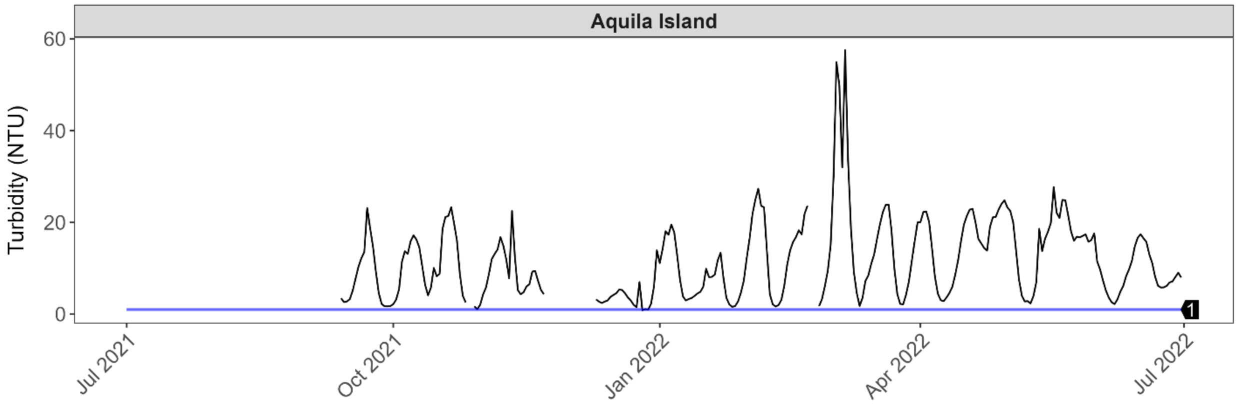

Figure 88. Linegraphs representing daily mean turbidity (NTU) at the Aquila Island Southern Inshore monitoring program in 2022. Missing data removed due to spikes and/or fouling. Guideline value represented by a blue line.

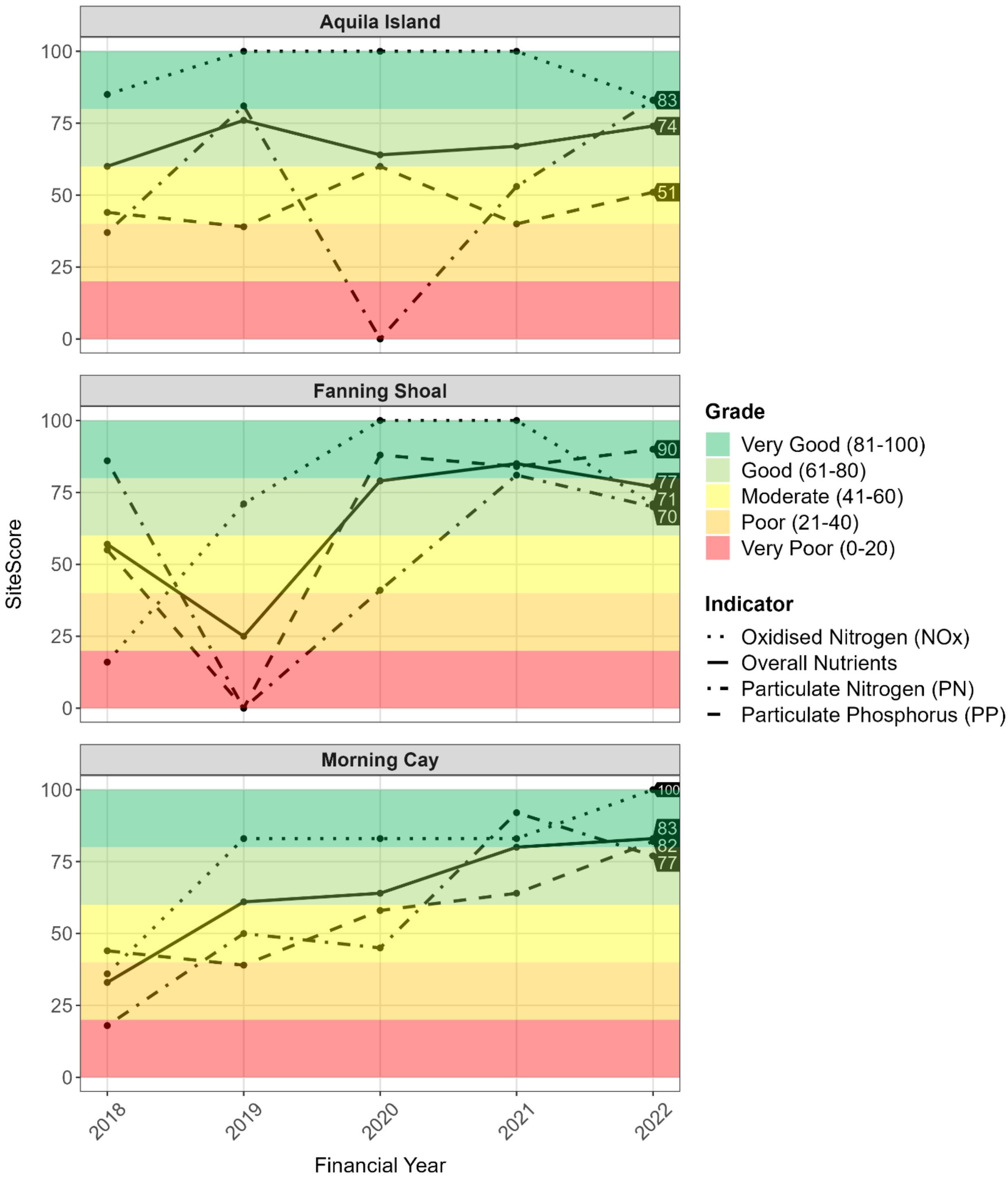

Figure 89. Site level nutrients scores in the MWI Southern Zone, 2021-22 compared to the historic record. The annotated solid black line (overall nutrients) is an average of the other indicators.

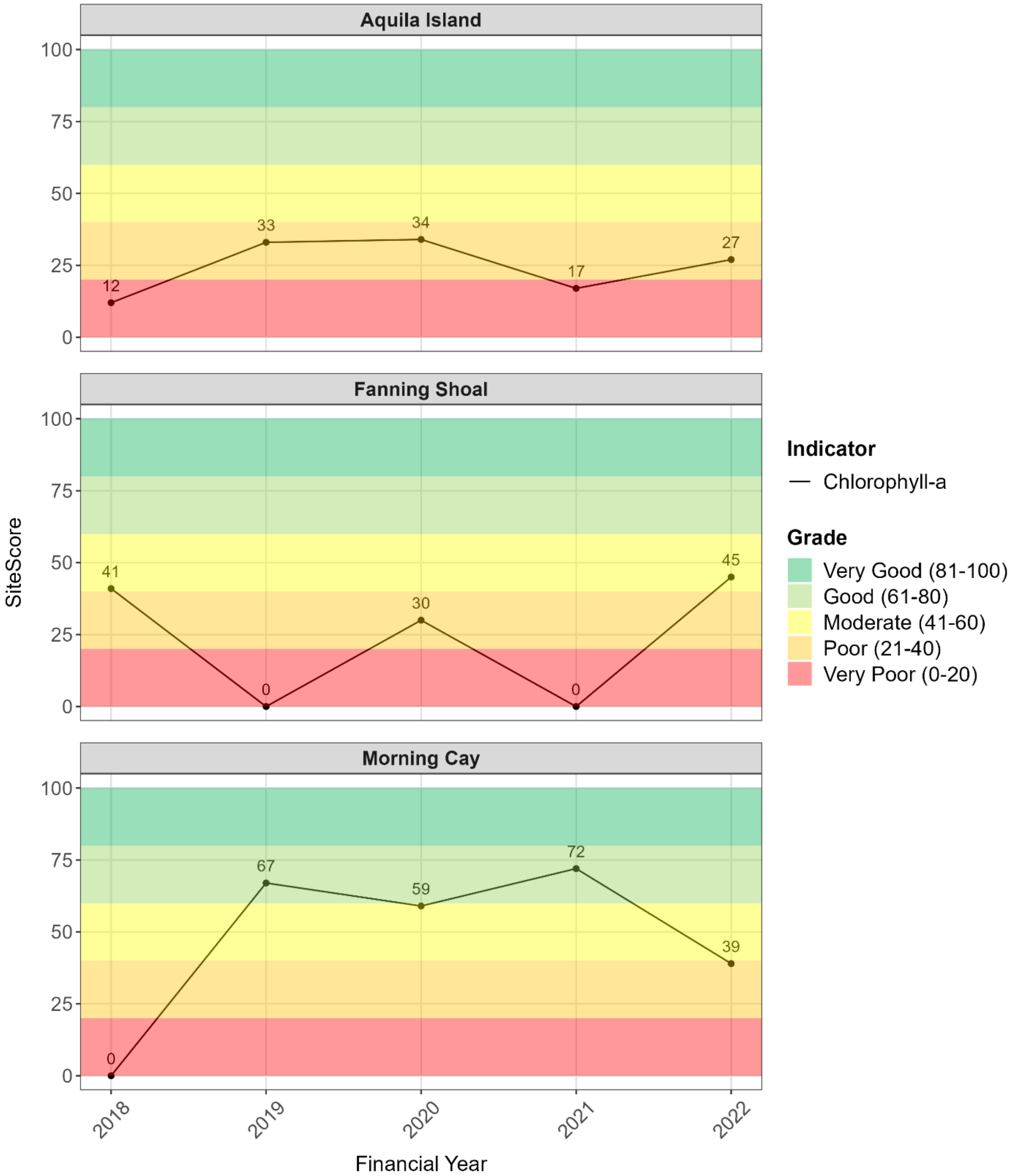

Figure 90. Site level Chl-*a* scores in the MWI Southern Zone, 2021-22 compared to the historic record.

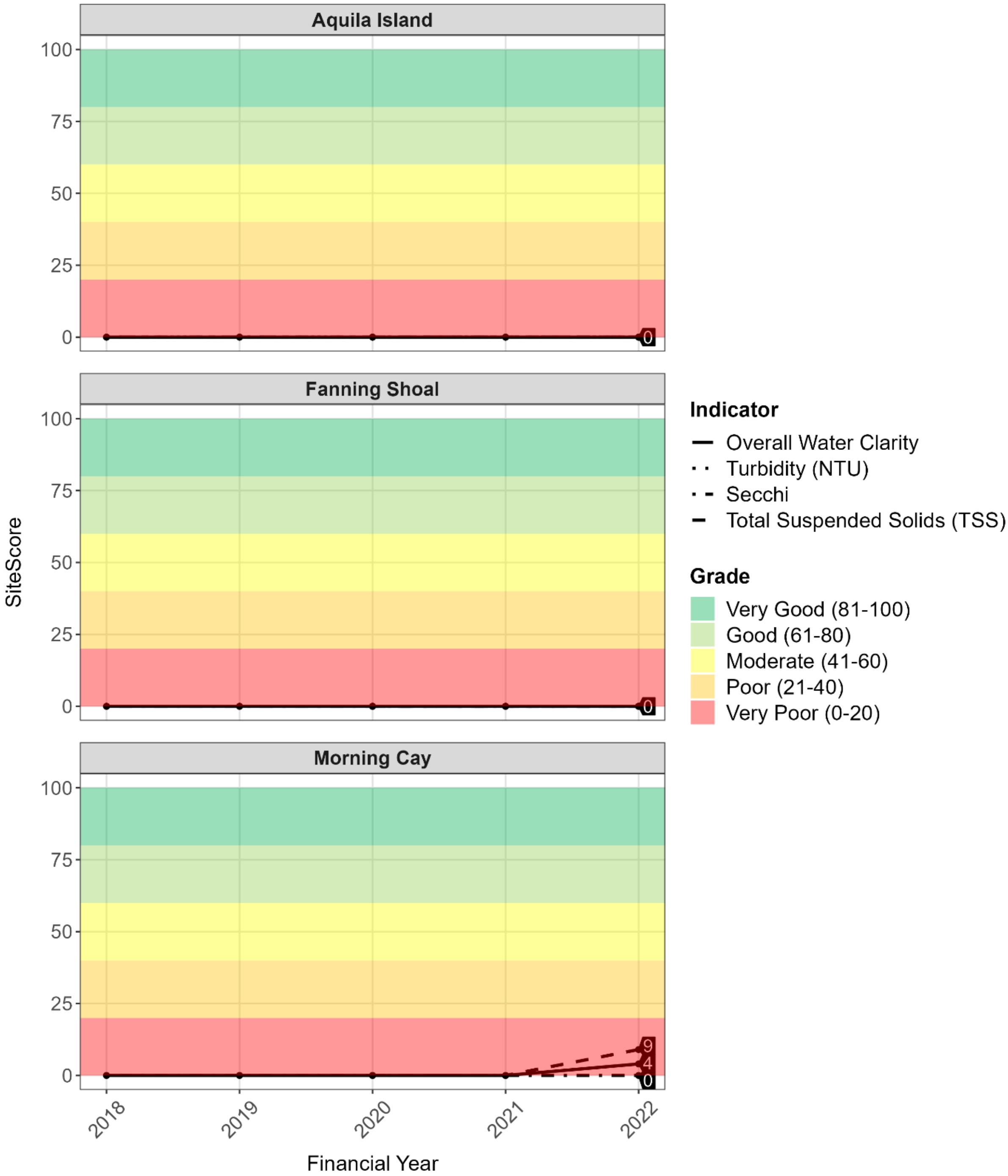

Figure 91. Site level water clarity scores in the MWI Southern Zone, 2021-22 compared to the historic record. The annotated solid black line (overall clarity) is an average of the other indicators.

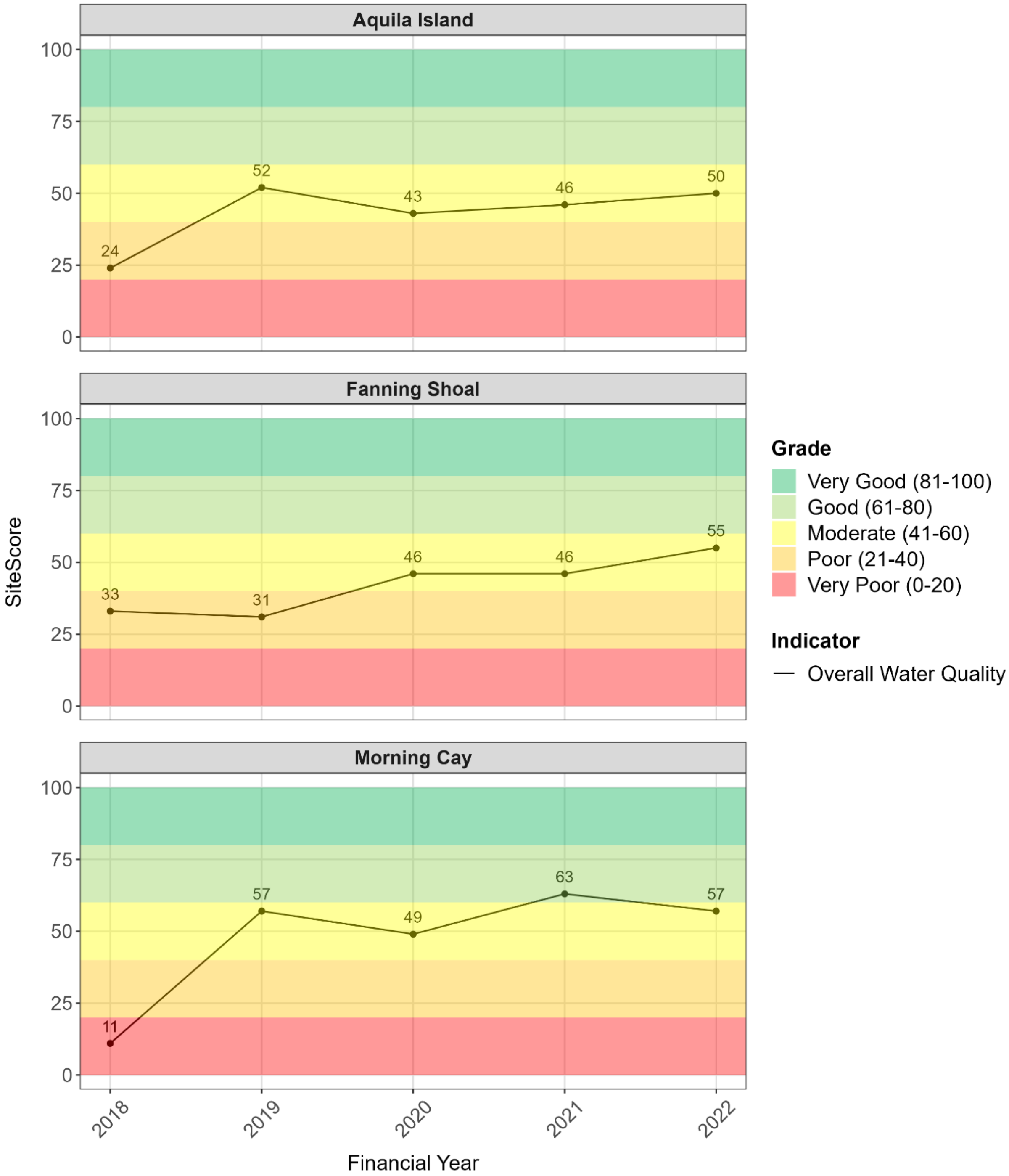

Figure 92. Site level overall water quality scores in the MWI Southern Zone, 2021-22 compared to the historic record.

Table 60. Summary statistics for water quality indicators in the Southern Zone for marine sites from July 2021 to June 2022. 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)	7	1.57	1	1	2	2	2	Median	3
	PN (µg/L)	8	13.38	6	8	14	19	19	Mean	20
	PP (µg/L)	8	3.12	1	2	2	3.5	9	Mean	2.8
	Chl-*a* (µg/L)	8	0.66	0.27	0.5	0.6	0.75	1.29	Mean	0.45
	TSS (mg/L)	8	8.96	2	4,78	5.4	9.2	26	Mean	2
	Secchi (m)	8	2.35	1.5	2	2.2	2.67	3.2	Mean	10
	Turb (NTU)	232*	10	0	5	9	13	52	Mean	<1
MKY_CAM2 (Morning Cay)	NOx (µg/L)	8	1.63	0.05	1	1.5	2	4	Median	3
	PN (µg/L)	9	14.89	12	13	13	14	23	Mean	20
	PP (µg/L)	9	2.22	1	1	3	3	4	Mean	2.8
	Chl-*a* (µg/L)	8	0.58	0.28	0.34	0.52	0.68	1.09	Mean	0.45
	TSS (mg/L)	9	3.59	1.3	3	**3.3**	4.5	6.9	Mean	2
	Secchi (m)	8	2.55	2	2	2.3	3.1	3.4	Mean	10
	Turb (NTU)								Mean	<1
MKY_CAM3 (Fanning Shoal)	NOx (µg/L)	8	2.38	1	2	2.5	3	3	Median	3
	PN (µg/L)	9	16.89	4	15	16	17	39	Mean	20
	PP (µg/L)	9	1.67	0	1	2	2	3	Mean	2.8
	Chl-*a* (µg/L)	8	0.54	0.28	0.32	0.54	0.64	0.93	Mean	0.45
	TSS (mg/L)	9	4.49	1	2.6	2.7	6.3	15	Mean	2
	Secchi (m)	8	2.81	2	2.42	2.75	3.22	3.6	Mean	10
	Turb (NTU)								Mean	<1

*While turbidity loggers were deployed for the entire 2021-22 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.

8.4.1.6 Pesticides

Table 61. Results and deployment periods for 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 2022 Report Card. The Pesticide Risk Metric reported for each passive sampler site is the maximum % species affected value out of *n* deployments per site.

2022 Report Card							
Zone	**Sample Type**	**Program**	**Site**	**Sample Timing and Size (*n*)**	**Value Reported**	**Pesticide Risk Metric (% Species Protected)**	**Pesticide Score**
Northern^	Passive	NQBP	Euri Creek	17/11/2021 – 13/12/2021, 30/03/2022 – 4/05/2022 2 deployments	Max	100%	**100**
Whitsunday							
Central	Passive	NQBP	Slade Island	15/11/2021 – 14/12/2021 1 deployment	Max	100%	**100**
Southern	Passive	SIP	Aquila Island	16/11/2021 – 05/05/2022 4 continuous deployments	Max	100%	**100**

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

^Northern Zone scores used as reference only due to lack of temporal representation during the wet season.

8.4.1.7 Offshore Water Quality Historic Scores

Table 62. 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

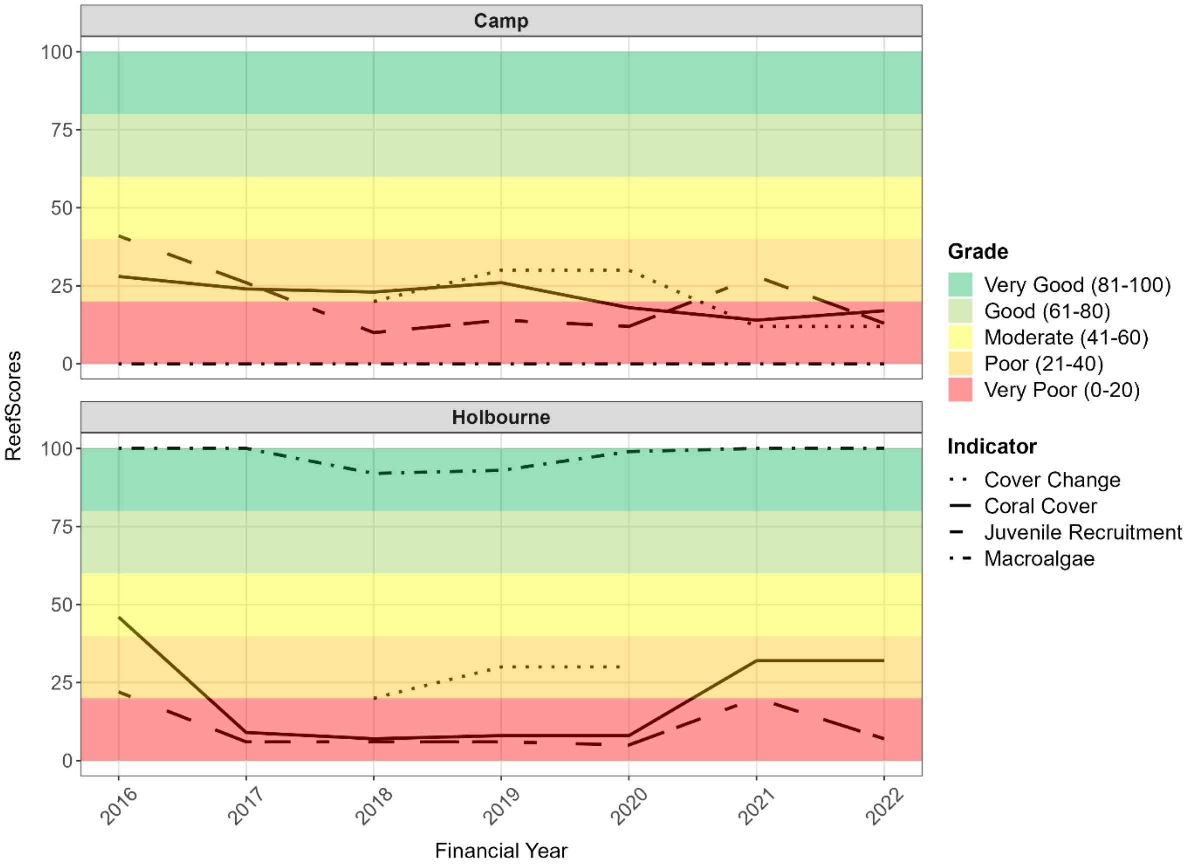

Figure 93. Northern Zone reef-level coral indicator scores and grades for the 2022 Report Card compared to the historic record. Scores in the **Northern Zone** before 2021 are not directly comparable to previous years due to changes in sampling design and before 2020 due to changes in reef aggregation level.

Figure 94. Whitsunday Zone reef-level coral indicator scores and grades for the 2022 Report Card compared to the historic record.

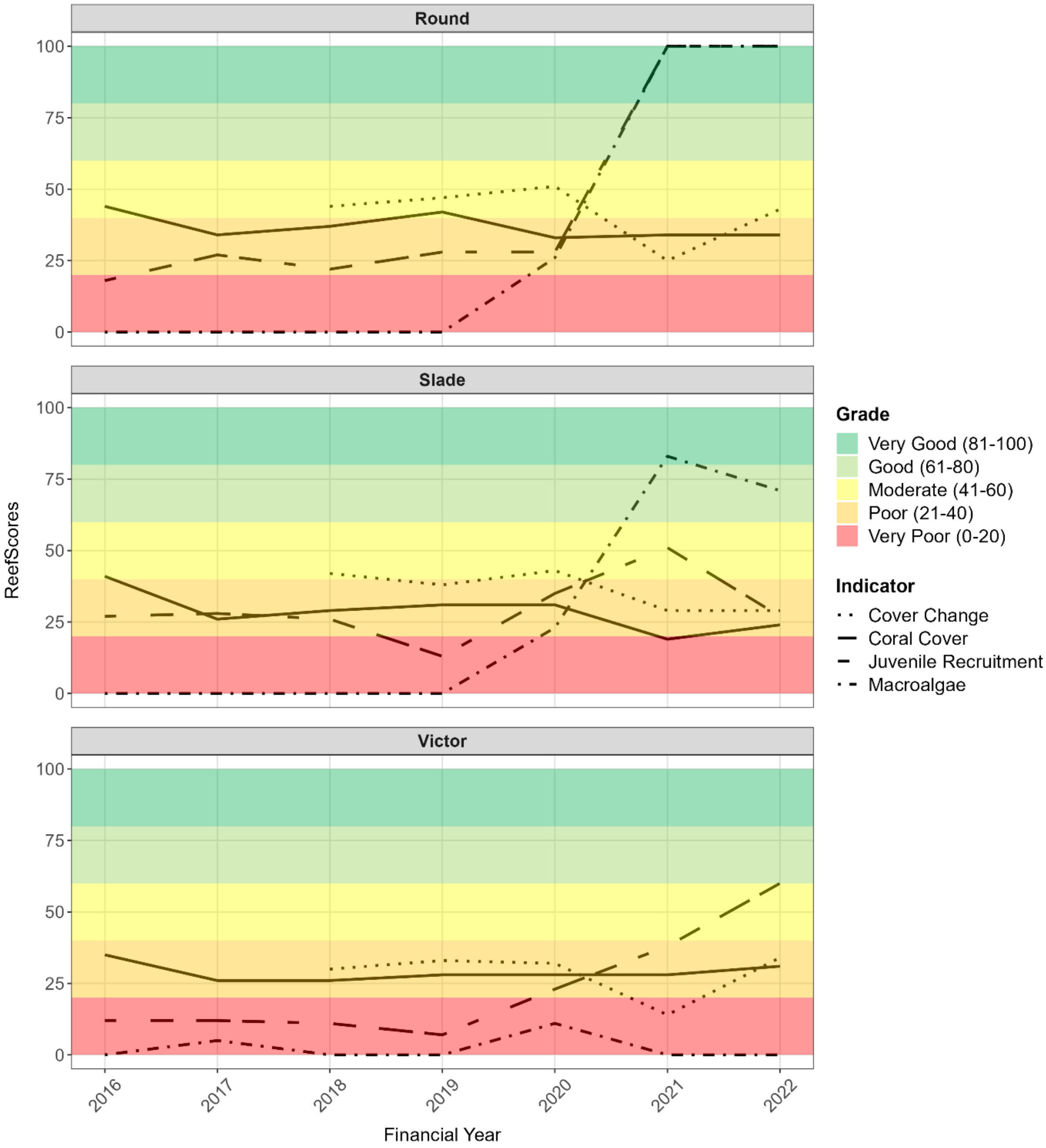

Figure 95. Central Zone reef-level coral indicator scores and grades for the 2022 Report Card compared to the historic record.

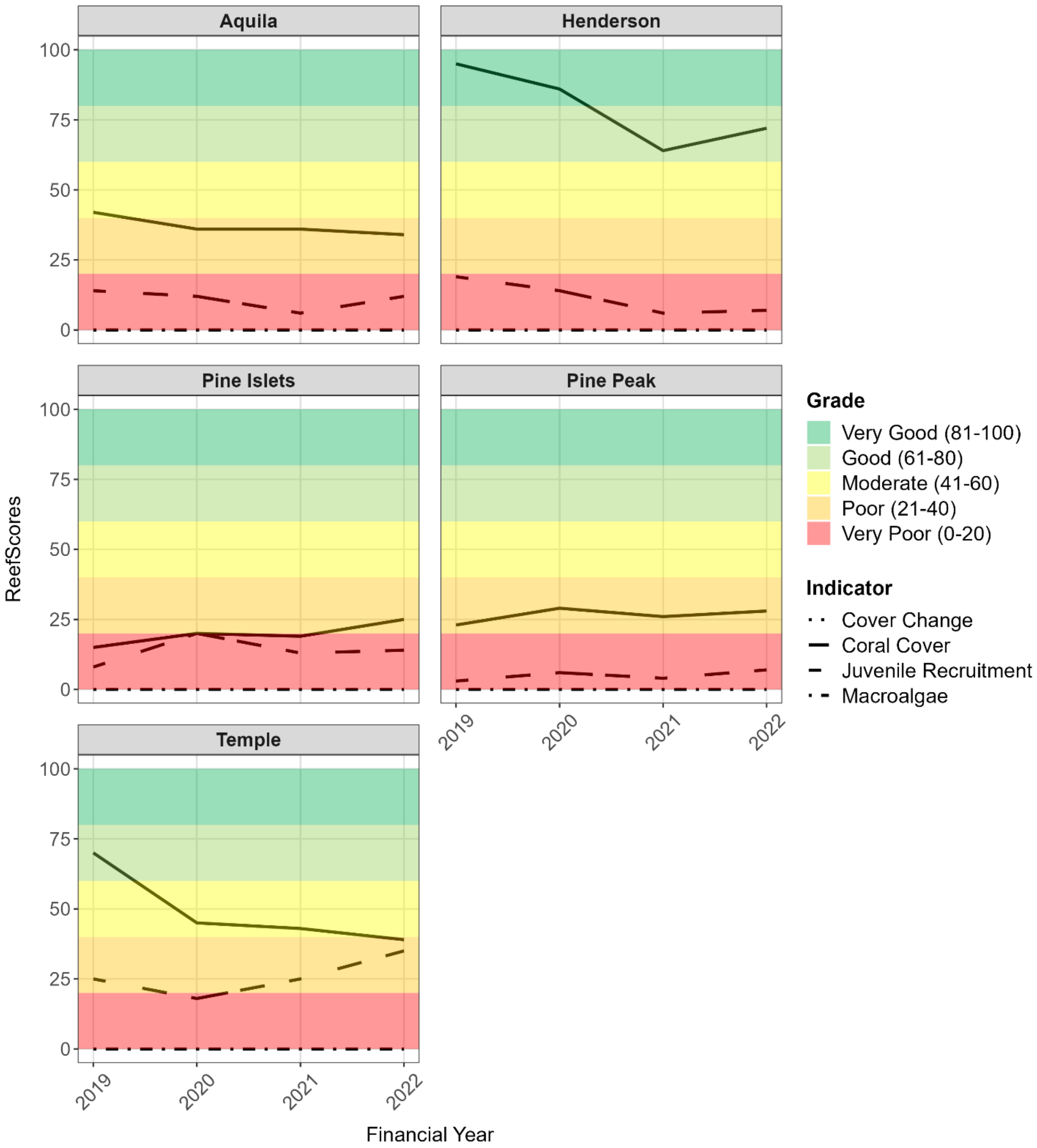

Figure 96. Southern Zone reef-level coral indicator scores and grades for the 2022 Report Card compared to the historic record.

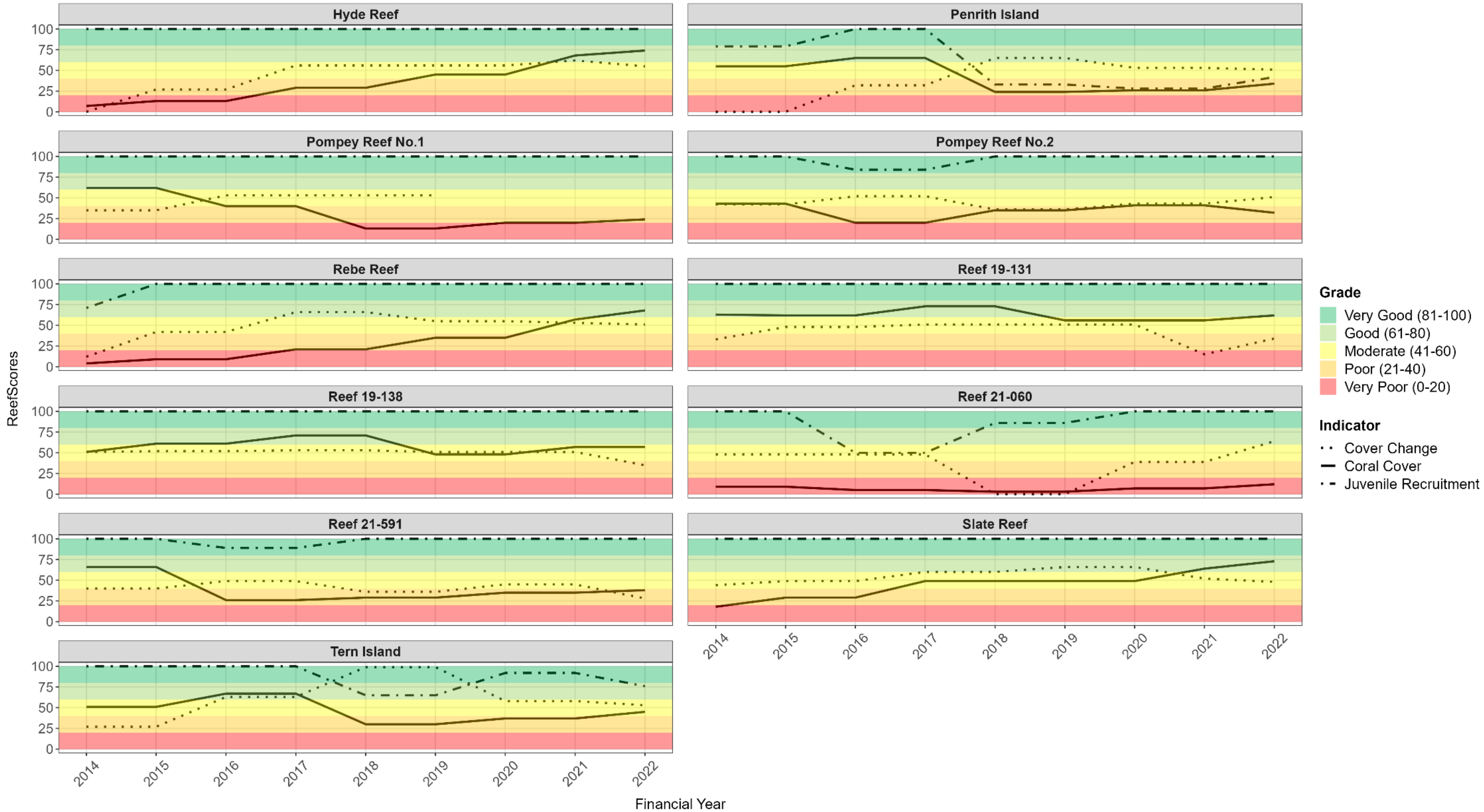

Figure 97. Offshore Zone reef-level coral indicator scores and grades for the 2022 Report Card compared to the historic record.

8.4.2.2 Reef level overall scores

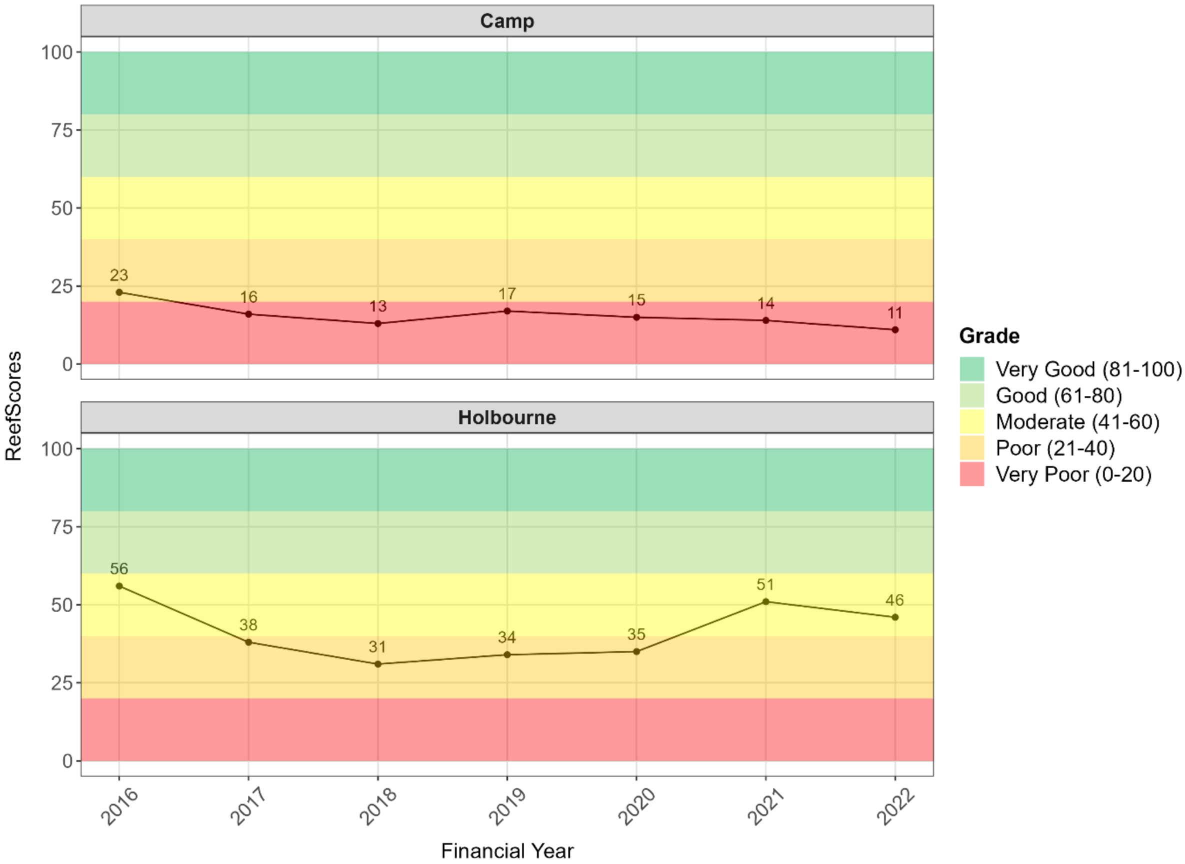

Figure 98. Northern Zone reef-level overall coral scores and grades for the 2022 Report Card compared to the historic record. Scores in the **Northern Zone** before 2021 are not directly comparable to previous years due to changes in sampling design and before 2020 due to changes in reef aggregation level.

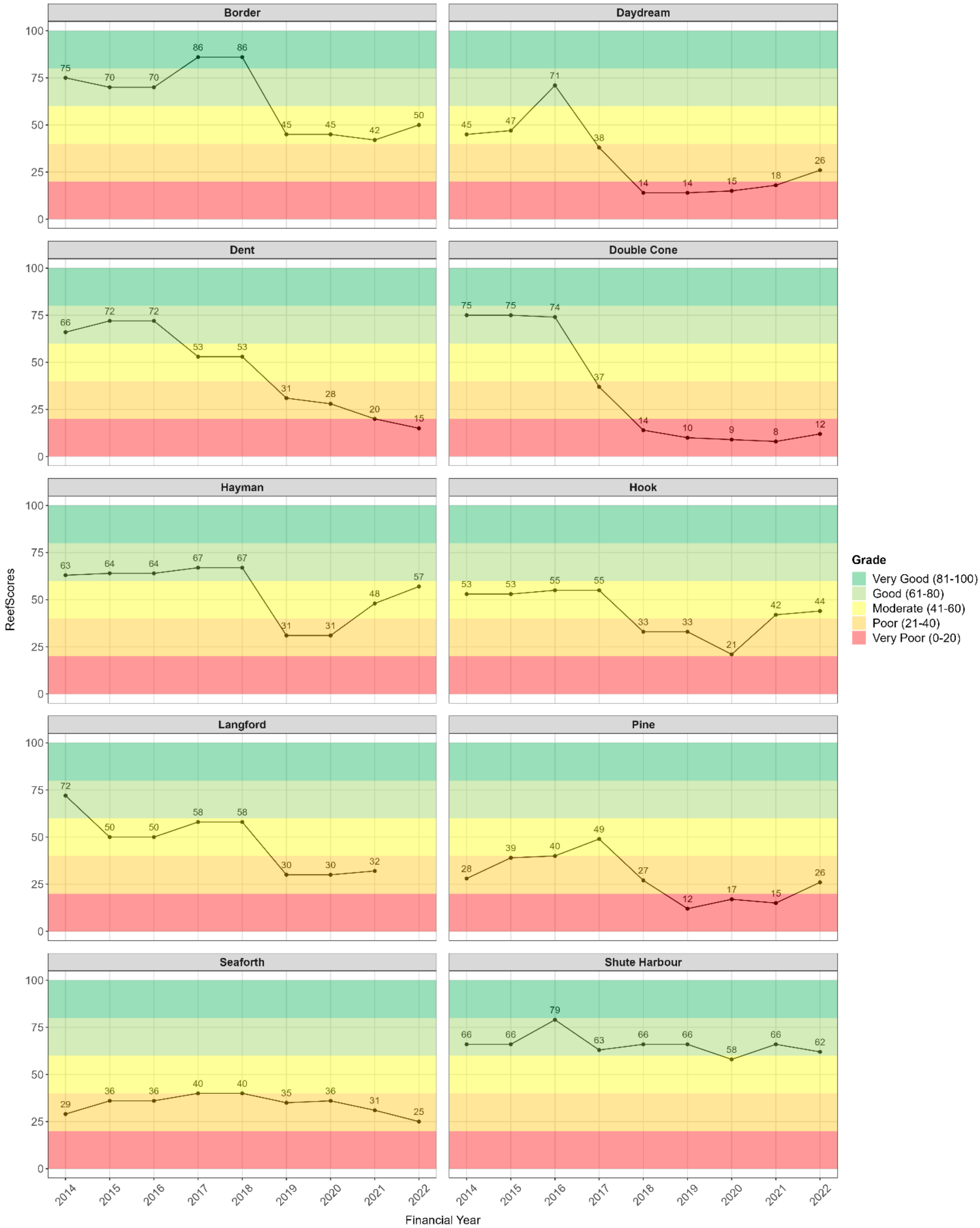

Figure 99. Whitsunday Zone reef-level overall coral scores and grades for the 2022 Report Card compared to the historic record.

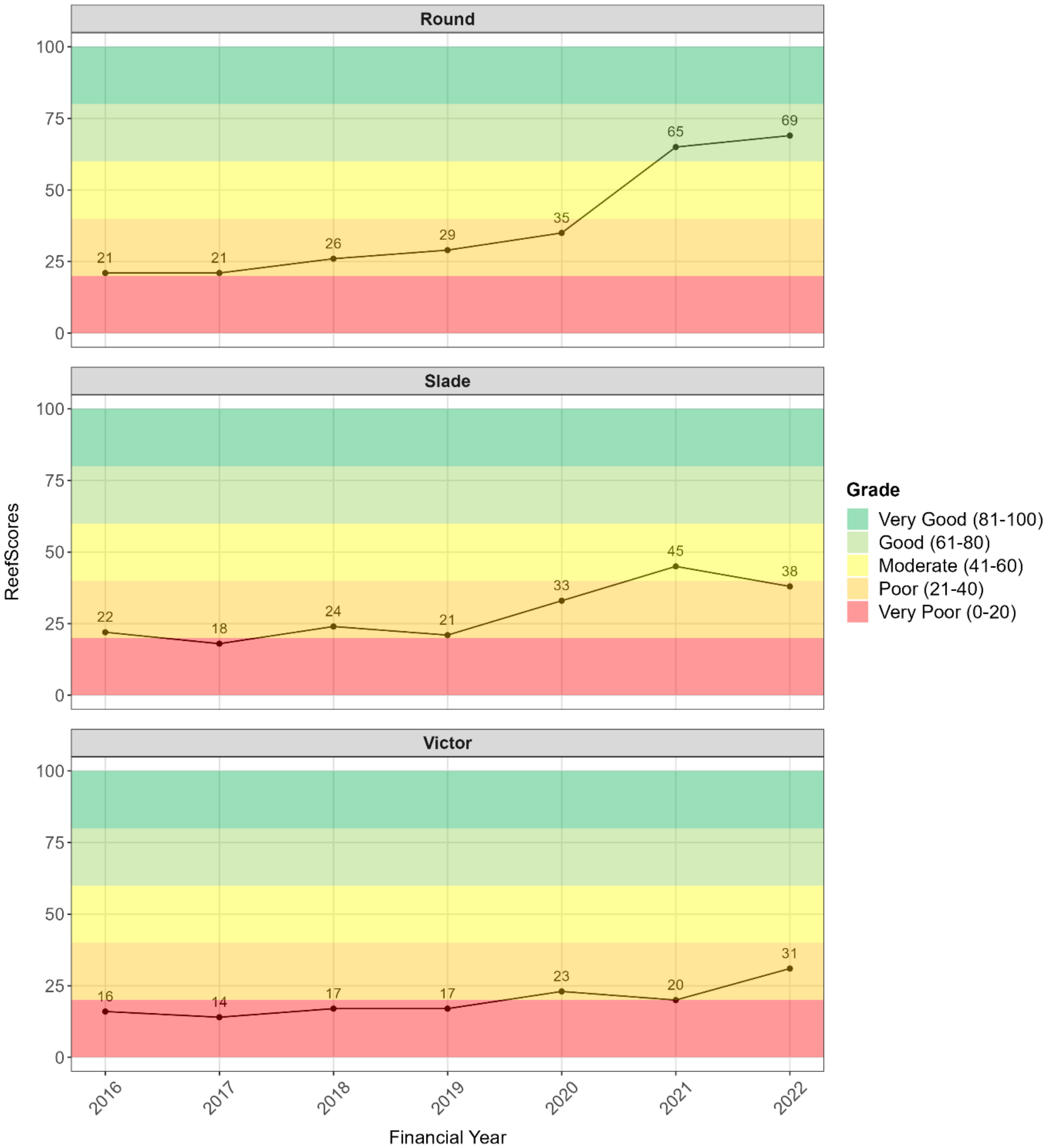

Figure 100. Central Zone reef-level overall coral scores and grades for the 2022 Report Card compared to the historic record.

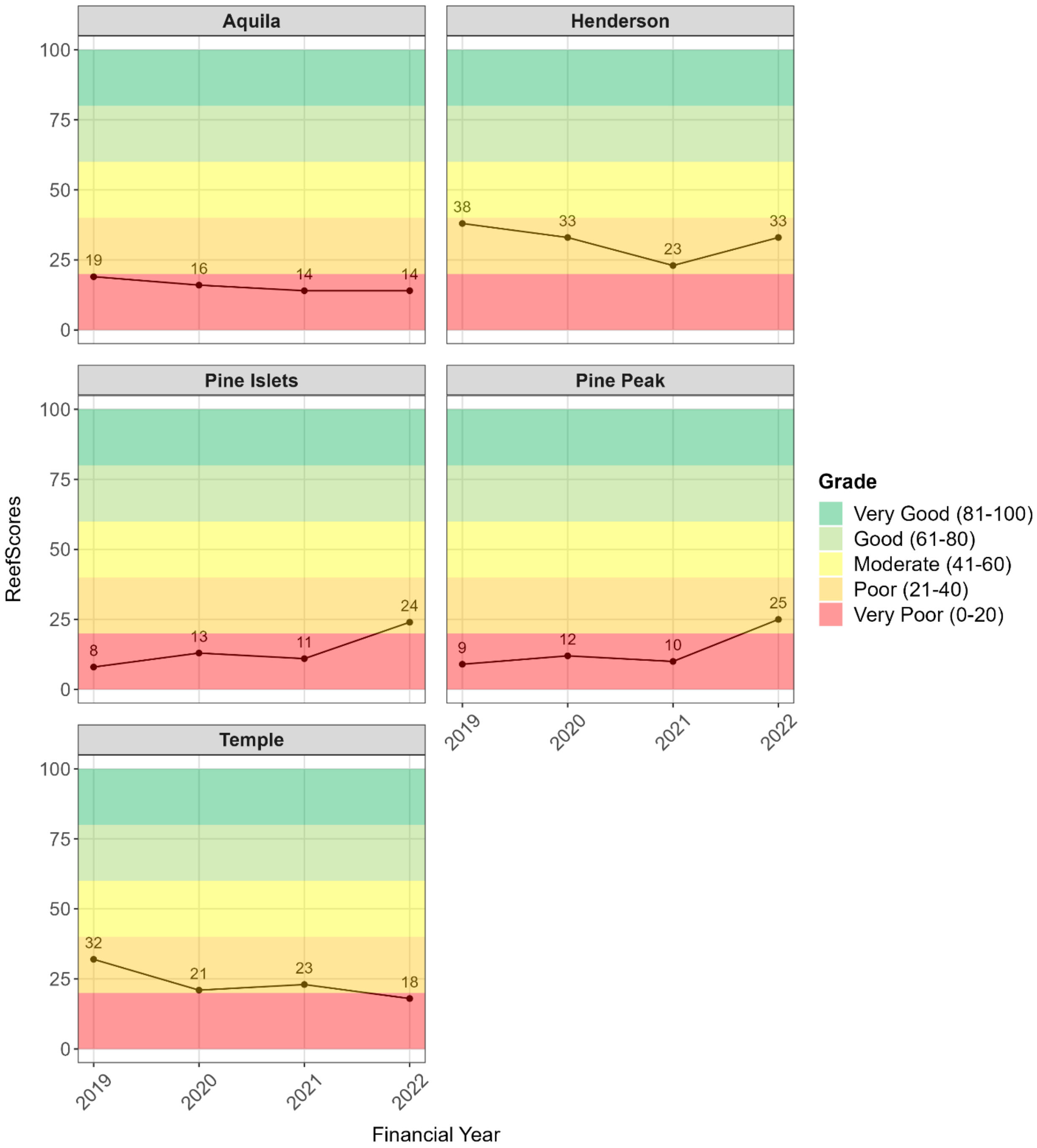

Figure 101. Southern Zone reef-level overall coral scores and grades for the 2022 Report Card compared to the historic record.

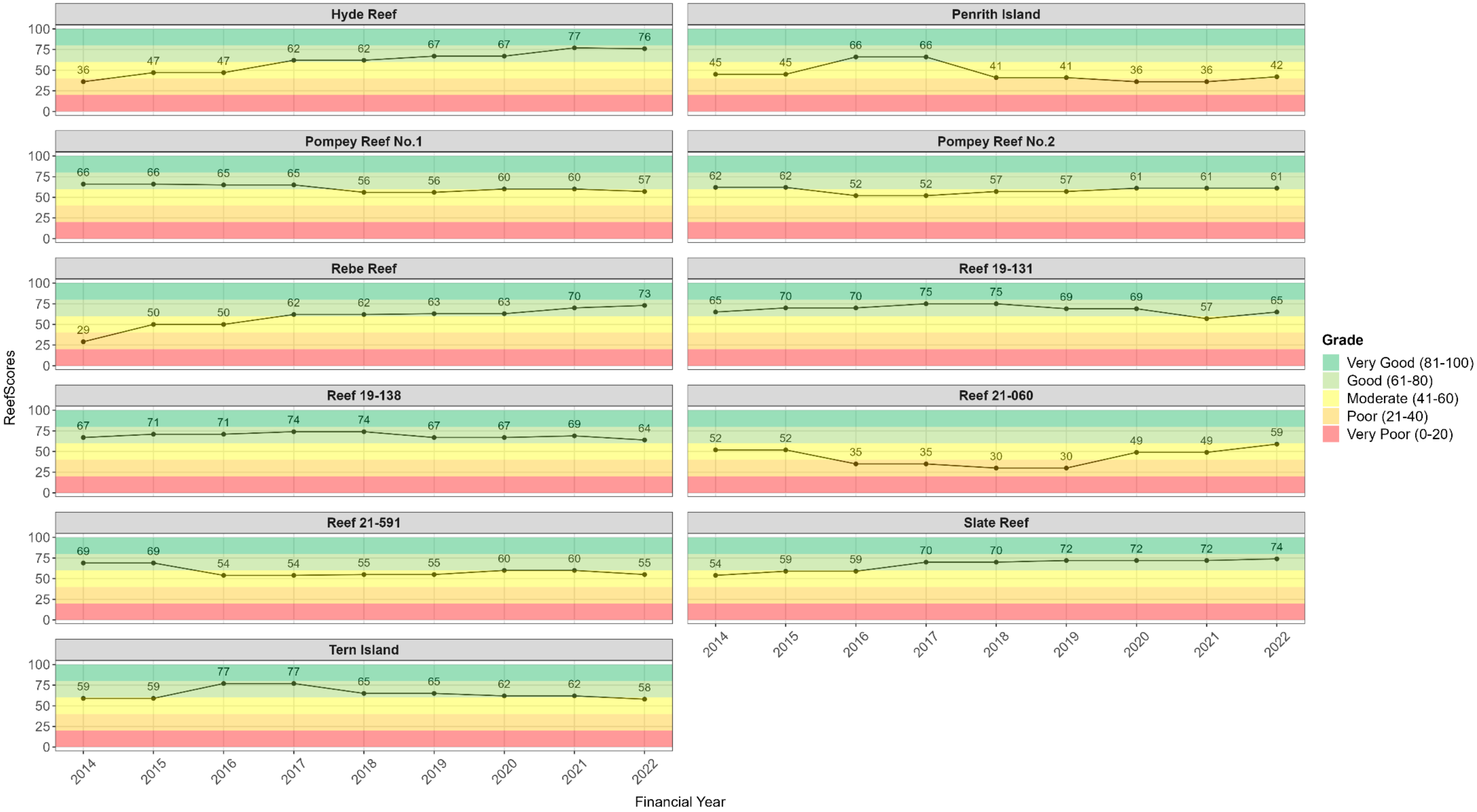

Figure 102. Offshore Zone reef-level overall coral scores and grades for the 2022 Report Card compared to the historic record.

8.4.3 Seagrass

Table 63. Inshore seagrass sampling design and indicator results for the 2021–22 reporting year. The 2021 Report Card scores are shown for comparison. Scores reported without a colour grade indicate calculations that have not been incorporated into overall scores. 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			Overall site/meadow score	Overall Zone Score	2021 Score
					Abundance	Resilience	Biomass	Area	Sp. Composition			
Inshore Marine Northern	Coastal	Inshore	Abbot Pt.	API3			93	66	88	66	78	70
				API5			86	100	92	86		
				API9			85	96	90	85		
		Subtidal		APD1-4			79	77	74	76		
		Intertidal	Bowen	BW2–3*	75					75		
Inshore Marine Whitsunday	Reef	Intertidal	Hydeaway Bay	HB1 and2*	88					88	38	29
			Hamilton Is. 1	HM1	0	30				15		
			Hamilton Is. 2	HM3	13	11				12		
			Lindeman Island	LN3	50	100				75		
		Subtidal	Tongue Bay	TO1 and 2^	0					0		
			Lindeman Island	LN1	13	70				41		
	Coastal	Intertidal	Pioneer Bay	PI2 and 3	38					38		
Inshore Marine Central	Coastal	Intertidal	Midge Point	MP2 and 3	100	80				90	64	58
			St Helens Beach	SH1*#	92					92		
		Subtidal	Newry Bay	NB1 and 2^	25					25		
	Estuarine	Intertidal	Sarina Inlet	SI1 and 2	13	29				21		
	Coastal	Intertidal/ Subtidal	Dudgeon Pt	DP1			85	86	94	85		
		Subtidal	St Bees Island	SB10			65	89	66	65		
			Keswick Island	KW14			67	93	93	67		
			Hay Point	HPD1			41	90	100	41		
			Mackay Offshore	MO5			91	96	100	91		
Inshore Marine Southern	Coastal	Intertidal	Clairview	CV1 and 2*	8					8	76	60
				CVH2			68	93	100	68		
				CVH6			79	83	81	79		
				CVH7			87	92	76	82		

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 also provided by SeagrassWatch; # = Not used in GBR-wide for MMP; ^ = QPWS drop-camera; na = not recorded