HEALTHY RIVERS TO REEF PARTNERSHIP
MACKAY-WHITSUNDAY-ISAAC

Mackay-Whitsunday-Isaac 2020 Report Card Results

Technical Report
Mackay-Whitsunday-Isaac Healthy Rivers to Reef Partnership
July 2021

Authorship Statement

The Mackay-Whitsunday-Isaac (MWI) Healthy Rivers to Reef Partnership (the Partnership) 'Mackay-Whitsunday-Isaac 2020 Report Card Results' technical report was compiled by the Partnership's Technical Officers, Talen Rimmer and Dr. Eleanor Pratt.

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, and Gia and Juru Peoples, and pays respect to the ancestors, the Elders both past and present, and to the people.

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Contents

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 which 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
DIN	Dissolved inorganic nitrogen
DO	Dissolved oxygen
Driver	An overarching cause of change in the environment.
Ecosystem	A dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit.
Ecosystem health	A concept that integrates environmental state and conditions with the impacts of anthropogenic activities to provide information for the sustainable use and management of natural resources.
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)	Fish community health is evaluated, and included in the ecosystem health assessment (coasters). Inclusion in the Report Card will contribute to an understanding of the health of local fish communities.
Fish Barriers (as an indicator)	Fish barriers relate to any man-made barriers which prevent or delay connectivity between key habitats which has the potential to impact migratory fish populations, decrease the diversity of freshwater fish communities and reduce the condition of aquatic ecosystems (Moore, 2016).
Flow (as an indicator)	Flow relates to the degree that the natural river flows have been modified in the region's waterways. This is an important indicator due to its relevance to ecosystem and waterway health.
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
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 are comprised of multiple measures (e.g. flow, estuary fish barriers).
Median	The middle value out of a defined list of values.
MMP	Marine Monitoring Program – Great Barrier Reef monitoring program, led by GBRMPA. This provides water quality, coral and seagrass data for the Central and Whitsunday reporting 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	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 (Neldner et al., 2019).
Pre-development Flow	The pattern of waterflows, during the simulation period, using the IQQM computer program as if there were no dams or other water infrastructure in the plan area, and no water was taken under authorisations in the plan area[1].
PRM	Pesticide Risk Metric
PSII herbicides	Photosystem II inhibiting herbicides (ametryn, atrazine, diuron, hexazinone, tebuthiuron, bromacil, fluometuron, metribuzin, prometryn, propazine, simazine, terbuthylazine, terbutryn)
PSII-HEq	Photosystem II herbicide equivalent concentrations, derived using relative potency factors for each individual PSII herbicide with respect to a reference PSII herbicide, Diuron.
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).

[1] 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

QPSMP	Queensland Ports Seagrass Monitoring Program
RAP	Representative Areas Program – Australian Institute of Marine Science (AIMS) coral monitoring program
RCA	Reef Check Australia
RE	Regional ecosystem
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
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 purposes of waterway assessment, the term water quality guideline refers to values for condition assessment of water quality drawn from a range sources including water quality objectives scheduled under the Environmental Protection (Water) 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 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 2020 Report Card, reporting on the 2019-20 financial year, is the Partnership's seventh 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, with the MWI Report Card being one of five regional report cards released annually in the Great Barrier Reef (GBR) World Heritage Area.

The 2020 Report Card contains data from a variety of condition assessments of our local waterways, which include freshwater, estuarine and inshore and offshore marine environments. For each of these waterway types, a series of environmental *indicators* are reported, which are aggregated into *indicator categories* and then into *indices*.

The purpose of this document is to provide the detailed results of the 2020 MWI Report Card and discuss these findings in relation to guideline values and previous years, as well as regional climate, weather and human activities. Specifically, this results report describes:

- Scaled scores and grades from the 2019-20 year for:
    - Indicators
    - Indicator categories and indices
    - Overall reporting zones
- Confidence levels associated with the results; and
- Scores for indicators, indicator categories and indices from previous report cards, where possible, to enable comparison of the results across the years.

i. Regional Climate

Annual rainfall was much lower than the long-term mean across much of the region (BoM (Bureau of Meteorology), 2021). The months leading up to the 2019-20 wet season were particularly dry, with November 2019 having 'very much below average' or 'lowest on record since 1911' rainfall for all basins. Consequently, annual discharges at flow gauging stations across the entire MWI Region were much lower than the long-term means. The reduced rainfall and associated reductions in runoff and flow in the region means that the regional climate is likely to have been a key driver of many scores in the 2020 Report Card.

Due to unusually warm conditions from January to March 2020, a widespread coral bleaching event occurred across parts of the GBR. This event extended much further south than the 2016 and 2017 mass bleaching events. In the MWI Region, the bleaching appeared to be mostly non-lethal. With lingering impacts of Tropical Cyclone (TC) Debbie on coral communities across the region, bleaching events such as this, are likely to further hinder coral reef recovery.

Under current climate change projections, marine heatwaves as recorded in 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. Cyclones 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.

ii. Freshwater Basins

For freshwater basin condition assessments, water quality and flow scores were updated for this reporting period. Scores for the fish index and the majority of the habitat and hydrology index were based on repeated data (following three or four-year reporting cycles).

Freshwater basins key findings:

- Overall grades for freshwater basins ranged from 'moderate' to 'good', with no grade changes from last year (Table I).
- Overall MWI basin water quality index grades were all 'moderate' in the 2020 Report Card (Table I).
- Sediment remains an issue in the MWI Region, with 'moderate' to 'very poor' grades observed across the Don, O'Connell and Plane basins for four or more consecutive years.
- Three of the four basins assessed for nutrients were graded as 'moderate', compared to the previous year. This is a grade decline in the Don Basin (from 'good' to 'moderate') and an improvement in the Plane Basin (from 'poor' to moderate').
- Pesticide risk remained the poorest scoring indicator for basin water quality in the MWI region, with the Proserpine, Pioneer and Plane basins graded as 'very poor'. In contrast, the Don Basin was 'very good', improving from three years at a 'good' grade. Imidacloprid and diuron were the key contributors to pesticide risk across most of the MWI region.
- Only data for the flow indicator category were updated in the habitat and hydrology index in this year's Report Card. In the Plane Basin, there was a grade improvement from 'poor' to 'moderate', while in the Pioneer Basin, there was a decline from 'good' to 'moderate'.

Table I. Condition grades and scores of freshwater basins for the 2020 Report Card compared to 2014 – 2019 Report Cards.

Freshwater Basin	2020 Report Card					2019	2018	*2017	^2016	^2015	^2014
	Water Quality	Habitat and Hydrology	Fish	Basin Score and Grade		Basin Score					
Don	49	75		**62**	**B**	71	56	47	48	48	54
Proserpine		50	79	**65**	**B**	65	66	53	53	53	52
O'Connell	55	43	92	**63**	**B**	63	66	54**	58	57	52
Pioneer	44	34	82	**53**	**C**	56	54	40	41	41	34
Plane	42	39	79	**53**	**C**	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

*denotes scores that 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.

iii. Estuaries

Similar to the freshwater basins, water quality scores were updated for this reporting period, while estuarine condition assessments were based on repeated data for the habitat and hydrology index (following three or four-year reporting cycles).

Estuaries key findings:

- Overall estuary grades ranged from 'moderate' to 'very good', with a notable score improvement in the Vines Creek estuary (Table II). The Carmila Creek estuary received a 'very good' grade for the first time since we have been reporting on the waterway. However, this was due to only a minor score increase.
- Overall MWI estuarine water quality index grades (combining nutrients, chlorophyll-*a* (chl-*a*), phys-chem, and pesticide risk scores) saw improvements in the St Helens/Murray, Vines, and Rocky Dam Creek estuaries from 'moderate' to 'good' grades.
- All estuaries were graded as 'good' for the nutrients category this year, representing grade improvements in the St. Helens/Murray, Vines and Sandy Creek estuaries.
- Chl-*a* scores improved markedly in the Gregory River and Carmila Creek estuaries relative to 2019, receiving 'very good' and 'good' grades, respectively.
- For the physical-chemical (phys-chem) category, notable score improvements were seen in the St Helens/Murray and Vines Creek estuaries, while the Sandy Creek estuary declined in grade from 'very good' to 'good'.
- Pesticides continue to be a concern for MWI estuaries, with four of the eight estuaries assessed meeting the desired low-risk category for pesticides. Imidacloprid, atrazine, and diuron were the key contributors to pesticide risk across much of the MWI Region.

Table II. Overall condition scores and grades of estuaries for the 2020 Report Card in comparison to 2015 – 2019 Report Cards.

Estuary	2020 Report Card					2019	2018**	2017*	2016*	2015*^
	Water Quality	Habitat and Hydrology	Fish	Estuary Score and Grade		Estuary Score				
Gregory River	79	83		**81**	**A**	80	82	79	80	79
O'Connell River	55	58		**56**	**C**	56	51	61	54	57
St Helens/Murray Creek	65	64		**67**	**B**	64	57	61	61	63
Vines Creek	72	68		**68**	**B**	57	68	64	72	73
Sandy Creek	58	50		**51**	**C**	51	58	52	50	52
Plane Creek	73	57		**64**	**B**	63	68	67	59	61
Rocky Dam Creek	62	74		**67**	**B**	66	76	70	73	70
Carmila Creek	73	96		**82**	**A**	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.

iv. Inshore and Offshore Marine

All indicators of inshore and offshore marine condition are updated annually. In the 2020 Report Card, litter has been reported for the first time. Litter is reported on at the site-level and is not rolled-up into overall zone scores.

Inshore and offshore marine key findings:

- The largest improvement in overall zone condition was in the Whitsunday Zone, although the grade remained at 'poor' for the fourth consecutive year.
- The Whitsunday Zone showed marked improvements in nutrients, chl-*a* and water clarity indicator categories, leading to a grade change for overall water quality from 'very poor' to 'moderate'.
- In the Central Zone, there was a small score improvement that translated into a grade change from 'poor' to 'moderate'.
- Nutrients in the Southern Zone improved from 'moderate' to a 'good' grade, as did chl-*a* in the Northern Zone. Chl-*a* in the Central Zone however, declined in grade from 'poor' to 'very poor'.
- The pesticide risk grade in the Central Zone improved from three consecutive years of 'moderate' condition to a grade of 'good' for the first time.
- Offshore water quality and coral remained stable for the seventh consecutive year, receiving 'very good' and 'moderate' grades, respectively.
- Coral condition was graded as 'poor' for all inshore zones (Table III).
- For the four years since TC Debbie, coral cover and juvenile coral density in the Whitsunday and Northern Zones have remained 'poor' and 'very poor' respectively, demonstrating limited recovery of these coral communities.
- Reef Check Australia (RCA) citizen science coral cover data have been incorporated into coral index scores for the first time.
- Seagrass index scores improved in all three inshore zones reported on this year, highlighting recovery across the region after impacts from TC Debbie in 2017. In particular, the Northern Zone has improved in grade for the past three years, receiving a 'good' grade this year.
- Litter was reported on for the first time, with most sites posing a 'low' or 'slight pressure' on the environment. Pioneer Bay in Airlie Beach was the poorest scoring site for this index across the MWI Region, likely due to the high levels of tourism and recreational use in the area.

Table III. Overall inshore and offshore marine scores and grades for the 2019-20 reporting year, compared to 2016 - 2019 Report Cards.

	2020 Report Card						2019	2018	2017*	2016
	Water Quality	Coral	Seagrass	Fish	Total Score and Grade		Total Score			
Northern	54	28	61		**47**	**C**	43	35	44	43
Whitsunday	42	28	35		**34**	**D**	25	27	27	47
Central	39	28	60		**42**	**C**	36	37	31	41
Southern	43	21			**32**	**D**	34	22		
Offshore	99	55			**77**	**B**	77	77	76	77**

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 overall marine score results were back-calculated to incorporate pesticide and seagrass method changes that were applied in the 2018 Report Card.

**Offshore coral scores amended due to error in methods.

Prior to the 2020 Report Card, Reef Check Australia (RCA) coral cover data were not included in the calculation of the total marine zone scores.

1. Introduction

1.1. Purpose of this Document

The purpose of this document is to provide detailed results to support the 2020 Mackay-Whitsunday-Isaac (MWI) Report Card on waterway health. The results provided in this document relate to the condition of environmental indicators.

This document presents:

- Scores and grades based on data collected between July 1st 2019 and June 30th 2020 (refer to the Mackay-Whitsunday-Isaac 2020 Report Card Methods[2] (hereafter referred to as the Methods Report) for indicators that are updated on three and four-year cycles).
- The 2020 condition assessments (scores) for environmental indicators in their original scale, and standardised scores that (where relevant) were used for aggregation.
- The confidence associated with 2020 results.

2020 Report Card results compared to 2019 - 2014 results, where the same methods were used across the years. Where this is not the case, previous results calculated using alternate methods are presented for reference. Additional information associated with 2020 Report Card results contained in appendices.

1.2. Background

The MWI Healthy Rivers to Reef Partnership (the Partnership) was established in October 2014, with the primary focus of producing an annual report card on the health of the region's waterways (Figure 1). The 2020 Report Card includes condition assessments of the freshwater, estuarine and marine ecosystems in the reporting region.

For each index, a series of indicators, broken into different indicator categories, is used to provide a holistic assessment of these environmental, social, cultural and economic factors. In contrast to last year, this report does not include human dimension reporting for agricultural stewardship due to the current Queensland Government review of marine protected area targets.

The 2017 – 2022 Program Design[3] outlines the guiding framework for the development and scope of the 2020 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 on the methods used to produce the MWI 2020 Report Card refer to the Methods Report[2] and the Mackay-Whitsunday Report Card Program Design 2017 to 2022[3].

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

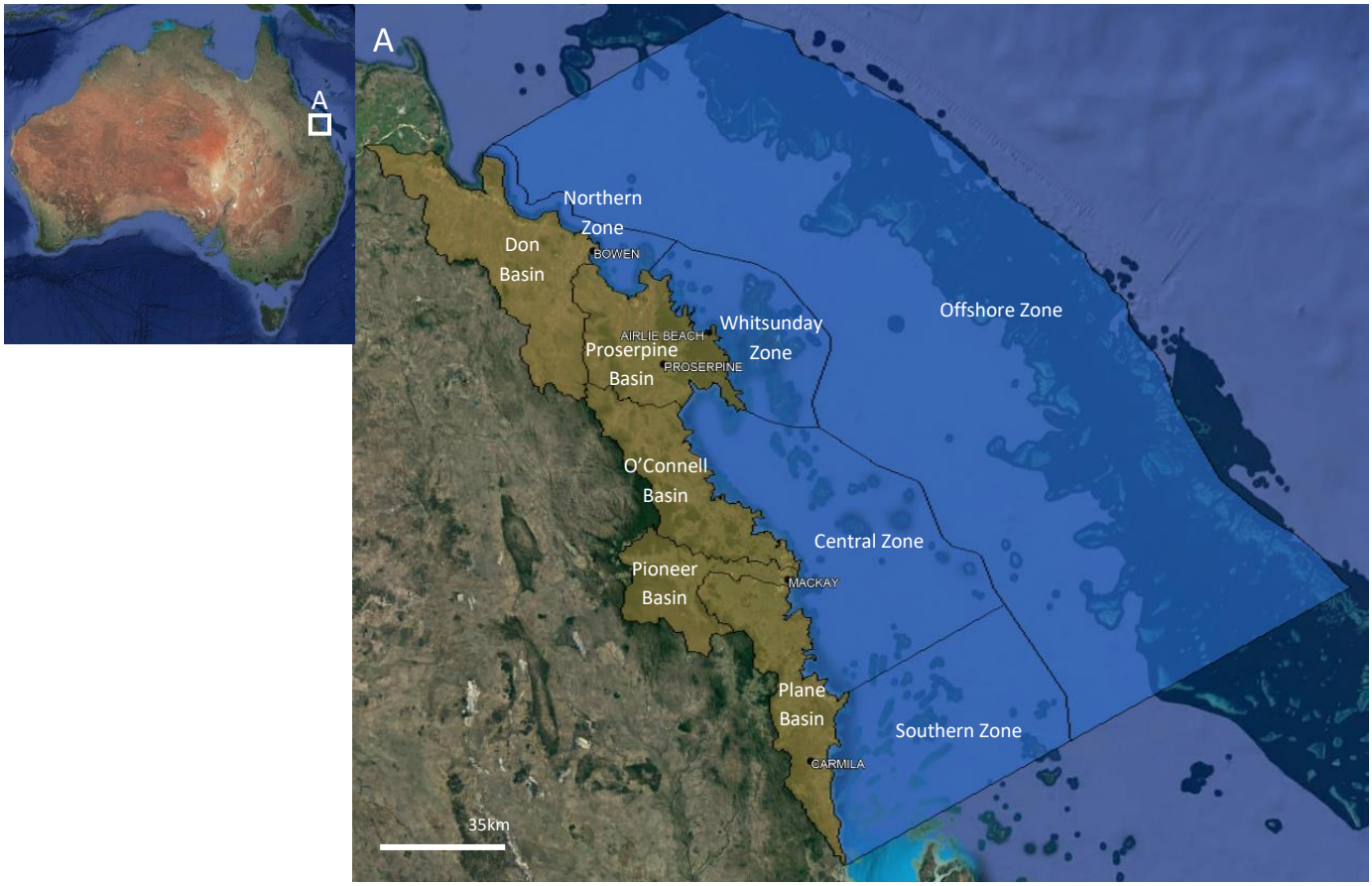

Figure 1. Mackay-Whitsunday-Isaac reporting region. Freshwater basins are represented in brown, while marine zones are shown in blue.

1.3. Terminology

The Report Card assesses different 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 fish.

The terminology used in this document for defining the level of aggregation of indicators is as follows:

- The overall score (and grade) is generated by the aggregation of indices or by a single index score.
- Index/indices (e.g. water quality) are generated by the aggregation of indicator categories.
- Indicator categories (e.g. nutrients) are generated by one or more indicators; and
- An indicator is a measured value (e.g. particulate nitrogen concentration).

In the Report Card, overall scores and grades for indices are represented in the format of a coaster (Figure 2). Presentation of the coasters can be with or without the outer ring (i.e. indicators).

Figure 2. 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 2019-20

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[4] (Figure 3). 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 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 3). Additional pressures that can impact the region's marine ecosystems include ports and marinas, shipping, fishing, tourism and recreational activities (Figure 3).

In the 2019-20 reporting period, the key drivers likely to directly affect scores of some of the environmental indicators are related to weather events, including below average rainfall across the region, and the residual impacts of Tropical Cyclone (TC) Debbie that hit the region in March 2017 and a monsoon trough that impacted the northern extent of the region during the 2018-19 wet season. Additionally, anthropogenic pressures such as excessive sediment, nutrient and pesticide loads within land-based run-off are likely to impact some environmental indicators.

Figure 3. Conceptual diagram of the key drivers, pressures, and ecosystems in the Mackay-Whitsunday-Isaac Region.

[4] 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. Regionally, the climate is characterised by two distinct seasons: a wet (November to April) and a dry (May to October) season. During the wet season, the MWI area may experience elevated rainfall, tropical lows and cyclones. Upon making landfall, cyclones 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

The Intergovernmental Panel on Climate Change (IPCC) 2014 Synthesis Report stated that "human influence of the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history". Recent climate changes have had widespread impacts on human and natural systems" (IPCC, 2014). Anthropogenic greenhouse gas emissions have increased since the pre-industrial era (before 1750), primarily driven by economic and population growth. Carbon dioxide (CO_2), methane and nitrous oxide are now in the highest atmospheric concentrations seen in at least the last 800,000 years. It is reported that half of the anthropogenic CO_2 emitted between 1750 and 2011 was emitted in the last 40 years (IPCC, 2014).

Since records began in 1910, Australia's climate has warmed by 1.44°C (±0.24°C)[5]. The majority of this warming has occurred since 1950, with every decade since being warmer than the one before. 'Very high' monthly maximum temperatures now occur six times as often as they did in 1960[5]. This is reflected locally, with the Mackay weather station recording annual maximum temperature (°C) anomalies that have been above zero (unusually warm) almost every year since the 1980s, a stark change to the 70 years prior (Figure 4).

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[5].

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[6]. Marine heatwaves have consequently increased in frequency and duration (defined by temperatures in the upper range of

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

historical baseline conditions for five+ days). 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 reduction in coral resilience[6].

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[6].

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[7]. Cyclones 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[7], putting increased pressure on coral populations that are already under significant stress.

Climate change impacts on the weather patterns and events in the MWI region in 2019-20 are discussed further in the sections below.

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

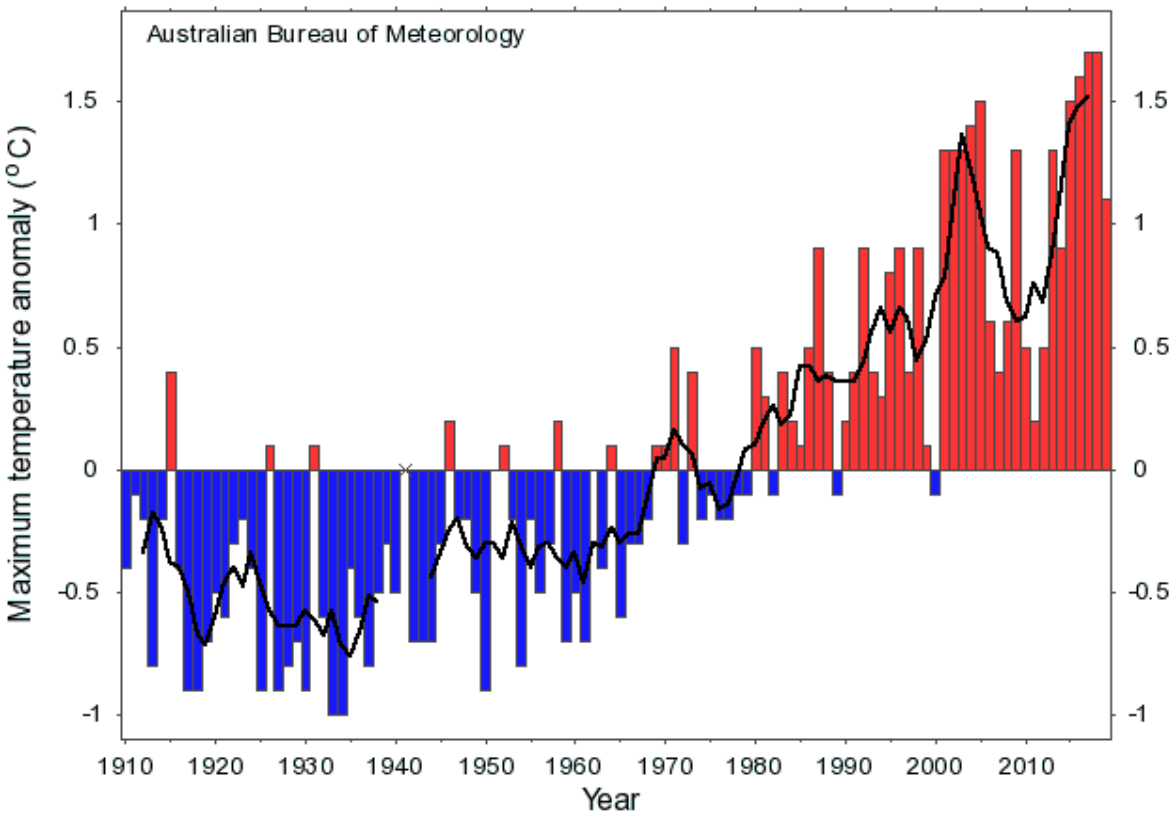

Figure 4. Annual maximum temperature (°C) anomaly at Mackay (site 033119) from 1910 to 2019. A rolling five-year average is shown by the black line. Source: Bureau of Meteorology, Australia climate change site data (http://www.bom.gov.au/climate/change/hqsites/).

1.4.4. Rainfall

Australian rainfall for the 2019-20 period was 24% below average, making it the sixth driest year on record. Combined with the 2018-19 year, this 24-month period was the second driest on record (since 1910)[8]. In the MWI Region specifically, annual rainfall for the 2019-20 reporting year varied between 40 and 90% of the long-term mean (1912-2020), with very small patches at 100 - 125% (Figure 5; Table 2). The Don Basin has consistently been the driest of the MWI basins since 1911, with a long-term mean of 945 mm compared to between 1,454 and 1,585 mm for the other basins (Table 2). In the last ten years, the Don Basin has recorded seven years with rainfall below this mean, including the 2019-20 reporting year (Appendix A), at just 64% of the long-term mean (Table 2). Both the Plane and Pioneer basins have had annual rainfall totals below the long-term mean for the last three years, and six of the last seven years (Appendix A). Indeed, all basins had lower annual rainfall in 2019-20 than both the long-term mean and the 2018-19 reporting year (Figure 6).

Annual rainfall patterns obscure the variation in rainfall observed throughout the year, with some months recording above average rainfall and others being much below average (Figure 7). July 2019 reported 'above average' rainfall across all MWI basins. This was also seen in May 2020 (except in the

[8] http://www.bom.gov.au/climate/updates/articles/a037.shtml

Pioneer Basin which had 'average' rainfall in May) (Figure 7), a pattern that was replicated across North Queensland due to a surface trough and moist onshore flow bringing heavy showers[9].

Similar to 2018-19, the months leading up to the 2019-20 wet season were particularly dry. Indeed, August and September had rainfall 'below' or 'very much below average' across most basins (Figure 7). Subsequently, November 2019 had 'very much below average' rainfall for all basins, except the Don River, which had rainfall that was the 'lowest on record since 1911' (Figure 7). Basins across both the Wet and Dry Tropics also had unusually low rainfall in November 2019, leading to a consistent pattern of 'average' or 'below average' annual rainfall across North Queensland (see Figure 7 for MWI).

Due to the low rainfall across the MWI region for 2019-20, discharges measured at gauging stations in all basins were much lower than the long-term mean annual discharge (Figure 8), impacting ecosystem condition scores across freshwater, estuarine and marine MWI zones. Additionally, rainfall in the previous year (2018-19) was more concentrated during the wet season than in 2019-20. This resulted in markedly lower river discharges for this reporting period compared to last, and likely contributed to score changes in the 2020 Report Card. Due to the impacts of climate change, declines in annual streamflow are being seen across the country, with many of Australia's largest basins (e.g. the Murray-Darling Basin) showing declining trends since 1975[5].

1.4.4.1. Implications for Local Industry

The pattern of particularly dry weather from around August 2019 through to February 2020 (Figure 7) meant that weed growth was suppressed and conditions were unsuitable for spraying across unirrigated farms (P. Trendell, pers. comm. 01/04/21). This was reflected in pesticide scores across the MWI basins and estuaries, with most zones improving or remaining similar to last year (Sections 2.1.3 (basins) and 3.1.4 (estuaries)). A large proportion of spraying was done in the period between large rainfall events in late December 2019 and January 2020. On-farm water quality monitoring in the southern part of the region consequently reported high pesticide concentrations (above ecosystem guidelines) in January 2020, but lower levels by February and March 2020 (P. Trendell, pers. comm. 01/04/21).

High rainfall in May 2020 across much of North Queensland (see Figure 7 for MWI) had major consequences for sugarcane, causing paddock erosion and washouts, reducing the vigour of what had already been planted and delaying planting until after the winter. These impacts resulted in reduced yield and spraying that was closer to the 2020-21 wet season. The 2020 crush was also delayed due to this wet weather, potentially impacting 2020-21 yields (P. Trendell, pers comms 01/04/21).

[9] http://www.bom.gov.au/climate/current/annual/qld/summary.shtml

Despite the weather-related challenges of 2019-20, there was increased productivity in the cane industry in Mackay and Place Creek milling areas, compared to 2018-19. However, yields were still considered relatively low compared to historical productivity, as these areas are still recovering from TC Debbie in 2017 and the very dry spring and early summer in 2018 (P. Trendell, pers. comm. 01/04/21).

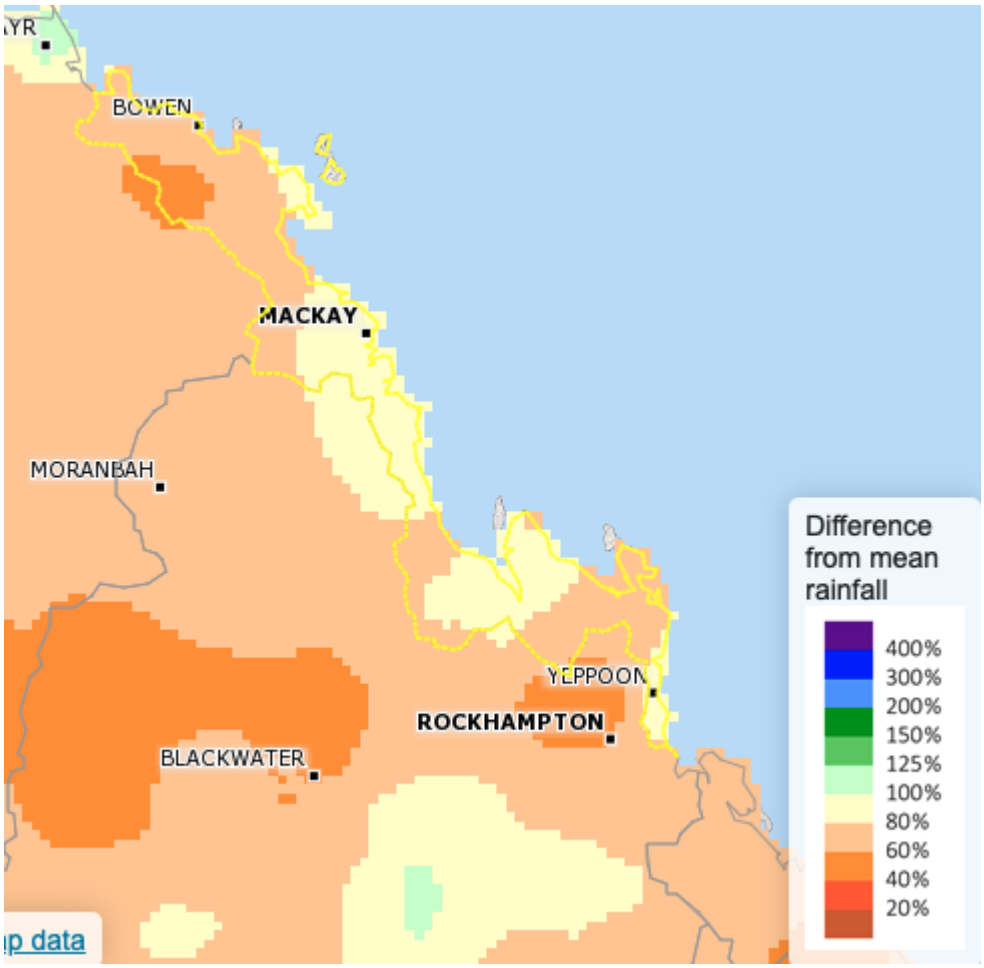

Figure 5. Difference of annual rainfall (2019-20) from long-term mean annual rainfall for the Mackay-Whitsunday-Isaac Region. The long-term mean is represented as a 'difference from mean rainfall' of 100% and was based upon historical rainfall records from 1912 to 2020. Data source: Bureau of Meteorology Regional Water Information Portal (http://www.bom.gov.au/water/rwi/#ra_pa/048/2019).

Table 2. Annual rainfall statistics for basins in the MWI Region for 2019-20.

Basin	Total (mm)	Long-term mean (mm)	Decile	Anomaly (mm) (+/- long-term mean	Percentage (%) of long-term mean
Don	606	945	2-3	339 -	64
Proserpine	1074	1454	2-3	380 -	74
O'Connell	1222	1585	4-7	363 -	77
Pioneer	1184	1498	4-7	314 -	79
Plane	1395	1543	4-7	148 -	90

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

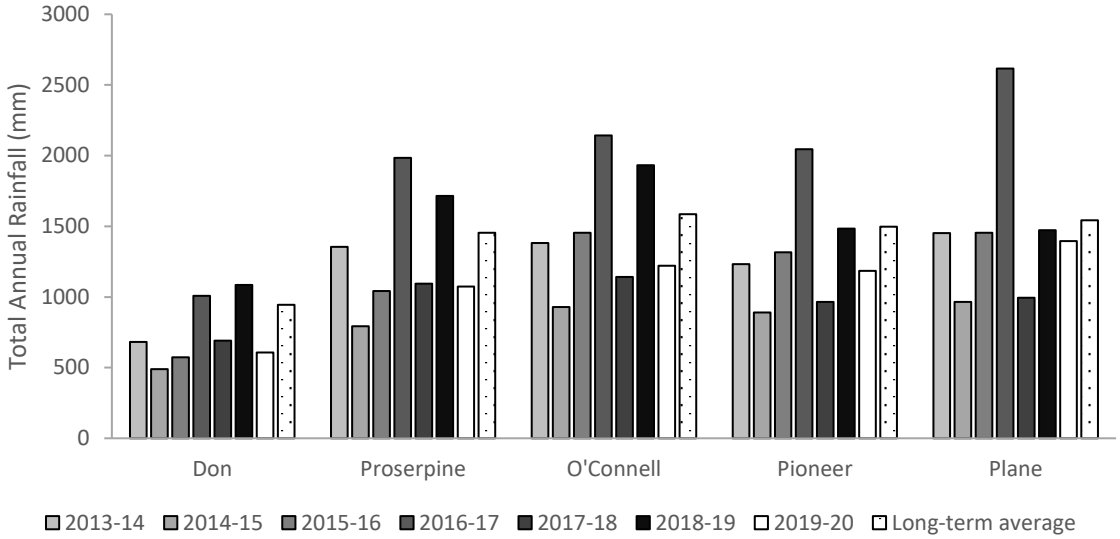

Figure 6. Annual rainfall across the Mackay-Whitsunday-Isaac Region basins for the 2019-20 reporting period compared to previous reporting periods and the long-term mean (1912-2020) (Data source: Bureau of Meteorology Regional Water Information (http://www.bom.gov.au/water/rwi/#ra_pa/048/2019).

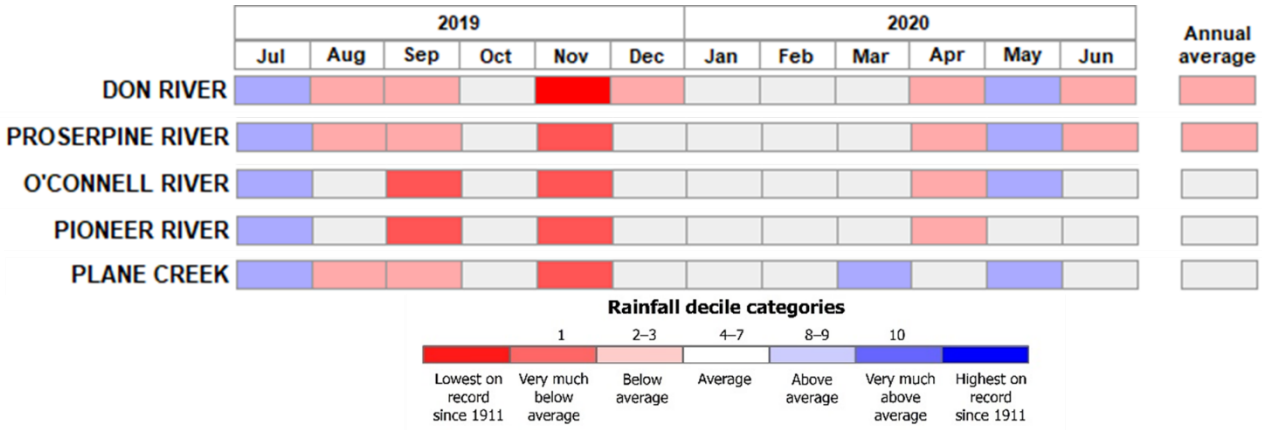

Figure 7. Monthly rainfall deciles and annual average decile for basin areas for the Mackay-Whitsunday-Isaac Region for 2019-20. Data source: Bureau of Meteorology Regional Water Information (http://www.bom.gov.au/water/rwi/#ra_pa/048/2019).

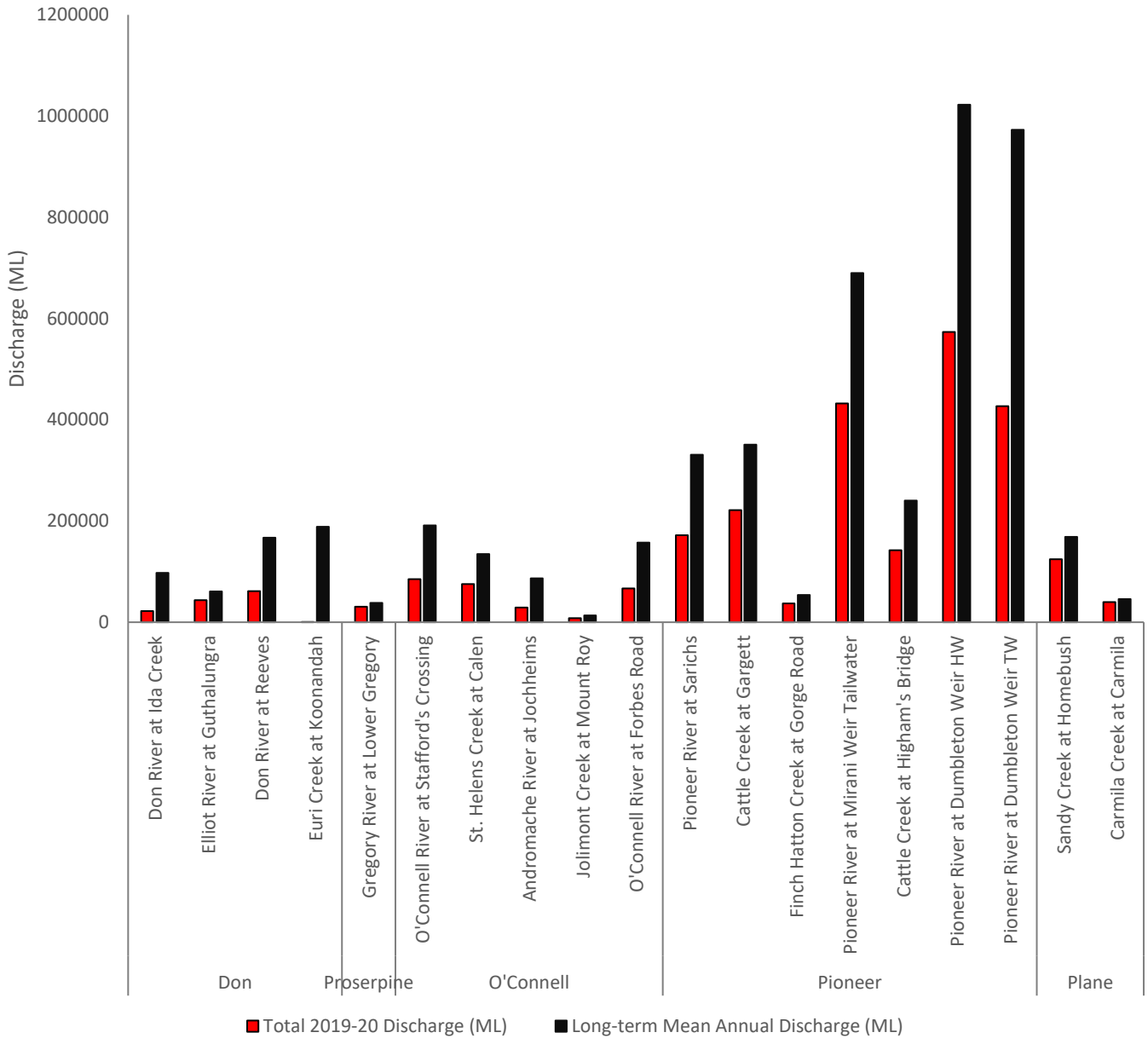

Figure 8. 2019-20 discharge recorded from gauging stations at major river channels in Mackay-Whitsunday-Isaac Region compared to the long-term mean (time frame varies according to the station). Long-term mean annual discharge is based on historical gauging station records until present. Source: Queensland Government (water-monitoring.information.qld.gov.au).

1.4.5. Coral Bleaching

Coral bleaching occurs when corals expel their symbiotic zooxanthellae, due to stress caused by changes in environmental conditions, often increased SST. If the SST stays high for a long period of time, as is the case during a marine heatwave, the coral may starve and die before they are able to uptake zooxanthellae again.

Across North Queensland, 2020 was dramatically warmer than 2018 and 2019, with a significant portion of inshore waters reporting 5 – 9 degree heating weeks (Figure 9A). During February 2020,

SSTs across the GBR were the warmest for any month on record (since 1900), 1.2°C higher than the long-term average for February. The preceding January and following March were both also warmer than their respective long-term monthly averages[10]. For the MWI region specifically, heat stress was particularly high in the central and southern inshore areas, at levels that have not been seen in the last five years (Figure 9B). The Bureau of Meteorology (BoM) attributed these particularly high SSTs to climate change (i.e. global warming), a very strong positive Indian Ocean Dipole and local weather patterns[11].

On the 26th of March 2020, the GBR Marine Park Authority (GBRMPA) confirmed that a mass bleaching event was occurring on the GBR, with "very widespread bleaching detected" due to the heat accumulation through February[12]. Across the whole GBR, 60% of shallow water reefs were moderately to severely bleached[13]. This was the third mass coral bleaching in five years[13], with widespread heat stress across the GBR causing major bleaching events in 2016 and 2017 (Figure 9A). The GBRMPA reported that the 2020 bleaching was more extensive than these past events, with some southern areas that were only minimally impacted in 2016 and 2017, now experiencing moderate to severe bleaching[12]. While MWI reefs were directly impacted, much of the bleaching appeared to be non-lethal, suggesting the possibility of reasonable recovery after this event (discussed further in Section 4.2). While heat stress is particularly damaging for corals, it is important to remember that it can also have major impacts on seagrass meadows and other organisms on the GBR.

[10] http://www.bom.gov.au/environment/doc/2020-GBR-marine-heatwave-factsheet.pdf
[11] http://www.bom.gov.au/cyclone/history/debbie17.shtml
[12] https://www.gbrmpa.gov.au/news-room/latest-news/latest-news/coral-bleaching/2020/statement-coral-bleaching-on-the-great-barrier-reef
[13] https://www.gbrmpa.gov.au/news-room/latest-news/latest-news/coral-bleaching/2020/statement-aerial-surveys-on-the-great-barrier-reef

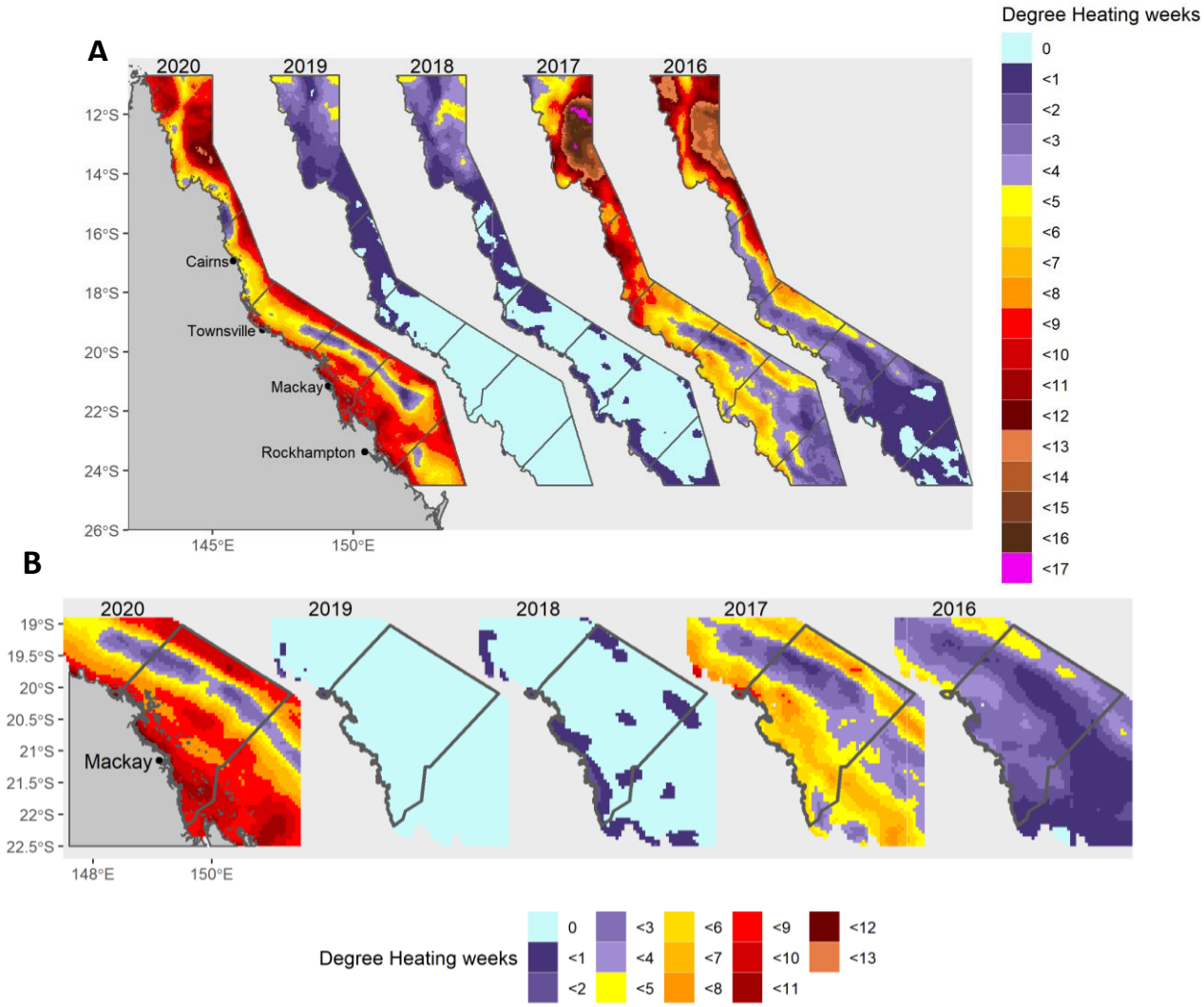

Figure 9. Degree heating weeks for North Queensland's inshore waters (A) and the MWI Region specifically (B) from 2016 to 2020. This is a measure of heat stress accumulation over the past 12 weeks, by summing SSTs exceeding 1°C above the long-term mean maximum temperature. Source: NOAA coral reef watch.

1.4.6. Tropical Cyclones

Tropical cyclone systems in the region develop from tropical lows, typically between November and April. For the 2019-20 reporting year, no TCs made landfall over the MWI region. The cyclone season across Queensland was below average, with the remnants of only the one TC entering the state – Esther in March 2020. This is in line with current climate change trends showing a decline in the number of TCs across Australia since 1982[5]. It has however, been predicted that the intensity of cyclones will increase[7].

Flow-on effects arising from TC Debbie in 2017 continue to impact some indicators, particularly coral and seagrass condition scores in the inshore marine environment. 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[11].

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). Water quality indicators and the flow indicator category were updated in the 2020 Report Card. For more information on reporting frequencies and metrics for each indicator, refer to the Methods Report[2].

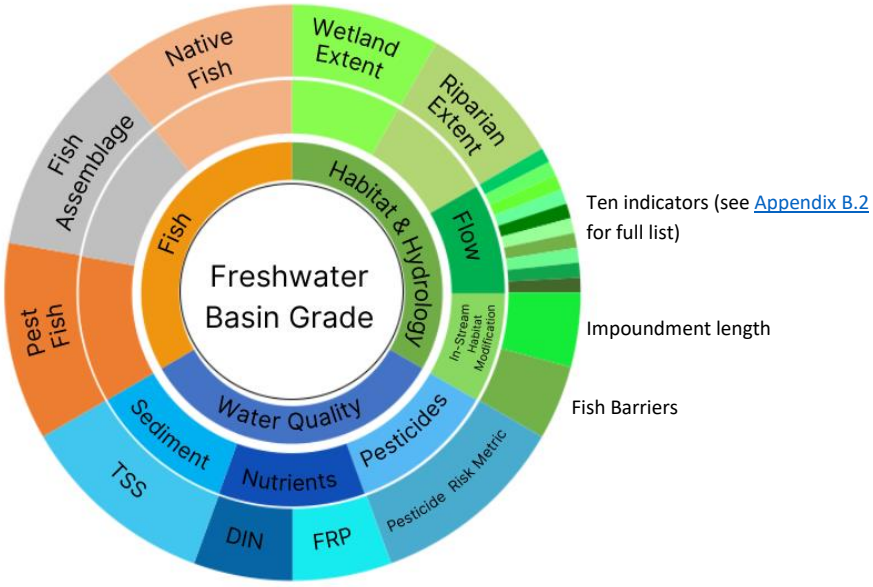

Figure 10. Indicators (outer ring), indicator categories (middle ring) and indices (inner ring) that contribute to overall freshwater basin scores.

2.1 Water Quality in Freshwater Basins

Water quality condition scores for the 2020 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 and Pioneer basins, and two in the O'Connell and Plane basins (Figure 11).

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 B.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[2].

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[14].

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

To assess water quality, criteria derived from the Queensland Water Quality Guidelines (DES 2009b) were adopted. However, these do not extend to the Don Basin, in which the assessed criteria were instead 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[2].

Tips for interpreting 2020 Report Card results:

- 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. While these data are suitable for determining pollutant loads leaving the Proserpine River (the purpose of the monitoring site), they are not suitable for reporting the ambient state (concentration) of nutrients and sediments in the freshwater ecosystem. As a result, nutrient and sediment indicator category results for the Proserpine Basin are not reported in the 2020 Report Card.

- Conversely, pesticides are still reported for the Proserpine Basin. Data from the Glen Isla site provides a reasonable estimate of pesticides in the freshwater catchment; 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[2] for further detail), and a PRM score calculated above the tidal zone would not necessarily provide a more accurate picture of the pesticide pressures in the catchment, as it would miss some of the inputs.

- 2019-20 was an exceptionally dry year with little rainfall and subsequent runoff in the Don River Basin. Water quality monitoring in this basin was therefore, restricted to periods of substantial rainfall in the area, specifically from February – April 2020. Other MWI basins were sampled across the entire year as is the case for the remainder of MWI basins. The scores for total suspended solids (TSS) and nutrients in the Don Basin are however, allocated as if water quality monitoring data were available for the entire year, encompassing both ambient (low flow) conditions and event (high flow) conditions (i.e. assessed against water quality guidelines that would typically apply to the combined dry/wet season water quality). Therefore, grades for the Don Basin should not be compared to previous grades that were calculated using data from uninterrupted sampling.

- Two freshwater sites in both the O'Connell and Plane basins were reported in the 2020 Report Card, which is the third year of reporting more than one site for these basins. Site-level scores are provided in Appendix B.4 for these basins.

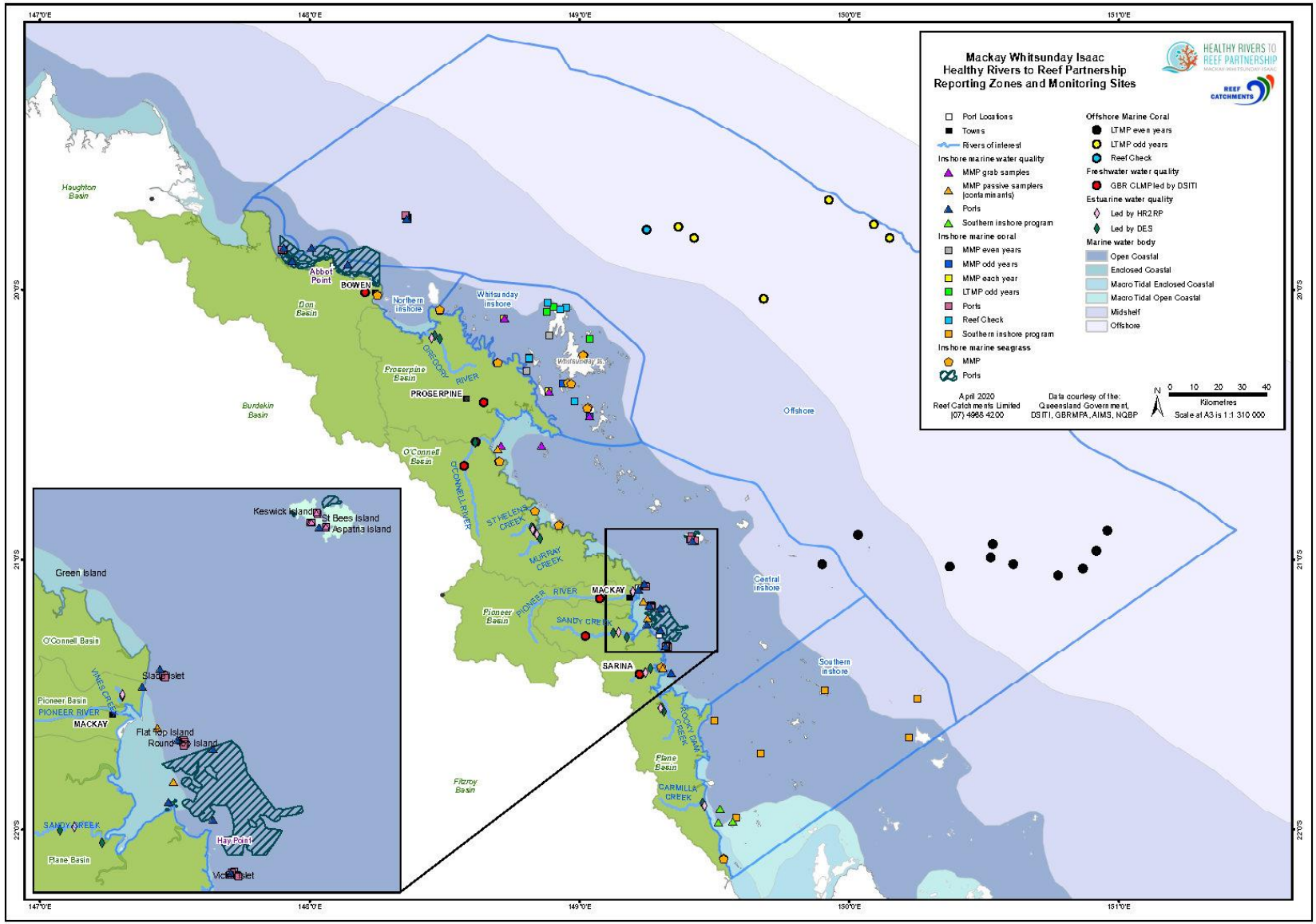

Figure 11. Sampling locations for water quality, coral and seagrass monitoring in the MWI Region for the 2020 Report Card.

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, influencing its grade.

Results (Table 3)**:**

Key Messages:

1) Sediment remains of concern for the MWI Region, where 'moderate' to 'very poor' grades have been observed in the Don, O'Connell and Plane basins for four or more consecutive years.

2) In the 2020 Report Card, sediment grades were similar or declined compared to the previous year, grading 'moderate' in the O'Connell and Plane basins, 'good' in the Pioneer Basin, and 'very poor' in the Don Basin (Table 3). This demonstrates that the median annual condition for sediment at the monitored sites fell below the target guidelines for three of the four basins in the region. The 'very poor' grade in the Don is likely to be the product of a reduced sample size in this basin during the 2019-20 year, as monitoring was only possible during periods of very high flow in the basin (February-April 2020).

- There was below average rainfall across the region in the 2019-20 wet season (Figure 5). The maximum median sediment concentrations for the Don, Pioneer, and Plane basins occurred in mid to late February 2020. The limited rainfall before February in these areas likely influenced the increased sediment medians during the period of heavy rainfall. Basins that received lower median rainfall in the months leading up to this flush (e.g. the Don Basin) reported maximum sediment values that exceeded the guideline value by more than an order of magnitude.

Table 3. Results for the sediment indicator category (based on a measure of TSS) score for water quality in freshwater basins for the 2020 Report Card (2019-20 data) in comparison to 2014 - 2019 scores. Scores from 2018 onwards include combined additional sites in the O'Connell and Plane basins.

Freshwater Basin	2020 Sediment Score	2019	2018	2017	2016	2015
		Sediment				
Don (Don River)	18	58	60	29		
Proserpine						
O'Connell (O'Connell River)	59	59	53	57	55	58
Pioneer (Pioneer River)	61	63	54	60	59	59
Plane (Sandy and Plane Creeks)	59	55	55	55	54	61

Sediment: ■ 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

*denotes reporting years where data was obtained from additional monitoring sites in the O'Connell and Plane basins. Consequently, these scores are not directly comparable to the values reported in 2017, 2016, 2015 and 2014.

^ Insufficient monitoring data was available to adequately assess sediment conditions within the Proserpine Basin. Consequently, no score is reported for this indicator. Further information on monitoring in the Proserpine Basin is provided in the Methods Report[2].

2.1.2. Nutrients

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

Results (Table 4)**:**

Key Messages:

1) Aggregated scores showed that nutrients remained in 'moderate' condition for the seventh consecutive year in the Pioneer Basin.

2) There was a marked improvement in the overall nutrient score in the Plane Basin, which improved in score from 37 to 47, largely due to a decline in levels of inorganic phosphorus in Sandy Creek.

3) The Don Basin declined from a 'good' (66) to 'moderate' (46) grade, largely due to a considerable decline in FRP indicator score.

2.1.2.1 Dissolved Inorganic Nitrogen (DIN)

Results (Table 4)**:**

- DIN remains an indicator of concern for the MWI Region. Three of the four basins in the region were graded 'moderate' in the 2019-20 reporting period. This indicates that none of the

annual medians for DIN met the relevant guidelines for the protection of environmental values in the 2019-20 reporting period.

- An improvement in the score for DIN was evident in the Pioneer Basin, increasing from 33 to 41 and consequently shifting from a 'poor' to 'moderate' grade (Table 4). This was likely driven by a decrease in monthly rainfall during the wet season relevant to the previous monitoring period, as monthly medians for this basin were considerably less throughout the wet season relative to 2018-19.

- There was also a grade decline in the Plane Basin from 'moderate' to 'poor', however the score shift behind this change was very small (41 in 2018-19 to 38 in 2019-20) and was not caused by any grade changes at the site level.

2.1.2.2 Filterable Reactive Phosphorus (FRP)

Results (Table 4)**:**

For FRP, there were mixed results compared to the previous reporting period:

- The Proserpine, O'Connell and Pioneer basins, and Plane Creek maintained the same grades as in the previous reporting period.

- The Don Basin saw a considerable decrease in FRP score, shifting from a 'good' (74) to 'poor' grade (40). While overall Don Basin water quality grades in the 2020 Report Card cannot be directly compared to previous years due to restricted event sampling, every monthly median for FRP recorded in the Don Basin in 2019-20 was higher than the corresponding monthly median in 2018-19. This suggests that exceedances of guideline values during periods of high rainfall may have influenced this grade change.

- Sandy Creek saw a considerable improvement in score, shifting from a 'poor' (29) to 'moderate' (56) grade (Appendix B.3). Counter to other water quality grade changes in the 2020 Report Card, this grade change was largely due to improvements during baseflow (dry season) conditions in the creek. Monthly medians for FRP were below the guideline value for five months during the 2019-20 year, compared to only one month in 2018-19.

Table 4. Results for DIN and FRP indicators and overall nutrients indicator category scores for water quality in freshwater basins for the 2020 Report Card (2019-20 data) in comparison to 2014 - 2019 Report Card scores. Scores from 2018 - 2020 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.

Freshwater Basin	2020 Report Card			2019	2018	2017	2016	2015
	DIN	FRP	Nutrients	Nutrients				
Don	52	40	46	**66**	**62**	**33**		
Proserpine								
O'Connell	60	62	61	**57**	**59**	**60**	60	90
Pioneer	41	60	51	**46**	**53**	**45**	52	53
Plane	38	56	47	**37**	**24**	**24**	39	27

DIN and FRP: 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

Nutrients: 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

*Insufficient monitoring data was available to adequately assess nutrient conditions within the Proserpine Basin. Consequently, no score is reported for this indicator. Further information on monitoring in the Proserpine Basin is provided in Section 2.1.

2.1.3 Pesticides

The pesticide indicator scores were developed using the PRM approach. This approach quantifies the ecological risk associated with exposure to a mixture of pesticides. Measured concentrations of up to 22 different pesticides[2] in a given 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[2].

The PRM can be expressed as either the percent species affected or as the inverse percent species protected. To best visualise the proportional pesticide contribution graph, pesticide proportions are shown as 'percent species affected' (Figure 12). Conversely, pesticide grades in the basins are listed as 'percent species protected' (Table 5).

Results (Table 5)**:**

Key Messages:

1) Pesticide risk scores were more varied compared to the previous reporting year. The grades ranged from 'very poor' in the Proserpine, Plane and Pioneer basins, to 'very good' in the Don Basin. This is the fourth consecutive year that the Proserpine and Plane basins have received a 'very poor' grade for this indicator.

2) Imidacloprid and diuron were the key contributors to the overall pesticide risk in the Proserpine, O'Connell, and Pioneer basins (Figure 12). In contrast, a high proportion of the pesticide risk was attributed to reported metolachlor concentrations in the Don Basin, and a high proportion of metsulfuron-methyl in the Plane Basin (Figure 12). This contrast in the pesticide risk profile between regions reflect the relevant land-use applications, where the Don Basin is dominated by horticultural crops as opposed to intensive sugarcane farming in the other basins.

3) Overall, pesticides remained the poorest scoring indicator for basin water quality in the MWI region in the 2019-20 reporting year, indicating a high risk of adverse effects to the region's aquatic species due to pesticide exposure.

- The Don Basin improved in grade, shifting from 'good' (76) in 2018-19 to 'very good' (82) in 2019-20, which is likely associated with an exceptionally low rainfall and river discharge in the basin during the 2019-20 wet season relative to 2018-19.

- Despite receiving less rainfall than in the previous reporting period, the Pioneer Basin declined in grade, shifting from 'poor' (31) in 2018-19 to 'very poor' (20) in 2020. Notably, the Pioneer has now oscillated between 'poor' and 'very poor' grades for four consecutive years.

- The spring of 2019 had very low rainfall in the region. Anecdotal evidence provided by growers suggested there was very minimal weed growth during this period, and that conditions were unsuitable for spraying outside of irrigated areas (P. Trendell, pers. comm. (01/04/21)). The first large rainfall in the region occurred in late December 2019, making weed growth and conditions very suitable for spraying until the next large rainfall in late January 2020, meaning that the majority of pesticide application in the region was likely done during this time.

- There has been evidence of increased cane beetles and grubs in the district, with more paddocks showing insect-related impacts and growers witnessing large flights of beetles. Therefore, imidacloprid, a popular insecticide used in the region, may have been applied to cane crops in greater quantities to mitigate these effects. However, the contribution of this chemical to the overall pesticide risk for the region did not change notably from last year (Figure 12).

Table 5. 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 2020 Report Card compared to 2017 - 2019.

Pesticides	2020 Report Card		2019	2018	*2017
Freshwater Basin	PRM (% species Protected)	Standardised Pesticide Score	Pesticide Score		
Don	99	82	76	70	75
Proserpine	71	19	17	18	19
O'Connell	91	45	49	48	36
Pioneer	78	20	31	19	26
Plane	73	19	19	17	15

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: 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 pesticides scores have been back-calculated to incorporate changes in pesticide method that occurred for the first time in the 2018 Report Card.

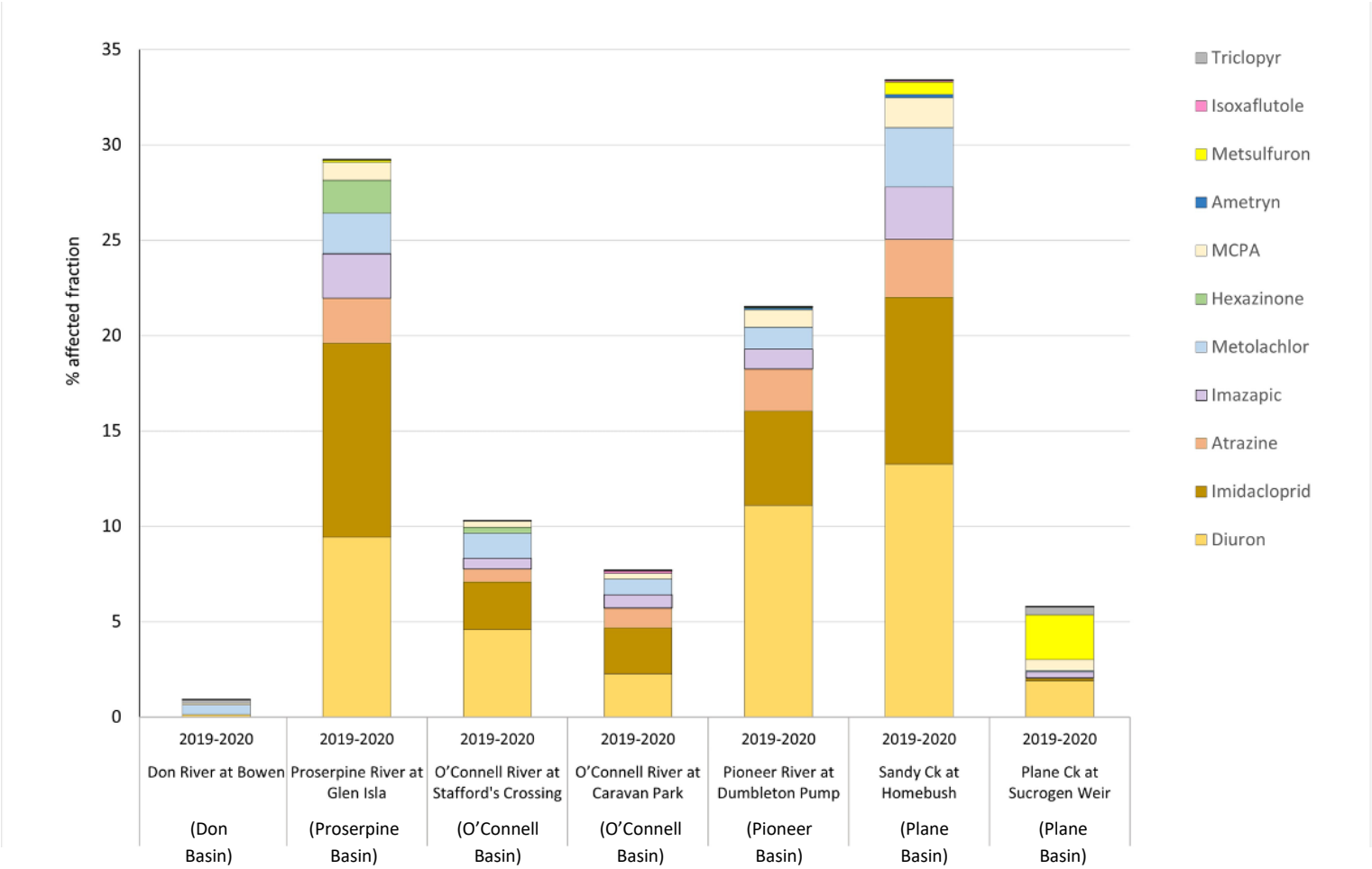

Figure 12. The proportional contribution of each chemical to the final Pesticide Risk Metric (PRM) score, for the 2019-20 reporting year. In this instance, the PRM is expressed as the % species affected fraction.

2.1.4 Water Quality Index Scores

In the 2019-20 reporting year, there were drier than usual conditions across the MWI Region (Figure 5). This is a likely driver behind many water quality grade changes in the 2020 Report Card, as reduced runoff is generally associated with reductions in nutrients, sediment and pesticides in the waterways. Due to these climatic influences and the natural variability of basin systems in the MWI Region, grade changes in the 2019-20 monitoring period are not necessarily indicative of long-term trends in waterway health. See Section 1.4 for more details on climate influences in the 2020 Report Card.

Results (Table 6)**:**

Key Messages:

1) Overall, water quality index grades in the MWI basins all received 'moderate' grades in the 2020 Report Card. This is the fourth consecutive year that scores for water quality have not met the desired criteria in the O'Connell Basin, and the seventh year in the Pioneer and Plane basins.

2) The Plane Basin recorded a similar score to the previous monitoring period, with an increase of only five points (37 to 42) driven primarily by an improvement in FRP. However, this small score improvement caused a grade change from 'poor' to 'moderate' in the Plane, which was the first time the basin received a moderate grade for water quality.

- Despite reduction in rainfall and base flow, overall water quality grades did not improve as might be expected in the Don Basin (likely due in part to monitoring restrictions, see below).

- The Don Basin declined in grade from 'good' to 'moderate', largely due to significant declines in scores for both sediment and FRP. Water quality grades for the Don should be interpreted with caution, as a lack of surface flow in the basin prevented sampling outside of periods of high flow (February – April 2020).

- 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).

Table 6. Results for water quality indicator categories and final water quality index scores in freshwater basins for the 2020 Report Card (2019-20 data) in comparison to 2014 – 2019 Report Cards.

Freshwater Basin	2020 Report Card				2019	2018	*2017	^2016	^2015
	Sediment	Nutrients	Pesticides	Water Quality Index	Water Quality Index				
Don	18	46	82	**49**	66	64	46		
Proserpine			19						
O'Connell	59	61	45	**55**	55	53	51	63	63
Pioneer	61	51	20	**44**	46	42	44	48	48
Plane	59	47	19	**42**	37	32	31	37	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

*2017 scores have been back-calculated to incorporate updates to freshwater pesticides made in the 2018 Report Card. 2017 scores do not incorporate additional sites that were included for the first time in the 2018 Report Card.

^ 2016-2014 Report Card scores do not include back-calculated pesticide updates that were established for 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[2].

Confidence in water quality scores for MWI basins varied depending on indicator category and basin (Table 7). 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 in the 2019-20 monitoring period, 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 7. Confidence associated with water quality index results in freshwater basins in the 2020 Report Card. Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1-5 (very low – very high), which indicates 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 parenthesis. 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	2	2	6.6	2
					Water Quality Index	**8.8**	**3**

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

2.2. Habitat and Hydrology in Freshwater Basins

The habitat and hydrology index is comprised of four indicator categories. Flow, which is updated annually, and three indicator categories (in-stream habitat modification, riparian extent and wetland extent) that are updated every three to four years.

2.2.1. In-stream Habitat Modification

The in-stream habitat modification indicator category is comprised of two sub-categories: fish barriers and impoundment, which are updated every four years. Fish barriers and impoundment data were last updated in the 2019 and 2018 Report Cards, respectively.

2.2.1.1. Fish Barriers

Results (2018-19 data, Table 8):

Key Message:

1) Northern freshwater basins, the Don and O'Connell, 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. 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.

- 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).

- As a component of the 2019 assessment, field validation works were undertaken in the Don and Proserpine basins to investigate potential fish barriers identified through a desktop review process. Based on the field validation, several potential fish barriers were reclassified as it was determined they did not impede fish passage. As a result, there was an increase in the condition of each of the reported fish barrier indicators, and ultimately, the overall fish barrier score for the Don Basin. 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).

- The grade for 'distance to the first low passability barrier' declined from 'good' to 'moderate' for the Proserpine Basin, where field validation works resulted in the identification of a large low passability barrier close to the estuarine interface on the Proserpine River. This barrier blocks connectivity to a large proportion (>60%) of the Proserpine River. This dam has been created to impound water for irrigation. Consequently, the final fish barriers score declined from 50 to 41 in the 2019 assessment (remaining at 'moderate').

Table 8. Results for fish barrier indicators in freshwater basins in the 2020 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.

	2020 Report Card								2018
	Barrier Density		Stream to the 1st Barrier		Stream to the 1st Low "Passability" Barrier		Fish Barriers		Fish Barriers
Freshwater Basin	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***

Refer to Table 9 for explanation of relevant scoring ranges.

*A data discrepancy for the Plane Basin was identified in the scoring for the previous assessment, which was recorded as having a score of 3 ('moderate') for '% of stream length to the first low passability barrier'. Instead, the Plane Basin recorded a score of 4 ('good') for this indicator. This discrepancy has been rectified here.

Table 9. Scoring ranges and corresponding grades for specific metrics within the fish barriers indicator.

	Very Poor	Poor	Moderate	Good	Very Good	No score/data
Barrier Density (km)	1 = 0 to 2km	2 = >2 to 4km	3 = >4 to 8km	4 = >8 to 16km	5 = >16km	
% of Stream Before 1st Barrier	1 = 0 to <40%	2 = 40 to <60%	3 = 60 to <80%	4 = 80 to <100%	5 = 100%	
% of Stream to 1st Low "Passability" Barrier	1 = 0 to 60%	2 = >60 to 80%	3 = >80 to 90%	4 = >90 to <100%	5 = 100%	
Total Score	3 to 4	5 to 7	8 to 10	11 to 13	11 to 13	
Fish Barriers (standardised)	0 to <21	21 to <41	41 to <61	61 to <81	81 to 100	

2.2.1.2. Impoundment Length

Impoundment Length Results (2017-18 data, Table 10):

Key Message:

1) All basins, excluding the Proserpine, remained at similar condition for the 2018 assessment, indicating there has been little change in the net proportion of ponded channel habitat within each basin since the previous assessment conducted in 2015.

- 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 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 to poor.

- 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'.

Table 10. Results for the impounded stream indicator in freshwater basins in the 2020 Report Card (2017-18 data).

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	598	16	614	2.6	**70**
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

In-stream Habitat Modification Results (2017-18 data, Table 11)**:**

Key Messages:

1) There were no changes to the in-stream habitat modification grades for the O'Connell, Pioneer and Plane, which were graded as 'good', '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 slight decline observed in the aggregated score for the Proserpine Basin owing to reductions in the condition of the fish barrier indicator. Although the fish barrier indicator remained in moderate condition, the score reduced from 50 (2015 assessment) to 41 in the current assessment.

- The impoundment and fish barrier indicator sub-categories are aggregated to form the in-stream habitat modification indicator category. As highlighted above, impoundment and fish barrier scores for the 2020 Report Card are based on repeated data (2017-18 and 2018-19 data, respectively).

Table 11. Results for the in-stream habitat modification indicator category in freshwater basins in the 2020 Report Card (2018-19 data), compared to 2018 (2017-18 data).

Freshwater Basin	2020 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	70	60	**65**	**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

2.2.2. Riparian and Wetland Extent

2.2.2.1. Riparian Extent

Results (2013 data, Table 12)**:**

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 2020 Report Card (2013-14 data), which should be noted when interpreting these results.

- 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 2020 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. Therefore, 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 2018-19 scores, supersede all previously reported results of wetland extent. Consequently, scores from the previous assessment (2013) have been back calculated using the new maps to evaluate any change in wetland extent over time (Appendix B.5).

Results (2017 data, Table 12)**:**

Key Messages:

1) The grades for wetland extent were highly variable across the region, ranging from 'very poor' to 'very good'.
2) The Don Basin received a 'very good' grade* and the Proserpine Basin graded 'moderate', with the remaining basins grading 'poor' or 'very poor' relating to wetland extent condition.
3) Whilst 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 the areal extent of wetlands in the region as a result of development. Declines at the basin level are particularly pronounced for the O'Connell and Pioneer basins, where palustrine wetlands have lost 66% and 71% of their pre-clearing extent, respectively.

- *In the Don Basin, net increases in the extent of freshwater wetland observed were attributed to the conversion of estuarine wetlands to freshwater wetlands through damming or bunding. These increases mask a loss amongst other freshwater wetlands. 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[15]. In this instance, decreases in the areal extent of wetlands, driven by land modification and filling, are 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.

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

Table 12. Results showing % of riparian and wetland extent loss compared to pre-clearing conditions for the 2020 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	2020 Report Card				2020 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, this is a somewhat false representation masking losses of converted estuarine wetlands and significant losses of freshwater wetlands in other locations (Section 2.2.2).

2.2.3. Flow

For the 2019 and 2020 Report Cards, flow scores for only the Pioneer and Plane basins were reported due to concerns that the score for the O'Connell Basin was giving an inaccurate reflection of on-ground flow observations. This was primarily connected to unusually prolonged periods of low or no flow relating to the very 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). It is expected that the flow tool will go through a review process for future report cards in collaboration with the TWG and aquatic ecology experts to identify further refinements to the tool and methods, including dealing with rainfall seasonality.

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. Considerable work has been undertaken between the release of the 2018 and 2020 Report Cards to explore opportunities to fill 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[2].

Tips for interpreting 2020 Report Card results:

- 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.

- 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 13, Appendix B.2: Table B2):

Key Messages:

1) The flow indicator category grade improved in the Plane Basin, shifting from 'poor' (35) in 2018-19 to 'moderate' (43) in this reporting period.

2) The Pioneer Basin saw a large decline in flow indicator category grade, declining from 'good' in the 2018 and 2019 Report Cards (66 and 72, respectively) to 'moderate' (49) in 2020. This was heavily impacted by periods of no flow in late 2019 at the Dumbleton Weir Tailwater site (Appendix B.2: Figure B4) due to high water demands for urban and sugar mill activities (B. Cockayne, pers. comm. 23/04/2021), resulting in that site scoring a zero (Appendix B.2: Table B2; also see Figure 8).

- Both the Pioneer and Plane basins received a 'moderate' grade for the 2020 Report Card, with scores of 49 and 43, respectively.

- While the Pioneer Basin flow score was assessed from five stream gauging stations, with individual stations grading 'very poor' to 'good', flow in the Plane Basin was based on one monitoring location which received a 'moderate' grade (43) (Appendix B.2: Table B2).

- The climate type for 2019-20 was classed as average for the Plane Basin, and dry for the Pioneer Basin using the flow indicator tool (Table 13). Conditions were particularly dry in both basins during the August to November period of 2019, with 'below' or 'very much below' average rainfalls during this period (BoM data, Figure 7). The Plane Creek however, had 'above average' rainfall in March and May 2020 resulting in rainfall that was comparable to the long-term average annual rainfall for that basin, as calculated by both the flow indicator tool and BoM (Table 13; Figure 7).

Table 13. Results for the flow indicator for freshwater basins for the 2020 Report Card and the climate type based on average rainfall, as compared to the 2018 and 2019 Report Cards.

Freshwater Basin	2020 Report Card		2019		2018	
	Climate Type	Flow Indicator	Climate Type	Flow Indicator	Climate Type	Flow Indicator
Don^						
Proserpine^						
O'Connell*					Dry	78
Pioneer	Dry	49	Average	72	Drought	66
Plane	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 is available.

*The O'Connell Basin was omitted from reporting in 2019 and 2020 due to anomalous scores.

2.2.4. Habitat and Hydrology Index Scores

The overall habitat and hydrology index grades for basins in the 2020 Report Card ranged from 'poor' to 'good' across the MWI Region, the same as in 2019 (Table 14).

Notably, the only habitat and hydrology indicator category that was updated in the 2020 Report Card was flow (in the Pioneer and Plane basins), and thus scores in the other basins remain unchanged from the 2019 Report Card.

Results (Table 14)**:**

- As data for the habitat and hydrology index includes repeated data (e.g. riparian extent from 2013-14, wetland extent and in-stream habitat modification from 2018-19), these scores do not fully capture changes in condition associated with major weather events, including TC Debbie, or potential anthropogenic impacts to riparian extent which may have occurred between 2014 and 2020. Updates to the riparian extent indicator are scheduled for future report cards, as described in Section 2.2.2.

Table 14. Results for habitat and hydrology indicator categories and the aggregated index in freshwater basins in the 2020 Report Card compared to the 2017 – 2019 Report Cards. Aside from an updated flow indicator, all other indicator categories use repeated data from 2019, 2018, and 2014 Report Cards.

	2020 Report Card						2019	2018*	*2017
Freshwater Basin	**In-stream habitat modification**	**Flow**	**Riparian Extent**	**Wetland Extent**	**Habitat and Hydrology Index**		**Habitat and Hydrology Index**		
Don	85		41	100	**75**		75	73	73
Proserpine	40		50	59	**50**		50	51	52
O'Connell	65		51	14	**43**		43	52	43
Pioneer	21	49	54	12	**34**		40	38	29
Plane	50	43	41	23	**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 15).

Table 15. Confidence associated with habitat and hydrology index results in freshwater basins for the 2020 Report Card. Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1-5 (very low – very high), which indicates 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 parenthesis. 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

Results (2018 data; Table 16):

Key Messages:

1) The native fish richness in the O'Connell Basin was graded 'very good', whilst the Proserpine and Pioneer basins were 'good'. Fish communities in the Plane Basin however, were in 'moderate' condition.

2) The proportion of alien (pest) fish in catches were graded as 'very good' across all of the basins assessed, which was an improvement from 2017 results, for which only the Plane was in 'very good' condition.

3) 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 two of the five basins (Table 5). 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 *diversity of species*, rather than the *abundance* or *health* of fish within each waterway. Please refer to our 'pesticides and fish' FAQ article on the Partnership's website[1] for more information on interpreting the fish and pesticide grades in this Report Card.

- The 'very good' grades for the relative number of pest fish species in the MWI Region are encouraging and highlight the importance of minimising the impact of pest fish through management and eradication programs. It is worth noting that the MWI Region has fewer introduced fish than other parts of Queensland, such as South-east Queensland and some basins within the Wet Tropics.

- Unfortunately, in 2019 a small number of peacock bass were caught in the Pioneer River and the Gooseponds at Mackay. Peacock bass are a voracious predator, native to central South America and have the potential to spread and cause major impacts on the region's waterways. Continuing the management of existing pest fish populations such as tilapia and peacock bass are critical to reducing threats to native fish species.

- Overall, local freshwater fish communities, at a catchment scale, are generally doing well, with results for the Pioneer and O'Connell basins improving from the previous monitoring year to 'very good', and the Plane maintaining a stable grade of 'good' (Table 16).

Table 16. Results for fish indicators in freshwater basins in the 2020 Report Card (2017-18 data) compared to the 2017 Report Card (2014-15 data).

	2020 Report Card				2017 Report Card*
Basin	**Native Fish Richness (PONSE)**	**Pest Fish (proportion of sample)**	**Fish Index**		**Fish Index**
Don					
Proserpine	70	89	79		
O'Connell	84	100	**92**		**65**
Pioneer	65	100	**82**		**48**
Plane	59	100	**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.

2.3.3. Confidence

Confidence associated with freshwater fish results was 'moderate' (Table 17).

Table 17. Confidence associated with fish index results in freshwater basins for the 2020 Report Card. Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1-5 (very low – very high), which indicates final confidence level. 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
Native Richness	2	2	2	2	2	9.0	3
Pest Fish Abundance	2	2	2	2	2	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

Tips for interpreting 2020 Report Card results:

- As scores for the fish index and the majority of the habitat and hydrology index are based on repeated data, any changes to the overall basin scores in the 2020 Report Card are driven by score changes for the water quality index and the flow indicator category.

Results (Table 18):

Key Messages:

1) The overall freshwater basin grades were the same as in the previous Report Card, ranging from C ('moderate') to B ('good').

2) Similar to the previous year, 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. Whilst this reflection agreed with on-ground observations of system condition by local experts, information is not available for several indicators of waterway health in the region (e.g. flow and fish metrics in the Don Basin).

Table 18. Condition grades and scores of freshwater basins for the 2020 Report Card compared to 2014 – 2019 Report Cards.

Freshwater Basin	2020 Report Card					2019	2018	*2017	^2016	^2015	^2014
	Water Quality	Habitat and Hydrology	Fish	Basin Score and Grade		Basin Score					
Don	49	75		62	B	71	56	47	48	48	54
Proserpine		50	79	65	B	65	66	53	53	53	52
O'Connell	55	43	92	63	B	63	66	54**	58	57	52
Pioneer	44	34	82	53	C	56	54	40	41	41	34
Plane	42	39	79	53	C	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

*denotes scores which 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 Report Card 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 comprised of a series of indicator categories and indicators (Figure 13). There is no established methodology for the assessment of estuarine fish, therefore, no score is reported for this index at this stageFigure 13. Indicators (outer ring), indicator categories (middle ring) and indices (inner ring) that contribute to overall estuary scores. . Following their four-year reporting cycles, habitat and hydrology indicators were not updated in 2019-20, and thus scores presented here represent repeated data from previous

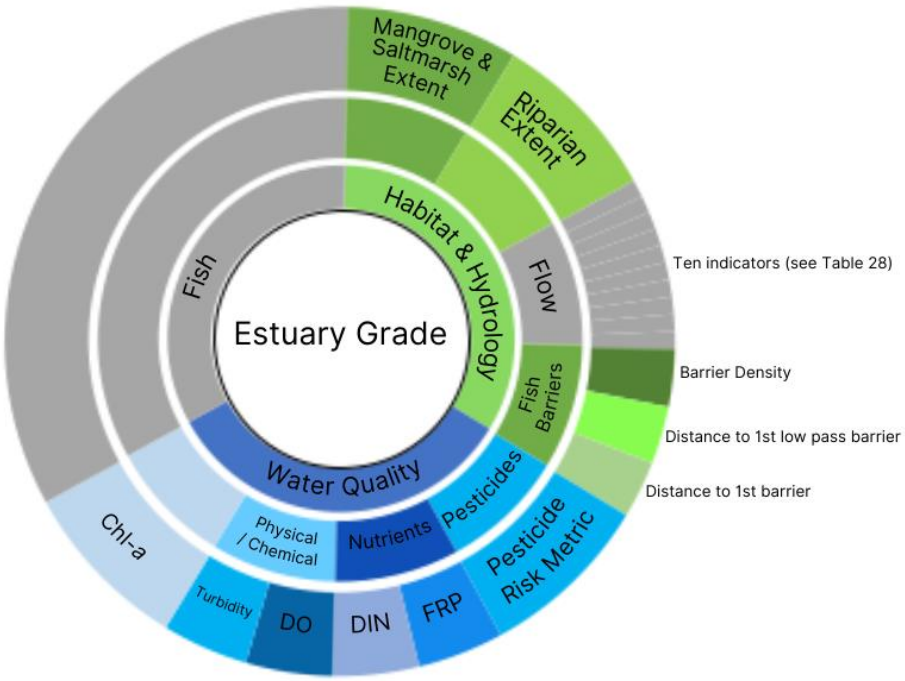

Figure 13. Indicators (outer ring), indicator categories (middle ring) and indices (inner ring) that contribute to overall estuary scores. In the 2020 Report Card, only indicators shaded blue were updated.

report cards. Due to minimal data availability, flow is currently not reported for estuaries.

Tips for interpreting 2020 Report Card results:

- When comparing overall scores and grades between reporting years, it is important to note that there were no habitat and hydrology indicators updated in the 2019-20 monitoring period, and thus any differences in scores are exclusively due to changes in water quality.

- The number of samples used to derive estuarine water quality grades has decreased since the last reporting period, due to restrictions caused by the COVID-19 pandemic. Water quality samples were unable to be collected by the DES from April – June 2020. While pesticide monitoring samples were supplemented partially by collections from a Partnership-funded

monitoring program, water quality sample sizes in the 2019-20 year are less representative than the previous monitoring period.

- In the 2019-20 reporting year, there were drier than usual conditions across the MWI Region (Figure 5). This is a likely driver behind many water quality grade changes in the 2020 Report Card, as reduced runoff is generally associated with reductions in nutrients, sediment and pesticides in the waterways. Due to these climatic influences and the natural variability of basin systems in the MWI Region, grade changes in the 2019-20 monitoring period are not necessarily indicative of long-term trends in waterway health.

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 11). Indicators used to report on the water quality index in estuaries include DIN, FRP, turbidity, dissolved oxygen (DO), chlorophyll-*a* (chl-*a*) and pesticides, in which pesticides are reported using the PRM. The results for DIN and FRP are aggregated to form the nutrients indicator category; turbidity and DO are aggregated to form the physical-chemical (phys-chem) indicator category (Figure 13). For methodological details on water quality monitoring and grading, please refer to the Methods Report[2].

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. As mentioned above, below average rainfall across the region is likely associated with nutrient grade improvements in MWI estuaries (see Section 1.4.4).

Results (Table 19 and Appendix C.2)**:**

Key Messages:

1) The grades for nutrients improved in several estuaries in the 2020 Report Card. The St Helens/Murray, Vines, and Sandy Creek estuaries changed from 'moderate' to 'good' grades in 2020 (60 to 65, 50 to 63, and 53 to 61, respectively). While the grade change in the Vines Creek estuary was driven primarily through an improvement in inorganic phosphorus ('good' to 'very good' grade), the grade change in Sandy Creek estuary was driven primarily by a shift in inorganic nitrogen from 'poor' (32) in 2019, to 'moderate' (48) in 2020. The improvement in St Helens/Murray Creek estuary was due to small score increases for both inorganic nitrogen (49 to 54) and inorganic phosphorus (72 to 77).

2) Conversely, the grade for the Gregory River estuary declined in the 2020 monitoring period, from 'very good' (90) to 'good' (77). This change was driven by a decrease in the inorganic nitrogen score (90 to 64) for this waterway.

- Scores and grades were similar to the previous year for the FRP indicator, except in the case of the Vines Creek estuary, which improved from a 'good' (69) to 'very good' (90) grade. This shift was driven by a decrease in monthly median FRP in both dry and wet season conditions in 2019-20 relative to 2018-19. Whereas the previous year showed exceedances of the guideline value from July 2018 – January 2019. Monitoring in the 2019-20 season reported only one month that exceeded the guideline value (March 2020) in the Vines Creek estuary.

- Similarly, the six out of the eight estuaries in the MWI Region retained the same DIN grade in the 2019-20 reporting period. The two estuaries that changed grades in 2020 were:
    - Sandy Creek estuary - 'poor' grade (32) in 2019 improved to a 'moderate' grade (48) in 2020. This grade change was driven by changes at the site level, wherein the upstream monitoring site showed reductions in monthly median exceedances of the guideline value during dry season conditions.
    - Gregory River estuary - 'very good' grade (90) in 2019 decreased to a 'good' grade (64) in 2020. This decline was driven largely by elevated median DIN values during months of high rainfall during the 2019-20 wet season (February – April 2020) relative to 2018-19.

Table 19. Results for DIN and FRP indicators and nutrient indicator category in estuaries for the 2020 Report Card in comparison to 2015 to 2019 Report Card nutrient scores.

	2020 Report Card			2019	2018	2017	2016	2015*
	DIN	FRP	Nutrients	Nutrients				
Estuary								
Gregory River	64	90	**77**	90	74	78	78	90
O'Connell River^	56	90	**73**	72	73	74	75	78
St Helens/Murray Creek	54	77	**65**	60	56	54	60	62

Table 19. Results for DIN and FRP indicators and nutrient indicator category in estuaries for the 2020 Report Card in comparison to 2015 to 2019 Report Card nutrient scores.

	2020 Report Card			2019	2018	2017	2016	2015*
	DIN	FRP	Nutrients	Nutrients				
Estuary								
Vines Creek	37	90	**63**	50	67	50	61	64
Sandy Creek	48	74	**61**	53	54	49	46	41
Plane Creek	66	90	**78**	76	74	75	74	74
Rocky Dam Creek	53	90	**71**	69	68	66	66	66
Carmila Creek	60	90	**75**	71	74	69	63	65

DIN and FRP 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

Nutrients 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

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

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

3.1.2. Chlorophyll-*a*

Results (Table 20 and Appendix C.2):

Key Message:

1) Chl-*a* grade returned to 'very good', from 'good' for just the one year in 2019, in the Gregory River estuary (73 to 90). This estuary has now received a 'very good' grade in five of the last six years of monitoring.

2) The greatest change in chl-*a* scores in the 2019-20 monitoring period came from the Carmila Creek estuary, which saw an improvement in grade from 'moderate' (43) to 'good' (68). This change follows an ongoing trend in this estuary, where there has been considerable variability in grades across reporting years, ranging from 'good' in 2015 and 2020 to 'very poor' in 2016. The present score of 68 is the highest for chl-*a* that the Carmila Creek estuary has received for this indicator.

- A slight score change in the chl-*a* indicator was observed at Vines Creek estuary, increasing from 60 in 2019 to 63 in the current assessment. As a result, the reported grade changed from 'moderate' to 'good'. Notably, chl-*a* in this estuary has now changed grades for the last three reporting periods, despite only having a score change of three points between the 2018 and 2020 Report Cards.

- Grades for chl-*a* remained 'moderate' in the O'Connell River and St Helens/Murray Creek estuaries, and 'good' in the Sandy, Plane and Rocky Dam Creek estuaries. Notably, the Plane Creek estuary score increased by seven points in 2020 (62 to 69), though this did not result in a grade change.

Table 20. Chlorophyll-*a* (chl-*a*) indicator scores within estuaries for the 2020 Report Card, compared to the 2015 to 2019 Report Cards.

Estuary	2020 Report Card		2019	2018	2017	2016	2015
	Chl-*a*		Chl-*a*				
Gregory River	90		73	90	90	90	90
O'Connell River^	49		53	58	63	**33**	
St Helens/Murray Creek	56		58	52	58	54	62
Vines Creek	63		60	62	55	74	90
Sandy Creek	64		68	66	51	60	63
Plane Creek	69		62	77	75	69	69
Rocky Dam Creek	62		62	76	65	58	90
Carmila Creek	68		43	43	0	0	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

^ 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.

3.1.3. Phys-chem

The phys-chem indicator category scores were generated by the aggregation of the turbidity and upper and low 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. 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 (Newham et al., 2017) characterised turbidity as too variable to derive a suitable guideline.

Results (Table 21 and Appendix C.2):

Key Message:

1) The Gregory and O'Connell River estuaries and Rocky Dam, Plane and Carmila Creek estuaries retained the same grade as last monitoring season. The Sandy Creek estuary decreased from a score of 90 to 79, declining from a 'very good' to 'good' grade.

2) The St Helens/Murray and Vines Creek estuaries both received improved phys-chem grades in the 2020 monitoring season. The St Helens/Murray Creek estuary changed from a 'moderate' (60) to 'good' (80) grade, which was driven exclusively by a large improvement in turbidity grade ('poor' to 'good') in the 2020 monitoring season. Conversely, the improved grade for the Vines Creek estuary is due to improved grades in both lower DO and turbidity ('good' to 'very good' grade). Notably, the Vines Creek estuary is representative of an urban catchment influenced by the Mackay city area, rather than the Pioneer catchment as a whole.

- Turbidity scores were similar or improved for the second consecutive year (Appendix C.3). Both the O'Connell River and Vines Creek estuaries increased from 'good' to 'very good' grades (77 to 90 and 64 to 90, respectively). The greatest improvement in turbidity was seen in the St

Helens/Murray Creek estuary, which improvement from a 'poor' to 'good' grade (30 to 70). These improvements were likely driven by reduced runoff across the region due to below average rainfall in 2019-20 (Figure 5).

- Lower DO scores were similar to those of the previous year, except in the Vines Creek estuary which improved from a grade of 'good' to 'very good' (65 to 90). This grade improvement was driven by improvements in DO above the guideline value during wet season conditions.

- Upper DO scores remained similar to those of the previous monitoring year, with the exception of the O'Connell River estuary, which declined from a 'poor' (30) to 'very poor' (10) grade. Exceedances of the adopted criteria for DO percent saturation (105%) were identified from July 2019 to Jan 2020 monitoring events in the estuary. This is likely due to the nature of the monitoring site for the O'Connell River estuary, which has been reported as characteristically lacustrine with periods of limited mixing (A. Moss, pers. comm 29/03/21).

- Scores for Sandy, Plane, Rocky Dam and Carmila Creek estuaries are based upon DO scores only, as the absence of a suitable guideline value inhibits interpretation of annual condition for the turbidity indicator.

Table 21. Results for turbidity, lower DO and upper DO indicators and the aggregated phys-chem indicator category within estuaries, for the 2020 Report Card in comparison to 2015 – 2019 Report Card scores for phys-chem. The aggregated phys-chem score is calculated by averaging the poorer DO scores with the turbidity score. In the absence of a suitable turbidity score, phys-chem results will be based upon the condition of DO.

Estuary	2020 Report Card				2019	2018	2017	2016	2015*
	Turbidity	Lower DO	Upper DO	Phys-chem	Phys-chem				
Gregory River	90	72	90	**81**	85	79	84	84	85
O'Connell River^	90	90	10	**50**	52	2	63	18	53
St Helens/Murray Creek	70	90	90	**80**	60	49	60	52	81
Vines Creek	90	90	90	**90**	64	77	64	90	84
Sandy Creek		79	90	**79**	90	78	90	77	90
Plane Creek		90	71	**71**	67	90	90	68	67
Rocky Dam Creek		90	90	**90**	90	90	90	90	90
Carmila Creek		90	66	**66**	62	0	0	90	65

DO and turbidity 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

Phys-chem 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 is repeated data 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.

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[2] in a given sample are converted to a PRM that expresses risk as the percentage of aquatic species that may be adversely affected by a mixture of pesticides. Further information on the method for assessing pesticide condition is presented in the Methods Report[2].

Tips for interpreting 2020 Report Card results:

- The number of samples used to derive the pesticide score have decreased slightly since the last reporting period, due to restrictions caused by the COVID-19 pandemic. Therefore, sample sizes in the 2019-20 year are less representative than the previous monitoring period, particularly in the O'Connell River and Sandy Creek estuaries.

Results (Table 22, Figure 14 and Appendix C.1)**:**

Key Messages:

1) Overall, PRM grades for the estuaries were similar or improved compared to the 2019 Report Card, ranging from 'very poor' (Sandy Creek estuary) to 'very good' (Carmila Creek estuary) in the MWI Region.

2) Imidacloprid, atrazine, and diuron were the key contributors to the overall PRM in all of the estuaries assessed, with the exception of the Plane Creek estuary where metsulfuron was the key contributor (Figure 14).

3) Of the eight estuaries assessed, four were reported to have met the desired low risk category, protective of 95% of species (less than 5% of species are affected). These results highlight that species are at moderate to high risk of experiencing toxic effects due to high pesticide concentrations in half of the monitored MWI waterways. There is a strong need to adopt management measures in these estuaries to mitigate impacts to aquatic biota.

- Pesticide grades were similar or improved compared to the 2019 Report Card. These improvements are likely associated with the 2019-20 wet season having lower rainfall across the region (see Section 1.4.4 for details).
    - The O'Connell River and St. Helens/Murray, Sandy, Plane and Rocky Dam Creek estuaries maintained the same grades as the 2018-19 monitoring period. Scores for these estuaries were all within three points relative to the previous monitoring season.
    - The Gregory River estuary improved from a 'moderate' (59) to 'good' (70) grade, the Vines Creek estuary improved from a 'poor' (26) to 'good' (71) grade. The Carmila Creek estuary increased from a 'good' (79) to 'very good' (82) grade.

Table 22. 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 2020 Report Card compared to 2017 - 2019 Report Cards.

	2020 Report Card		2019	2018	2017*
Estuary	PRM (% species protected)	Standardised Pesticide Score	Standardised Pesticide Score		
Gregory River	97.00	**70**	59		39
O'Connell River^	92.30	**50**	48		36
St Helens/Murray Creek	94.70	**59**	58		62
Vines Creek	97.10	**71**	26		64
Sandy Creek	75.60	**19**	18		18
Plane Creek	98.00	**75**	74		73
Rocky Dam Creek	81.60	**24**	22		40
Carmila Creek	99.10	**82**	79		96

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

* 2017 pesticides scores have been back-calculated to incorporate changes in pesticide methods that occurred for the first time for the 2018 Report Card. Hindcasted scores do not account for changes associated with the addition of new monitoring sites or increased sampling effort. In this way, scores cannot reasonably be compared.

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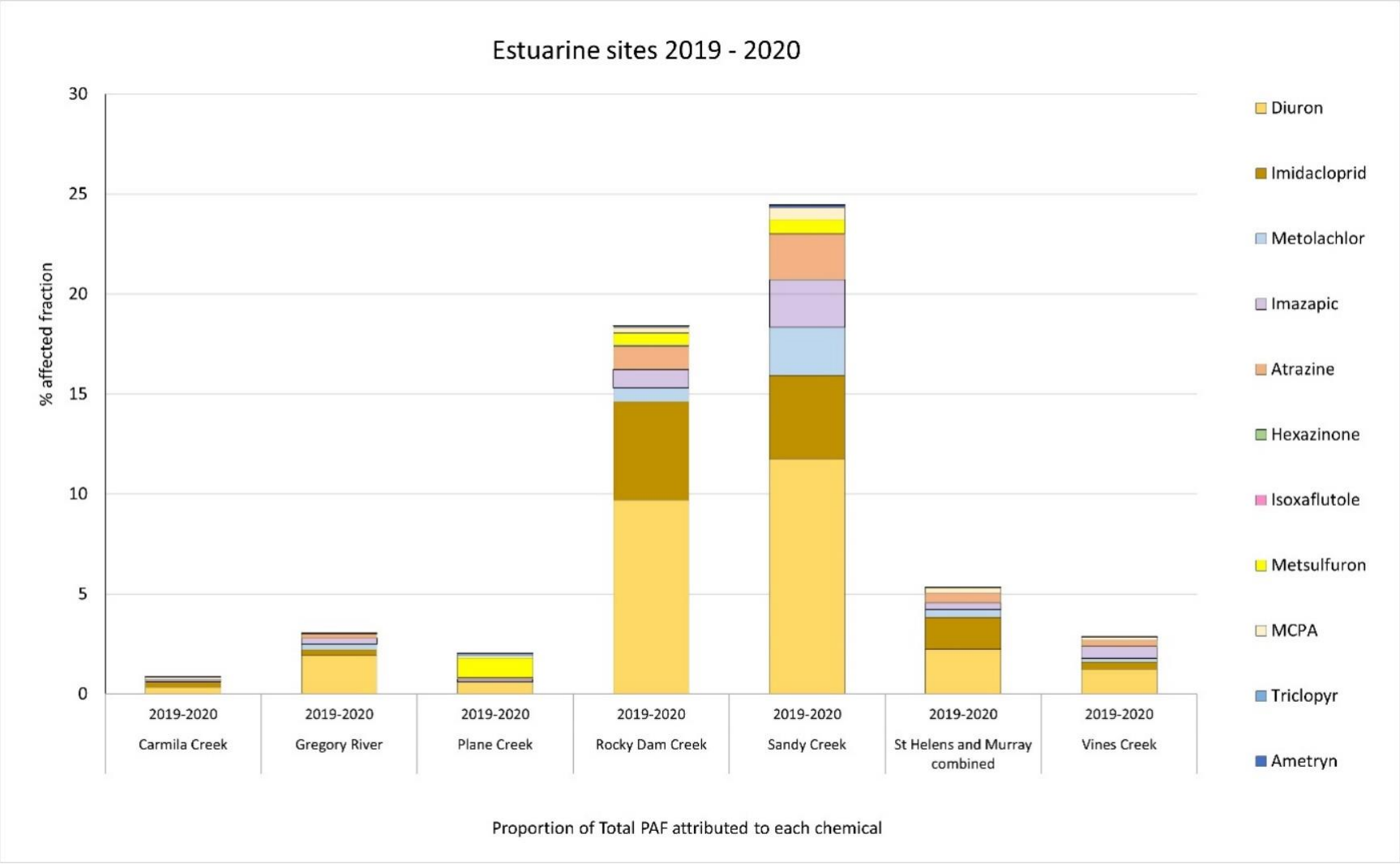

Figure 14. Proportional contribution of each pesticide to as the total percentage of species affected (PAF) as calculated using the Pesticide Risk Metric (PRM), for the 2019-20 reporting year in the MWI estuaries.

3.1.5. Water Quality Index Scores

Tip for interpreting 2020 Report Card results:

- 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 23 and Appendix C)**:**

Key Messages:

1) Water quality grades ranged from 'moderate' to 'good' in the current assessment period, where six of the eight estuaries met the water quality objective for the monitoring period.

2) Three estuaries (St. Helens/Murray, Vines and Rocky Dam Creeks) improved from a 'moderate' to 'good' grade respective to the previous monitoring period. The Carmila Creek estuary saw a marked water quality score increase with respect to the previous year (64 to 73) however, this did not translate to an improvement in grade. These score improvements are likely associated with decreased rainfall in the 2019-20 wet season relative to 2018-19.

3) The Vines Creek estuary had the greatest improvement of any estuary in the region, increasing in score from 50 to 72, driven largely by improvements in pesticide and phys-chem grades.

Table 23. Results for water quality indicator categories and final water quality index scores in estuaries for the 2020 Report Card (2019-20 data) in comparison to the 2015 to 2019 Report Card scores.

	2020 Report Card					2019	2018	2017	2016	2015^
Estuary	Phys-chem	Nutrients	Pesticides	Chl-*a*	Water Quality Index	Water Quality Index				
Gregory River	81	77	71	90	**79**	77	81	75	76	75
O'Connell River^	50	73	50	49	**55**	56	44	65	50	57
St Helens/Murray Creek	80	65	60	56	**65**	59	53	62	61	66
Vines Creek	90	63	71	63	**72**	50	69	61	75	79
Sandy Creek	79	61	20	64	**59**	57	66	54	51	53
Plane Creek	71	78	76	69	**73**	70	80	78	62	66
Rocky Dam Creek	90	71	24	62	**62**	60	78	65	71	66
Carmila Creek	66	75	83	68	**73**	64	39	37	50	63

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.

3.1.5.1. Confidence

The representativeness criterion for 2020 water quality index confidence has been adjusted to reflect the reduction in sample size due to the COVID-19 pandemic (Table 24). There is lower confidence in the O'Connell, Vines and Carmila Creek estuaries water quality (excluding pesticides) scores due to sampling occurring at only a single site, compared to two or three monitoring sites in the other estuaries.

Table 24. Confidence associated with water quality index results in estuaries for the 2020 Report Card. Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1-5 (very low – very high), which indicates 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 parenthesis. 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]**	**4 [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 distinct from those in the basins, comprising four indicators, including fish barriers, riparian and mangrove/saltmarsh extent and flow. Impoundments are not assessed as a component of the estuaries. To assess vegetation condition in the estuaries, the same broad principles of assessment are applied within the assessment area which includes from the estuary mouth upstream to the tidal limit. Reporting cycles for the habitat and hydrology indicators are detailed in each section below, noting that these were not updated for the 2020 Report Card (Table 25).

3.2.1. Fish Barriers

Similar to freshwater basins, estuary fish barrier indicators are updated every four years and were last updated for the 2019 Report Card.

Results (Table 25, 2018-19 data):

Key Message:

1) Since the previous assessment, there has been no change to the overall fish barrier grade in any of the estuaries assessed. There was a slight 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) Vines Creek estuary, and the O'Connell and Gregory River estuaries 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'. A high proportion of the Plane Creek catchment (upstream of the estuary) is used for sugarcane production. The creek also flows through Sarina, a large population centre 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 primarily located in the middle and upper river reaches, falling outside the estuary extent (18.5 m above the declared downstream limit (DDL)).

Table 25. Results for fish barrier indicators in estuaries in the 2020 Report Card (2018-19 data) compared to the 2018 Report Card (2014-15 data). Indicators assessed on Stream Order (SO) ≥3 or ≥4 as indicated. NB: no barriers. NLPB: no low "passability" barriers.

	2020 Report Card								2018
	Barrier Density		Stream (%) to the First Barrier		Stream (%) to 1st Low "Passability" Barrier		Fish Barriers		Fish Barriers
Estuary	km per barrier on SO ≥3	Score	% of stream before first 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

Refer to Table 9 for explanations of the relevant scoring ranges.

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 manifold 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 & Wolanksi, 2001). To understand continuing threats to estuarine riparian vegetation extent and mangrove/saltmarsh extent, indicators are assessed every four years and were last updated in the 2019 Report Card (Table 26). Notably, these scores represent repeated data (indicated below) and changes only in the extent of vegetation since pre-clearing, not changes in the condition of the vegetation assessed.

Results (2018-19 data, Table 26):

Key Message:

1) The riparian extent grades ranged from 'very poor' in the O'Connell River estuary to 'very good' in the Gregory River and Rocky Dam and Carmila Creek estuaries. The St Helens/Murray, Vines and Plane Creek estuaries were in 'moderate' condition for riparian extent, whilst the Sandy Creek estuary graded 'poor'.

2) The mangrove/saltmarsh extent grades ranged from 'moderate' in the Vines Creek estuary to 'very good' in the Gregory River and O'Connell, St Helens/Murray and Plane Creek estuaries.

- 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 C.3).

- The mangrove/saltmarsh extent grades ranged from 'moderate' in the Vines Creek estuary to 'very good' in the Gregory River and O'Connell, St Helens/Murray and Plane Creek estuaries. The remaining estuaries were reported to be in 'good' condition for mangrove/saltmarsh extent. In the Sandy Creek estuary, approximately 2.9 ha of mangrove and saltmarsh vegetation have been lost since the 2013 assessment (Appendix C.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 & Wolanksi, 2001; A. Moss, pers comms, 08/04/2020). 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 & Wolanksi, 2001).

Table 26. Results for riparian and mangrove/saltmarsh extent loss since pre-clearing (%), hectares remaining and standardised riparian and mangrove & saltmarsh extent in estuaries in the 2020 Report Card (2017 data). Hectares were rounded to the nearest whole number.

	2020 Report Card					
	Mangrove/Saltmarsh Extent		Riparian Extent			
Estuary	Hectares lost since pre-clearing	% loss since pre-clearing	Hectares lost since pre-clearing	% loss since pre-clearing	Standardised Mangrove/ Saltmarsh Extent	Standardised Riparian Extent
Gregory River	96.2	3.2	9.4	4.9	87	81
O'Connell River^	108.9	4.0	40.5	57.2	84	17
St Helens/Murray Creek	-6.5*	-0.2*	54.2	17.1	100	58
Vines Creek	114.0	15.6	8.6	18.1	60	56
Sandy Creek	411.0	14.0	70.0	38.3	63	32
Plane Creek	26.1	2.2	23.0	17.0	91	58
Rocky Dam Creek	432.2	7.1	11.9	4.7	76	82
Carmila Creek	29.0	6.9	0.0	0.0	77	100

Riparian and mangrove/saltmarsh 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 riparian and mangrove/saltmarsh extent 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.

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 2020 Report Card.

Considerable work has been undertaken between the release of the 2018 and 2020 Report Cards to explore opportunities 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

As no habitat and hydrology indicators were updated in the 2020 Report Card, scores for this index are repeated from the 2019 Report Card. In accordance with the reporting frequency for these indicators, being due for update every four years, scores for riparian extent, mangrove/saltmarsh extent and fish barriers were all last updated in the 2019 Report Card. Scores have been back-calculated using new methodologies to facilitate comparison between datasets over time.

Results (Table 27 and Appendix C):

Key Message:

1) The overall habitat and hydrology index grades for estuaries in the 2020 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 previous assessment. Whilst the overall grade remained the same ('good'), there was a modest increase in the habitat and hydrology score for St Helens/Murray Creek estuary. This change was driven by an improvement in the fish barriers condition score from 41 to 50 in the current assessment.

- 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.

Table 27. Results for habitat and hydrology indicator categories and index in estuaries for the 2020 Report Card (2018-19 data) compared to the 2018 Report Card (2014-15 data).

	2020 Report Card						2018*
Estuary	**Mangrove/ Saltmarsh Extent**	**Riparian Extent**	**Fish Barriers**	**Flow**	**Habitat and Hydrology Index**		**Habitat and Hydrology Index**
Gregory River	87	81	80		**83**		83
O'Connell River^	84	17	70		**57**		57
St Helens/Murray Creek	100	58	50		**69**		66
Vines Creek	60	56	80		**65**		66
Sandy Creek	63	32	41		**45**		45
Plane Creek	91	58	21		**56**		56
Rocky Dam Creek	76	82	61		**73**		77
Carmila Creek	77	100	100		**92**		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 back-calculated to incorporate changes associated with refinements to the source mapping used to assess vegetation (riparian and mangrove/saltmarsh) extent.

3.2.4.1. Confidence

Overall confidence for the habitat and hydrology indicator category was 'moderate' (Table 28).

Table 28. Confidence associated with habitat and hydrology index results in estuaries for the 2020 Report Card. Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1-5 (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

There is no score for the condition of 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.

3.4. Overall Estuary Condition

Results (Table 29 and Appendix C.2):

Key Message:

1) Overall estuary grades were similar or improved in the 2019-20 monitoring period:

- **a.** The Gregory River ('B' to 'A'), Vines Creek ('C' to 'B'), and Carmila Creek ('B' to 'A') estuaries improved in grade. These changes were driven by improvements in chl-*a* and pesticide grades in these estuaries, in addition to modest improvements in DIN and upper DO in the Carmila Creek estuary.
- **b.** The Carmila Creek estuary received an 'A' grade for the first time since the Partnership have been reporting on the waterway, although this was due to only a small improvement in score from 80 in 2018-19 to 82 in 2019-20.
- **c.** The Vines estuary had the largest score change of any estuary in the region, improving from a 'C' to 'B' grade. This was due exclusively to improvements in grade for pesticide and phys-chem indicators.

Table 29. Overall condition scores and grades of estuaries for the 2020 Report Card in comparison to 2015 – 2019 Report Card scores.

	2020 Report Card					2019	2018**	2017*	2016*	2015*^
Estuary	Water Quality	Habitat and Hydrology	Fish	Estuary Score and Grade		Estuary Score				
Gregory River	79	83		**81**	**A**	80	82	79	80	79
O'Connell River^	55	57		**56**	**C**	56	51	61	54	57
St Helens/Murray Creek	65	69		**67**	**B**	64	57	61	61	63
Vines Creek	72	65		**68**	**B**	57	68	64	72	73
Sandy Creek	56	45		**50**	**C**	51	58	52	50	52
Plane Creek	73	56		**64**	**B**	63	68	67	59	61
Rocky Dam Creek	62	73		**67**	**B**	66	76	70	73	70
Carmila Creek	73	92		**82**	**A**	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.

4. Inshore and Offshore Marine Results

The inshore marine region is divided into four zones: The Northern, Whitsunday, Central and Southern Inshore Marine Zones (hereafter referred to as the Northern, Whitsunday, Central and Southern Zones, respectively). The entire offshore region is represented by the Offshore Marine Zone (hereafter referred to as the Offshore Zone) (Figure 11). Scores for each zone are calculated from a series of indices, comprised of a number of indicators under relevant indicator categories (Figure 15). Litter scores are reported in inshore zones and urban areas for the first time in the 2020 Report Card. These scores do not however, contribute to the overall inshore marine grade as they are on a scale of 'very high pressure' to 'slight pressure', compared to 'very poor' to 'very good'. These results are therefore presented separately from the water quality, coral and seagrass scores (which contribute to the overall inshore zone grade).

Significant contributors to the inshore marine dataset used for score calculation are the North Queensland Bulk Ports Corporation Ltd (NQBP) Marine Monitoring Programs and the GBR Marine Monitoring Program (MMP). Monitoring reports for NQBP Monitoring Programs can be found on the NQBP website[16], while the MMP annual reports can be found in the GBRMPA e-library[17]. Water quality data for the Offshore Zone are sourced from the BoM marine water quality (MWQ) dashboard based on remote sensing.

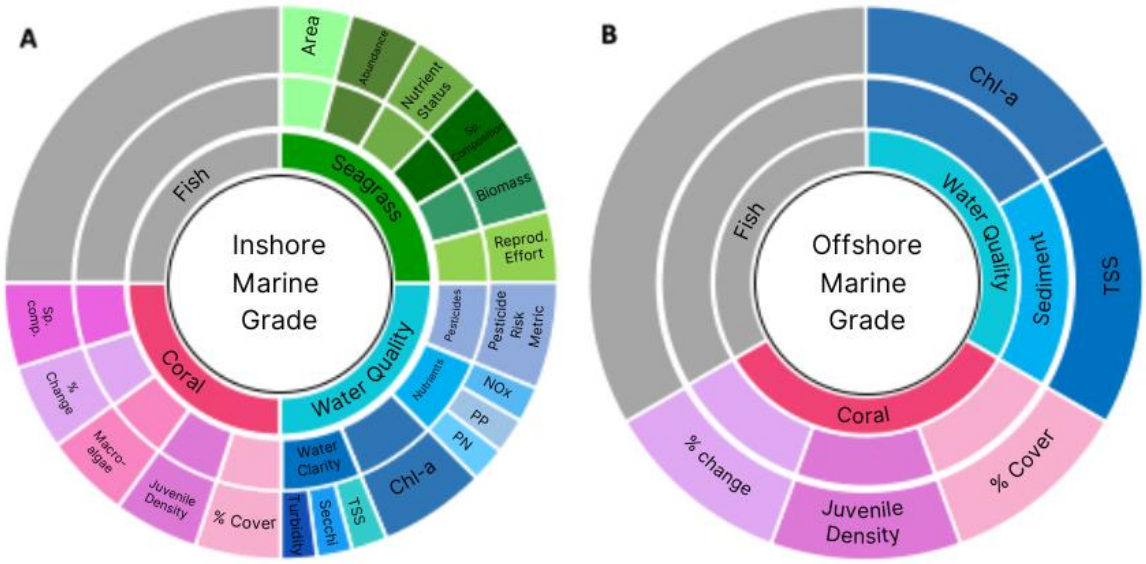

Figure 15. Indicators (outer ring), indicator categories (middle ring) and indices (inner ring) that contribute to overall inshore (A) and offshore (B) marine scores/grades. Where no indicator category is listed, this represents that the indicator/s (e.g. juvenile density) does not fit into any category below the index level (e.g. coral). Grey shading represents no data. Note: NO_x = nitrogen oxides, PP = particulate phosphorus, PN = particulate nitrogen, TSS = total suspended solids, chl-*a* = chlorophyll-*a* concentration, sp. comp = species composition and reprod. = reproductive.

[16] https://nqbp.com.au/sustainability/research-and-reports
[17] https://elibrary.gbrmpa.gov.au/jspui/browse?type=series&value=Marine+Monitoring+Program

4.1. Water Quality in Marine Zones

Inshore marine water quality in the MWI Region is influenced by six major river basins; the Proserpine, O'Connell, Pioneer, Plane, Don basins in the MWI Region and the Fitzroy Basin. More specifically, the Pioneer and Fitzroy rivers appear to have the greatest influence on the Whitsunday region. Under strong discharge conditions, the Pioneer River dominates waters inshore of the Whitsunday Islands, while the offshore area of this region is influenced by the Fitzroy River (Baird et al., 2019). The Whitsunday region is also potentially influenced by run-off from the Burdekin Basin during extreme events or through longer-term transport and mixing. The region is typified by higher variability in discharge and loads compared to surrounding regions such as the Wet Tropics basins (Waterhouse et al., 2018).

4.1.1. Inshore Marine Zones

4.1.1.1. Nutrients, Chlorophyll-*a* and Water Clarity

Nutrient scores for inshore zones are based upon reported concentrations of oxidised nitrogen (NOx), particulate phosphorus (PP) and particulate nitrogen (PN), while the water clarity indicator category is informed by secchi depth, TSS and turbidity indicators. Condition scores are calculated by comparing annual means or medians to guideline values (with the appropriate statistic identified within the guidelines), 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 the Methods Report[2] for more information).

Tips for interpreting 2020 Report Card results:

- 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). Turbidity is recommended as the 'primary' measure of water clarity, with secchi and TSS providing supporting evidence to clarify patterns.

- In the Central Zone, the Ports monitoring site MKY_AMB11 was removed from score calculations for the 2020 Report Card. This site is within the Mackay Harbour and is therefore thought to be not truly representative of inshore marine condition in this region. Due to a lack of guideline values for other indicators for this site, only the chl-*a* score is impacted by this change.

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

Results (Table 30 and Appendix D.1.1)**:**

Key Message:

1) The Whitsunday Zone showed marked improvements in nutrients, chl-*a* and water clarity indicator categories. These were likely influenced by below average rainfall in this region (Figure 5) reducing freshwater discharge and associated sediments and nutrients moving into Whitsunday inshore waters. Reduced nutrient levels would have consequently limited chl-*a* levels in the region.

- In the 2020 Report Card, nutrients, chl-*a* and water clarity grades ranged from 'good' to 'very poor' across the MWI inshore zones (Table 30). Appendix D.1.1 presents boxplots, and site-level and past (2016 to 2019) scores for individual indicators.

Nutrients

- In both the Southern and Whitsunday Zones, improvements in PP scores drove improvements for the overall nutrients indicator category. Particularly dry conditions across the region for 2019-20 likely influenced this result by reducing the amount of phosphorus moving from local rivers into the marine environment.
    - The Southern Zone improved from 'moderate' in 2017-18 (49) and 2018-19 (57) to 'good' (69) this year.
    - The Whitsunday Zone improved in score from 24 in 2018-19 to 36 in this reporting period, but remained at a 'poor' grade for the third consecutive year.

Chlorophyll-*a*

- Northern and Whitsunday Zones showed marked improvement in chl-*a* scores, likely due to a reduction in available nutrients with below average freshwater discharge from local rivers (Figure 8).
    - The Northern Zone recovered, improving to a grade of 'good' (72) after declining to 'moderate' (57) in 2018-19 from 'good' or 'very good' grades for the three years prior.
    - The Whitsunday Zone improved from a 'very poor' (11) grade in 2018-19 to 'moderate' condition (50) in this reporting period.

- Excluding the Mackay marina site (MKY_AMB11) from score calculations influenced a chl-*a* score decline in the Central Zone, from 37 ('poor') to 20 ('very poor') (see above for explanation).

Water Clarity

- Water clarity remained at a 'very poor' grade in the Southern Zone, with a score of 0 for the third year in a row. This pattern has likely been driven by the strong influence of tidal

movement in this zone, which can cause large amounts of sediment to become resuspended in the water column.

- Due to improvement in turbidity scores in the Central Zone, there was a small score increase from 20 in 2018-19 to 27 in 2019-20, which resulted in a grade change from 'very poor' to 'poor' generally consistent with previous years.

- TSS and turbidity scores drove an improvement in the water clarity grade in the Whitsunday Zone, shifting from 'very poor' (20) last reporting period to 'poor' (39) in 2019-20, the highest since 2015.

Table 30. Results for inshore water quality indicator categories for the 2020 Report Card (2019-20 data) compared to 2016 to 2019 Report Cards.

	2020 Report Card			2019			2018			2017			2016		
	Nutrients	Chl-*a*	Water Clarity	Nutrients	Chl-*a*	Water Clarity	Nutrients	Chl-*a*	Water Clarity	Nutrients	Chl-*a*	Water Clarity	Nutrients	Chl-*a*	Water Clarity
Northern	53	72	36	52	57	36	88	61	17		89	50		89	40
Whitsunday	36	50	39	24	11	20	32	22	30	1	0	21	28	53	38
Central	35	20	27	27	37	20	63	27	30	55	29	25	36	38	52
Southern	69	30	0	57	35	0	49	18	0						

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

4.1.1.2. Pesticides

Pesticides in the Inshore Zones were reported using the PRM for the third consecutive year (Table 31). This approach considers pesticides with multiple Modes of Action (MoA) which 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 PSII-HEq (PSII Herbicide Equivalent Concentration) method (2017 and prior).

In the 2020 Report Card, 19 pesticides were reported on in the Central Zone and 18 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.

Tips for interpreting 2020 Report Card results:

- Pesticide data were collected using a combination of passive samplers and grab samples (limited to once per wet and dry season), depending on the program. As the report card endeavours to assess ambient water quality, grab sample data were used as a reference only given their temporal constraint and were not incorporated into the overall pesticide score. Furthermore, only nine of the 22 possible pesticides were captured at two time points in the reporting period. These results should, therefore, be interpreted with caution. Passive sampler data from NQBP programs will be available for the Northern and Central Zones from the 2021 Report Card onwards.

- Passive sampler deployments record a time-averaged estimate of pesticide concentrations, and the maximum percentage species affected for the site was adopted for the calculation of the PRM. For the purpose of reporting, the percentage species protected (the inverse of percentage species affected) is reported alongside the final PRM score.

- This is the second year that pesticide scores have been reported for the Southern Zone.

- Pesticides are not currently monitored in the Whitsunday Zone, and therefore, pesticide outflow from the Proserpine River into the waters around the Whitsunday Islands is not well understood. The Partnership is investigating potential opportunities to introduce passive pesticide samplers into this zone.

Results (Table 31 and Appendix D.1.2)**:**

Key Message:

1) Low rainfall in the MWI region reduced freshwater discharge into the marine environment (Section 1.4.4). This is likely to have driven the pesticide grade in the Central Zone to improve from three consecutive years of 'moderate' condition to a grade of 'good' (74) for the first time.

- In the 2020 Report Card, both the Central and Southern Zones were graded as 'good' for pesticides (Table 31). Appendix D.1.2 presents site-level and past (2017 to 2019) scores.

- Site-level improvements in the PRM (i.e. percentage of species protected) were the key drivers for the overall pesticide score increase in the Central Zone.
    - Most notably, Repulse Bay improved from a 'moderate' (92% species protected) to 'very low' risk (99% species protected), and Flat Top Island improved from 'moderate' (92% species protected) to 'low' risk (97% species protected).
    - Sandy Creek inshore was graded as 'low' risk (97% species protected (99% in 2018-19)), however the pesticides score in the Sandy Creek estuary was 'very poor' (75% species protected). A similar pattern was found in 2018-19, and it was surmised that there was a high level of mixing and dilution as pesticides reached

the inshore marine environment in that region, thereby reducing the risk of these chemical to marine organisms at the Sandy Creek inshore site.

- There was a grade decline from 'very good' (100) in 2018-19 to 'good' (75) in 2019-20 in the Southern Zone. This may be impacted by the sampling regime. In the 2019 Report Card, data from two sampler deployments from late January to mid-August 2019 were used, consisting of periods where the samplers were in the water longer than recommended. In the current Report Card however, three deployments were carried out from November 2019 to April 2020. The data collected during this reporting period are likely more representative of actual pesticide levels as deployments were shorter and captured a greater portion of the wet season flows.

- The pesticide grade for the Carmila Creek estuary improved from 'good' (79) to 'very good' (82), suggesting that other outflows may negatively impact pesticide levels in the Southern Zone.

- The grab sample reference grades in the Northern and Central Zones were 'very good' (100) for the time points of August 2019 and May 2020.

Table 31. Standardised pesticide scores for the 2020 Report Card, compared to the 2017 to 2019 Report Cards. Scores are calculated from the Pesticide Risk Metric (PRM) (up to 22 pesticides) reporting on the percentage of aquatic species protected (%) for inshore zones. MMP = Marine Monitoring Program, SIP = Southern Inshore Monitoring Program.

	2020 Report Card			2019	2018	2017
	Sample Type	**Program**	**Pesticide Score**	**Pesticide Score**		
Northern	Grab *(used for reference only)*	Ports	100*	99*		
Whitsunday						
Central	Passive	MMP	**74**	60	54	50
	Grab *(used for reference only)*	Ports	100*	99*		
Southern	Passive	SIP	**75**	100		

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

* Grab samples are displayed for reference only, and do not contribute to water quality grades.

4.1.2. Offshore Marine Zone

Offshore marine water quality scores are based on chl-*a* and sediment (TSS) data 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, the more recent data for the 2019-20 time series may be of lower quality than earlier time series data. In early 2021, the BoM advised that the

MWQ dashboard had been decommissioned and that the underlying data preparation workflow is likely to be discontinued during the year. Alternative data sources are to be identified for reporting offshore water quality for the 2020-21 reporting year.

Results (Table 32)**:**

- Both indicator categories were graded as 'very good' for the seventh consecutive year.

Table 32. Offshore Zone water quality indicator scores 2016-2020 Report Cards.

	Indicator Categories		Water Quality Index
	Chlorophyll-*a*	Water Clarity (Sediments (TSS))	
2020 Report Card score: 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

4.1.3. Overall Marine Water Quality Index

Results (Table 33)**:**

Key Messages:

1) Water quality in the Whitsunday Zone received a 'moderate' grade (42) for the first time since 2015, improving from 'very poor' (18) last year. This was likely associated with below average rainfall across the region (Figure 6), causing lower freshwater discharge into inshore Whitsunday waters (Figure 8). Less nutrients and sediments would therefore have been washed from farming and urban land into the marine environment, causing reduced chl-*a* levels compared to years with higher rainfall.

2) Water clarity still remains a key issue in the Whitsundays, with the local tourism industry, researchers and recreational users reporting significant amounts of silt and other sediments still in the system.

- Water quality was graded as 'moderate' for all inshore zones, except the Central Zone which was graded as 'poor' (39).

- The Northern and Southern Zones remained at a 'moderate' level, despite small score changes. In both zones, the score changes were likely linked to the interaction between nutrient levels, particularly PN, and chl-*a*.

- The water quality score in the Northern Zone increased from 48 in 2018-19 to 54 this year, despite maintaining a 'moderate' grade. An improved nutrients score for this zone indicated that a decline in nutrients may have limited algal growth in the 2019-20 year, thereby improving the chl-*a* score.
- Conversely, the Southern Zone declined from 48 in 2018-19 to 43 in 2019-20, with a poorer PN score potentially driving the slightly worse chl-*a* score.
- In both cases, PP scores moved in the opposite direction to PN and chl-*a*, suggesting chl-*a* levels are more closely linked to PN than to PP levels.

- Overall water quality within the Offshore Zone was 'very good' for the seventh consecutive year. This is much higher than the inshore zones, likely due mostly to reduced human influence and high levels of natural flushing in offshore waters.

Table 33. Water quality scores and grades for the 2020 Report Card for inshore zones, including previous water quality scores for the 2014-2019 Report Cards. Scores from 2014 and 2015 Report Cards have been back-calculated to exclude pesticide scores in the Whitsunday Zone so that they are directly comparable to 2016 and 2017 scores.

	2020 Report Card					2019	2018	2017	2016	2015	2014
	Nutrients	Chl-*a*	Water Clarity	Pesticides	Water Quality Index	Water Quality Index					
Northern	53	72	36		**54**	48	55				40
Whitsunday	36	50	39		**42**	18	28	7	40	42	4
Central	35	20	27	74	**39**	36	44	40	44	54	
Southern	69	30	0	75	**43**	48	22				
Offshore		99	99		**99**	99	99	92	93	94	95

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

4.1.3.1. Confidence

Confidence in water quality index scores in the inshore zones is 'moderate', ranging from 'moderate' to 'low' for different indicators (Table 34). 'Low' confidence in the overall water quality index for the Offshore Zone is due to the use of remote sensing data to inform indicator scores, and the limited maintenance of this program. 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 34. Confidence associated with water quality index results in marine zones for the 2020 Report Card. Confidence criteria are scored 1-3 and then weighted by the value identified in the parenthesis. Final scores (4.5-13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1-5 (very low – very high), which indicates 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	0.5	2	1	5.3	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	2	2	1	8.3	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	1	2	1	6.3	1
						Inshore Water Quality Index	**9.6**	**3**
Offshore	Chl-*a*	2	1	2	1	1	6.9	2
	TSS	2	1	2	1	1	6.9	2
						Offshore Water Quality Index	**6.9**	**2**

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 general understanding that healthy and resilient coral communities exist in a dynamic equilibrium between acute disturbances and reef recovery. Disturbance events may include cyclones, thermal bleaching and outbreaks of crown-of-thorns starfish (COTS) (Thompson et al., 2018).

This year, for the first time, citizen science coral cover data collected by Reef Check Australia (RCA) volunteers are included in score calculations for the Whitsunday and Offshore Zones (Cook et al., 2020).

This is the second year that coral condition in the Southern Zone has been reported. This is following three years (2017-2019) of baseline data collection as part of the partnership-funded Southern Inshore

Monitoring Program. Coral monitoring methods in the zone align with the MMP coral monitoring program (see the Methods Report[2]).

4.2.1. Inshore Marine Zones

Results (Table 35 and Appendix D.2)**:**

Key Messages:

1) Coral index scores were graded as 'poor' for all inshore marine zones within the MWI Region in the 2020 Report Card (Table 35). All inshore zones were heavily impacted by a marine heatwave from January to March 2020, which led to coral bleaching (see Section 1.4.5). In particular, the Southern Zone was exposed to some of the highest estimates of heat stress across the GBR during this event (Figure 9). Coral index scores in 2019-20 reflected these impacts and the continuing slow recovery from the severe impacts of TC Debbie in 2017.

2) For the four years since TC Debbie, coral cover and juvenile coral density in the Whitsunday Zone have remained at a 'poor' grade. Macroalgal cover continued to rise, with the score declining from 51 ('moderate') in 2018-19 to 30 ('poor') for this reporting period (Appendix D.2.2: Table D12). Ongoing low water clarity in the Whitsundays is likely to have limited the recovery of coral communities. Furthermore, RCA reported that there was very low representation of soft corals in 2019-20, with increasing levels of algae, sand and silt throughout the zone (Cook et al., 2020).

3) Coral cover and juvenile coral density in the Northern Zone both remained 'very poor' for the fourth consecutive year. Recovery of the coral communities after TC Debbie in 2017 has been hampered by the low coral recruitment due to site-level issues with potential isolation from the broodstock and strong competition with macroalgae (A. Thompson, pers. comm. 20/04/21).

- In the Central Zone, all sites were graded as 'poor' or 'very poor'. This reflected the high level of macroalgae ('very poor', 15), which outcompeted corals and reduced clear reef space on which juvenile corals could settle. There was however, a small improvement in macroalgae and juvenile coral density scores compared to 2018-19, but this will require a longer-term trend before reliably indicating community recovery.

- Although the Southern Zone coral index improved from a 'very poor' grade in 2018-19 to 'poor' in 2019-20, this resulted from a small change in score from 20 to 21. This increase is therefore too small to be reliably interpreted as a true improvement in condition.

- The coral index score in the Southern Zone was heavily influenced by 'very poor' macroalgae cover (0) and juvenile coral density (17); similar results were reported in the 2019 Report Card (Appendix D.2.4). As mentioned above, these variables are intrinsically linked, as high levels of macroalgae means that there is less suitable substrate for juvenile corals to recruit to.

4.2.2. Offshore Marine Zone

The Offshore Zone felt some minor impacts of the 2017 TC Debbie in 2017, and has shown a slight recovery since the event. Small impacts on these reefs are also attributed to COTS, although this is typically balanced by recovery of coral cover.

Results (Table 35 and Appendix D.2.5)**:**

Key Message:

1) The coral index in the Offshore Zone graded 'moderate' (55) for the seventh consecutive year, driven by 'very good' grades for juvenile coral densities (95), but 'poor' coral cover and community change (35 for both).

- Coral index scores ranged from a 'good' to 'poor' grade across sites in the Offshore Zone (Appendix D.2.5).

- Juvenile coral density was 'very good' at every site in the Offshore Zone except Penrith Island. Coral recruits require space amongst a coral reef on which to settle and are susceptible to poor water quality. This score therefore suggests that there had been no considerable environmental limitations to hard coral recruitment for some time, and is reassuring for potential coral community recovery in this zone.

- The low juvenile coral density score of 28 ('poor') for Penrith Island is potentially due to the spatial remoteness of this island. This is the most inshore of the offshore sites (see the Methods Report[2]), and may be isolated from the relevant brood stock (A. Thompson, pers. comm. 14/04/21).

- Coral community change dropped from a 'moderate' to 'poor' grade in the Offshore Zone, however this was due to only a small score decrease from 41 in 2018-19 to 35 this year.

- During March 2020 surveys, RCA reported 15% of Hardy Reef coral colonies were bleached, which was the highest level since surveys began at that site in 2002. However, coral at Australian Institute of Marine Science (AIMS) Long-term Monitoring Program (LTMP) sites was not dramatically impacted by the 2020 bleaching event.

Table 35. Final 2019-20 coral scores for MWI inshore and offshore zones compared to previous Report Cards (2014-2019). Notably, 2020 is the first Report Card in which weighted RCA data contributes to the coral cover and overall coral index scores for the Whitsunday and Offshore Zones.

	2020 Report Card						2019	2018	2017	2016	2015	2014
	Cover	Macroalgae	Juvenile	Change	Composition	Coral Index	Coral Index					
Northern	11	66	7	30		**28**	29	25	31	45		
Whitsunday	25	30	34	25	26	**28**	30	42	52	61	58	56
Central	35	15	22	38		**28**	23	23	23	30		
Southern	47	0	17			**21**	20					
Offshore	35		95	35		**55**	55	56	60	57*	57*	54*

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

*Offshore coral scores are not directly comparable to previously reported values due to revision of the coral change metric. Scores presented are back calculated using the revised method.

4.2.3. Confidence

Confidence in scores for coral indicators in the inshore zones is 'high', while in the Offshore Zone confidence is 'low' (Table 36).

Table 36. 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 parenthesis. Final scores (4.5 – 13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1-5 (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	1	8.1	2
	Change	3	3	1	3	1	8.1	2
	Juvenile	3	3	1	3	1	8.1	2
						Offshore Coral Index	**8.1**	**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.

4.3. Seagrass Index

Seagrass condition for the 2020 Report Card was assessed based on indicators measured as part of either the MMP and/or the Queensland Ports Seagrass Monitoring Program (QPSMP). Different

indicators are used across the two programs, with MMP-associated indicators being abundance (percent cover), reproductive effort and tissue nutrient status, while the QPSMP associated indicators are area, biomass and species composition.

The 2021 Report Card onwards will report on seagrass condition in the Southern Zone, following a period of baseline data collection by the Partnership-funded Southern Inshore Monitoring Program (aligning to QPSMP methods).

Seagrass meadows across the region have been showing grade improvements since the devastating impacts of TC Debbie in March 2017. During TC Debbie, meadows sustained high rainfall, flood plumes, increased wave height, and strong winds which severely impacted seagrass in the region. In the 2019-20 season, environmental conditions such as rainfall, river flow and light levels, were favourable for seagrass growth from March 2019 through to the end of the year, with only a short period of high rainfall at the beginning of the 2019 calendar year.

Tips for interpreting 2020 Report Card results:

- To combine the MMP and QPSMP results, the seagrass index score is derived from averaging site/meadow scores from within a zone, as opposed to averaging the indicator scores within a zone (see Appendix D.3 for site-level scores). This is because the MMP takes the average of indicator scores while the QPSMP takes a conservative approach and allocates the lowest of the indicator scores to the site/meadow. If species composition drives the score because it is the lowest indicator, it is given a 50% weighting. This can sometimes lead to overall seagrass index scores and ratings appearing to contradict the indicator scores.

- MMP and QPSMP indicator scores are often dramatically different (even in the same zone), ranging from 'very poor' to 'moderate', and 'good' to 'very good', respectively, for the 2020 Report Card. While this can be impacted by the difference in sampling sites between the two programs, MMP scores are typically lower due to the reproductive effort indicator. This indicator has been identified to negatively bias scores and not reflect the true condition of seagrass meadows as it does not take into account differing life histories among seagrass species.

- From 2021 onwards, the MMP will be replacing the reproductive effort indicator with a resilience metric and will also be removing the nutrient status indicator. These changes will be reflected in future MWI Report Cards.

- In 2008, five inshore meadows were identified as seagrass habitats that could be representative of the whole of Abbot Point for long term monitoring (McKenna et al., 2008). After ten years of monitoring, it was decided that the three *Halodule uninervis* meadows on the south-eastern side of Abbot Point (API5, 7 and 8) would be reported as one *H. uninervis* monitoring meadow (API5) (Van De Wetering et al., 2020), which is reflected in this year's scores and grades (Appendix D.3).

Results (Table 37 and Appendix D.3)**:**

Key Messages:

1) Overall seagrass index scores improved in all three inshore marine zones reported on this year compared to 2018-19, highlighting recovery across the region after impacts from TC Debbie in 2017. Reduced freshwater discharge from local rivers in 2019-20 (Figure 8) is also likely to have had a positive impact on seagrass meadows across MWI.

2) The Northern Zone continued to show improvement after devasting seagrass loss from TC Debbie, moving from a 'poor' grade (25) in 2017-18 to 'moderate' (52) in 2018-19 and now to 'good' (61) in 2019-20.

- In the Northern Zone, average biomass and area across meadows/sites improved from 'moderate' in 2018-19 to 'good' in 2019-20. Average species composition across all meadows/sites remained 'good' with an increase in score from 67 to 74.

- In the Whitsunday Zone, indicator scores improved for all three MMP indicators: abundance, reproductive effort and nutrient status. Site-level grades improved at Hamilton Island (HM2), Lindeman Island and Pioneer Bay, while Hydeaway Bay condition declined from 'very good' to 'good' due to abundance declines.

- In the Central Zone, score increases were reported for seagrass abundance at Midge Point, St Helens Beach and Sarina Inlet, while increases in biomass occurred at Dudgeon Point and Hay Point.

- Although not officially reported in the 2020 Report Card, seagrass abundance remained 'very poor' at the Seagrass Watch monitoring site at Clairview in the Southern Zone. Formal scores will be given for seagrass condition in this zone from the 2021 Report Card onwards.

Table 37. Results for seagrass indicators for inshore zones for the 2019-20 reporting year, compared to previous Report Cards (2016-2019). Indicators are based on data collected from the Marine Monitoring Program (MMP) or Queensland Ports Seagrass Monitoring Program (QPSMP). Seagrass scores were back-calculated for 2016-2017 to reflect updates to the MMP method in 2018.

	2020 Report Card							2019	2018	2017	2016
	MMP			QPSMP			Seagrass Index	Seagrass Index			
	Abundance	Reprod. Effort	Nutrient Status	Biomass	Area	Species Comp.					
Northern				72	80	74	**61**	52	25	58	42
Whitsunday	30	33	29				**35**	27	13	24	34
Central	53	6	48	76	84	92	**60**	52	45	30	50
Southern											

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

Note, to derive the seagrass index, an average of *site/meadow* scores (Appendix D.3) is calculated, not an average of indicators.

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 38).

Table 38. Confidence associated with seagrass index results in inshore zones for the 2020 Report Card. Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1-5 (very low – very high), which indicates 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
Reproductive Effort	3	3	1	3	2	8.8	3
Nutrient Status	3	3	1	3	2	8.8	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	**8.8**	**3**
Rank based on final score: 1 (very low): 4.5 – 6.3; 2 (low): >6.3 – 8.1; 3 (moderate): >8.1 – 9.9; 4 (high): >9.9 – 11.7; 5 (very high): >11.7 – 13.5							

4.4. Litter

A formal grade is given for litter for the first time in the 2020 Report Card. Data were sourced from the Australian Marine Debris Initiative (AMDI) Database. Scores were calculated based on a comparison of the data to a four-year baseline period from 2014-15 to 2017-18, representing the time before the Queensland Government state-wide management strategies were put in place (plastic bag ban began 1st July 2018 and the container refund scheme began 1st November 2018).

Tips for interpreting 2020 Report Card results:

- Scores are provided at the site level due to inconsistencies in sample sizes and sampling location across zones and years, and our 'very low' confidence in the results.

- ReefClean events are conducted quarterly, collecting standardised beach clean-up data. ReefClean data provide more reliable trends of litter levels change across the years compared to volunteer beach clean-up data which are non-standardised (i.e. individual volunteer effort cannot be accounted for).

- Litter score cut-off points are based on annual data distribution, and refer to a scale of 'very high pressure' to 'slight pressure'.

- Both inshore (coastal and island) and urban sites were cleaned in 2019-20. It is important to remember the potential differences in litter source and the frequency of clean-ups. Urban areas, for example, are much more likely to be cleaned regularly by the council and community.

- Mackay has a large number of gross pollutant traps (GPTs) installed around the city. It is therefore expected that the amount of litter reaching marine waters would be lower in that zone compared to other zones.

Results (Table 39):

Key Message:

1) Pioneer Bay in Airlie Beach was the poorest scoring site across the MWI Region, with a score of 20 ('high pressure'). This likely relates to the high levels of tourism and recreational use in the area and a low number of GPTs installed in urban areas.

- Scores ranged from 'high pressure' to 'slight pressure' across the MWI Region.

- Both the urban and inshore sites in the Whitsunday Zone showed more cases of 'high' and 'moderate pressure' than in the other zones.

- Sites in the Southern Zone were both scored as 'slight pressure' with a score of 99.

Table 39. Site-level litter scores across the MWI Region for the 2020 Report Card.

Zone	Site-type	Site	2020 Report Card Score
Northern	Inshore	Queens Beach, Bowen*	99
		Don River Mouth, Bowen*	95
Central	Urban	Mackay City Centre	80
		Mackay Industrial Precinct	98
		Sarina Townsite	51
		Pioneer River, Glenella Connection Road North Mackay*	76
	Inshore	Town Beach, Mackay*	56
		Conway Beach*	96
		Harbour Beach, Mackay*	99
		Half Tide Beach, Hay Point*	33
		Lamberts Beach, Mackay	94
		Wilson Beach, Conway*	100
		Louisa Creek Beach, Hay Point*	98
		Armstrong Beach*	81
Whitsunday	Urban	Proserpine Town*	47
	Inshore	Turtle Bay, Whitsunday Island*	80
		Saba Bay, Hook Island*	25
		South East Bay, Long Island*	87
		Border Island	86
		Coral Beach, Airlie Beach*	66
		Mackerel Bay, Hook Island*	70
		South End of Runway, Hamilton Island	59
		Georges Point	28
		Eagle Bay, Shaw Island	71

Table 39. Site-level litter scores across the MWI Region for the 2020 Report Card.

Zone	Site-type	Site	2020 Report Card Score
		Solway Circuit, Whitsunday Island	76
		Hook Island, East	53
		Bluff Point North East Side, Pioneer Bay*	20
		Turtle Bay, South Molle Island*	52
		Luncheon Bay, Hook Island*	97
		Southern Tip, Whitsunday Island*	35
		Dingo Beach*	84
Central	Urban	Mackay City Centre	80
		Mackay Industrial Precinct	98
		Sarina Townsite	51
		Pioneer River, Glenella Connection Road North Mackay*	76
	Inshore	Town Beach, Mackay*	56
		Conway Beach*	96
		Harbour Beach, Mackay*	99
		Half Tide Beach, Hay Point*	33
		Lamberts Beach, Mackay	94
		Wilson Beach, Conway*	100
		Louisa Creek Beach, Hay Point*	98
		Armstrong Beach*	81
Southern	Inshore	Avoid Island, The Percy Group	99
		Clairview Beach North*	99

Scoring range: Very High Pressure = 0 to 5 | High Pressure = >5 to 36 | Moderate Pressure = >36 to 65 | Low Pressure = >65 to 95 | Slight Pressure = >95 | No score/data gap (note, scoring range cut-offs are dependent on annual data distribution).
ReefClean sites are marked with an asterisk (*).

4.4.1. Confidence

Data for the litter index are sourced from citizen scientists, introducing potential issues with data recording and input into the AMDI Database. Confidence for the litter index is therefore 'very low' (Table 40).

Table 40. Confidence associated with litter index results in inshore zones for the 2020 Report Card. Confidence criteria are scored 1-3 and then weighted by the value identified in parenthesis. Final scores (4.5 – 13.5) are additive across weighted confidence criteria. Final scores correspond to a rank from 1-5 (very low – very high), which indicates the final confidence level. Unless otherwise specified, confidence in results is the same across inshore zones where relevant.

Indicator Category	Maturity of Methodology (x0.36)	Validation (x0.71)	Representativeness (x2)	Directness (x0.71)	Measured Error (x0.71)	Final Score	Rank
Litter	1	1	1	3	1	**5.9**	**1**

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.

4.5. Fish Index

There is no score for marine fish condition for the 2020 Report Card. Identification of appropriate indicators and methodology development is required for progressing fish assessment indicators in

inshore and offshore zones. Potential 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.

4.6. Overall Marine Zone Condition

Results (Table 41)**:**

Key Messages:

1) The largest score improvement was in the Whitsunday Zone, moving from 25 in 2018-19 to 34 in 2019-20. This did not, however result in a grade change, remaining at 'D' ('poor') for the fourth consecutive year. The score increase was primarily driven by an improvement in water quality, likely due to below average rainfall across the region and subsequently lower freshwater discharge into the Whitsunday inshore marine environment.

2) The Central Zone improved in overall condition grade from 'D' ('poor') in the 2019 Report Card to 'C' ('moderate') this year. This change was driven by small score improvements in the coral and seagrass indices, but will require a longer-term trend before reliable inferences can be made.

- The overall condition grades for inshore zones in the 2020 Report Card ranged from 'D' (poor) to 'C' (moderate). In contrast, the Offshore Zone remained as a 'B' (good) for the seventh consecutive year (Table 41).

- Index grades for the Offshore Zone remained stable for the seventh consecutive year, suggesting that this zone is subject to less environmental variability and anthropogenic influence than the inshore zones.

- The partnership-funded Southern Inshore Monitoring Program is now well-established, with water quality (including pesticides) and coral indicators now reported on for multiple years. Seagrass condition scores are expected to be reported in the 2021 Report Card (released in 2022) after sufficient baseline data has been collected.

Table 41. Overall inshore and offshore marine scores for the 2019-20 reporting year, compared to 2016 - 2019 Report Cards.

		2020 Report Card						2019	2018	2017*	2016
		Water Quality	Coral	Seagrass	Fish	Total Score and Grade		Total Score			
Inshore	Northern	54	28	61		**47**	**C**	43	35	44	43
	Whitsunday	42	28	35		**34**	**D**	25	27	27	47
	Central	39	28	60		**42**	**C**	36	37	31	41
	Southern	43	21			**32**	**D**	34	22		
Offshore		99	55			**77**	**B**	77	77	76	77**

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 overall marine score results were back-calculated to incorporate pesticide and seagrass method changes that were applied in the 2018 Report Card.

**Offshore coral scores have been amended due to error in methods.

Prior to the 2020 Report Card, Reef Check Australia (RCA) coral cover data were not included in the calculation of the total marine zone scores.

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Waterhouse, K., Longborg, C., Logan, M., Petus, C., Tracey, D., Lewis, S., Howely, C., Harper, E., Tonon, H., Skuza, M., Doyle, J., Costello, P., Davidson, J., Gunn, K., Wright, M., Zagorskis, I., Kroon, F., & Gruber, R. (2018). *Marine Monitoring Program: Annual report for inshore water quality monitoring 2016-17. Report for the Great Barrier Reef Marine Park Authority*.

6. Appendices

Appendix A – Annual Rainfall

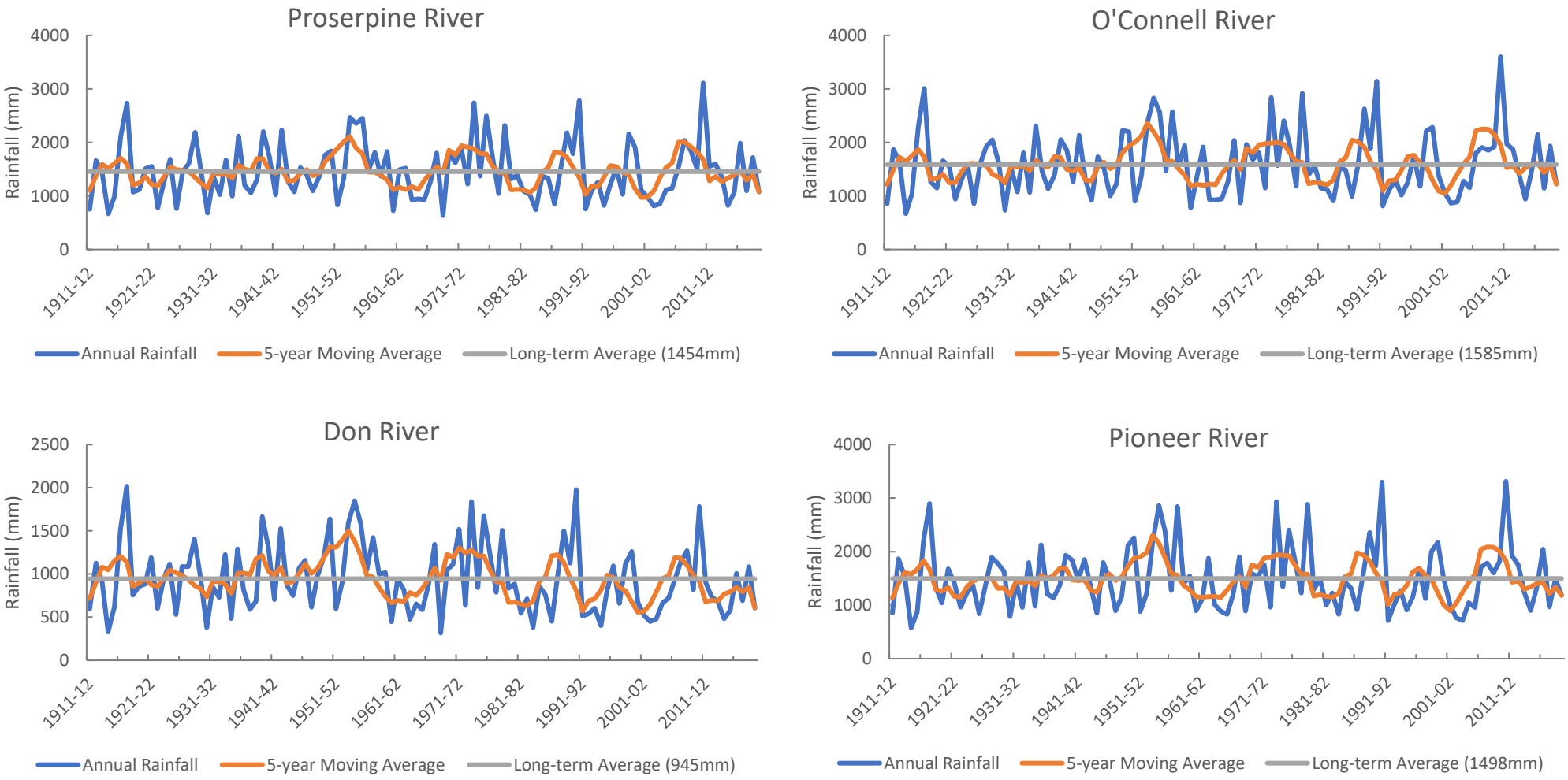

Figure A1. Annual rainfall totals (FY), five-year moving average of totals and long-term annual rainfall average (1911-12 to 2019-20) for the Don, Proserpine, O'Connell, Plane and Pioneer basins in the MWI Region. Long-term annual rainfall data sourced from BoM and calculated using results from 1911-2020, inclusive.

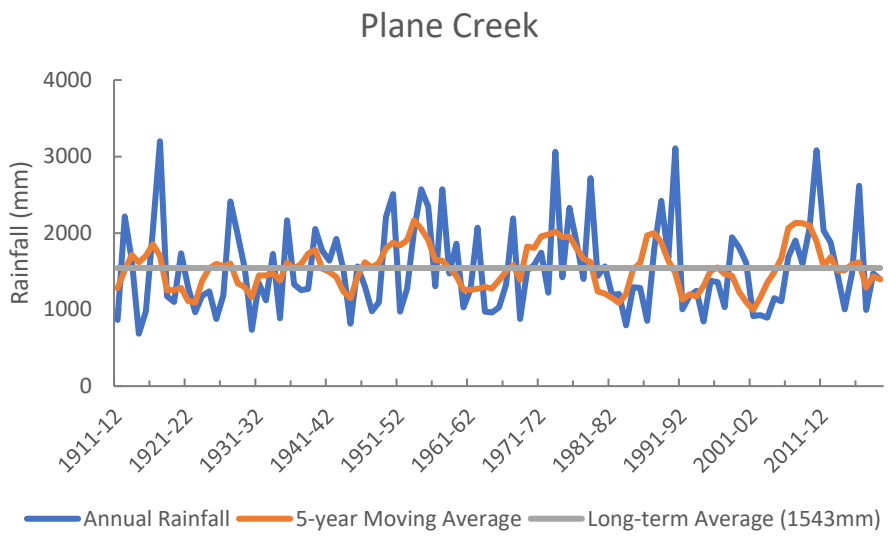

Figure A1 continued. Annual rainfall totals (FY), five-year moving average of totals and long-term annual rainfall average (1911-12 to 2019-20) for the Don, Proserpine, O'Connell, Plane and Pioneer basins in the MWI Region. Long-term annual rainfall data sourced from BoM and calculated using results from 1911-2020, inclusive.

Appendix B – Freshwater Environment

Appendix B.1 – Basins – Summary Statistics and Boxplots

Table B1. Summary statistics for monitored water quality in the MWI basin reporting areas, from July 2019 to June 2020. Summary statistics are presented to three significant figures. Presented alongside summary statistics are relevant guideline values and the adopted statistic for comparison. In the estuaries, the 50th percentile (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 (mg/L)
Don River at Bowen	TSS	35	126	3	83	163	188	213	Median	5
	DIN	35	0.15	0.13	0.13	0.14	0.16	0.18	Median	0.03
	FRP	35	0.079	0.025	0.052	0.080	0.107	0.134	Median	0.045
Proserpine River at Glen Isla	TSS	68	149	17	104	138	191	458	Median	5
	DIN	68	0.42	0.00	0.14	0.23	0.39	2.07	Median	0.03
	FRP	68	0.087	0.032	0.058	0.076	0.114	0.166	Median	0.025
O'Connell River at Caravan Park	TSS	54	19	4	5	7	31	50	Median	2
	DIN	54	0.08	0.00	0.05	0.05	0.11	0.42	Median	0.03
	FRP	54	0.010	0.001	0.002	0.005	0.016	0.032	Median	0.006
O'Connell River at Stafford's Crossing	TSS	66	23	1	2	6	51	92	Median	2
	DIN	66	0.10	0.00	0.01	0.03	0.11	0.60	Median	0.03
	FRP	66	0.011	0.001	0.004	0.005	0.024	0.028	Median	0.006
Pioneer River at Dumbleton Weir	TSS	79	9	1	3	6	10	29	Median	5
	DIN	79	0.152	0.002	0.080	0.144	0.246	0.444	Median	0.008
	FRP	102	0.014	0.001	0.003	0.006	0.026	0.049	Median	0.005
Plane Creek at Surcogen Weir	TSS	60	30	4	4	8	27	37	Median	3
	DIN	60	0.694	0.002	0.005	0.012	0.068	0.187	Median	0.008
	FRP	60	0.056	0.001	0.003	0.005	0.052	0.124	Median	0.008
Sandy Creek at Homebush	TSS	108	14	2	3	10	54	110	Median	5
	DIN	108	0.05	0.04	0.18	0.58	1.08	2.56	Median	0.03
	FRP	108	0.029	0.001	0.009	0.018	0.126	0.162	Median	0.015

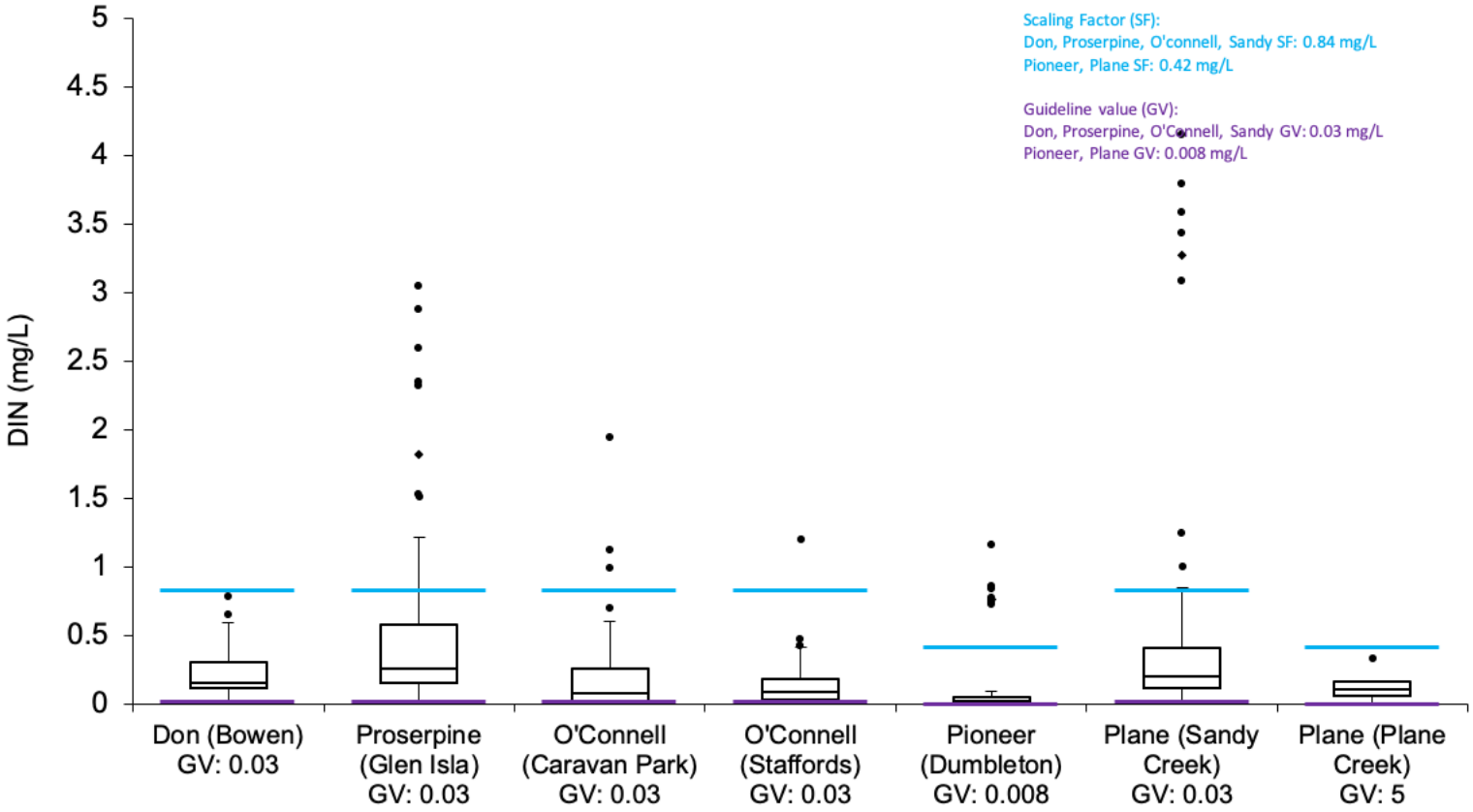

Figure B1. Box and whisker plot (box showing 20th, 50th and 80th percentiles, whiskers 1.5 x interquartile range [IQR]) of sample DIN concentrations in the MWI basins. Scaling factors (SF) and guideline values (GV) are provided for each basin, where information is available. Outliers (>1.5 x IQR) are also pictured.

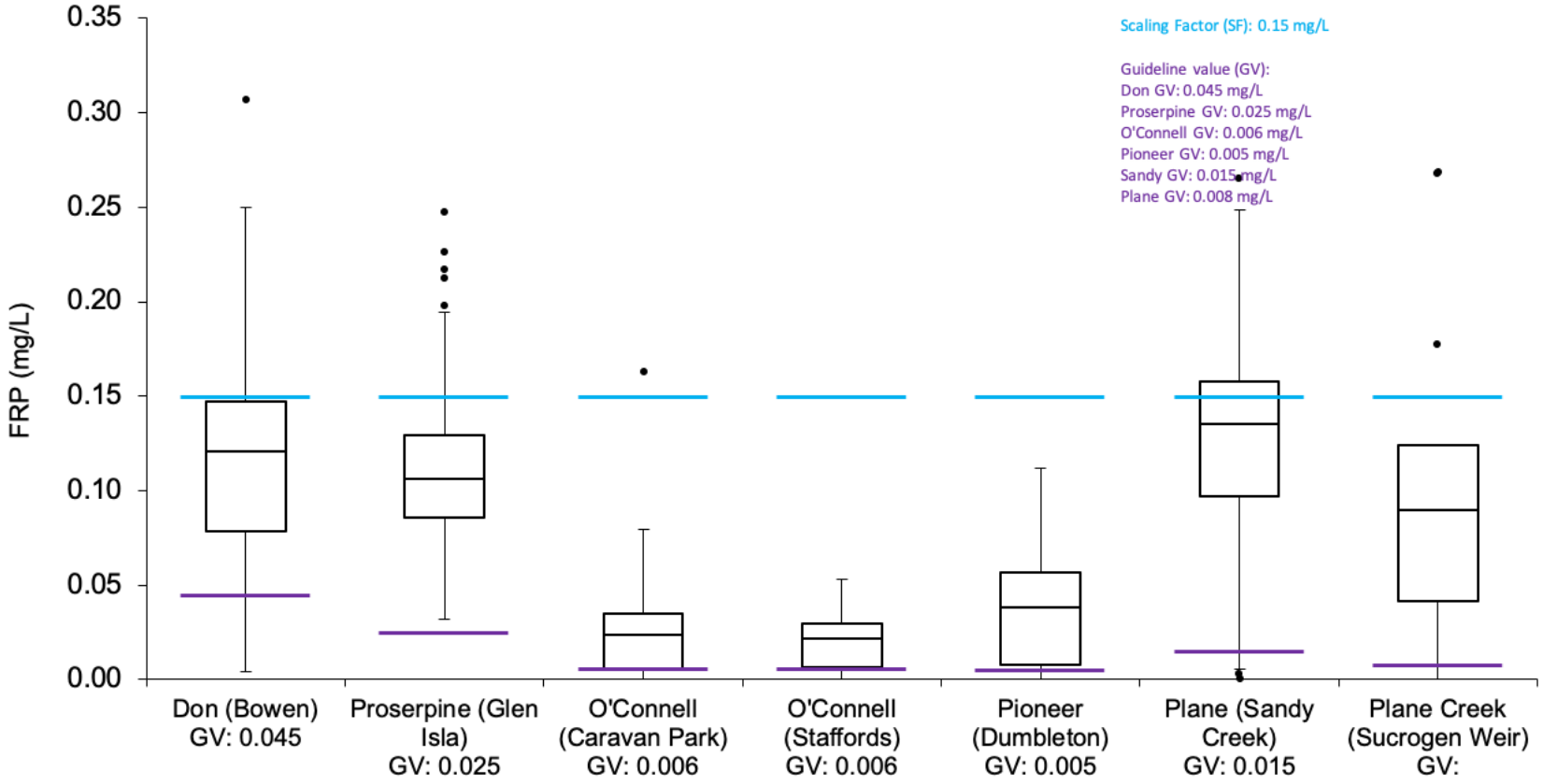

Figure B2. Box and whisker plot (box showing 20th, 50th and 80th percentiles, whiskers 1.5 x Interquartile range [IQR]) of sample FRP concentrations in the MWI basins. Scaling factors (SF) and guideline values (GV) are provided for each basin, where information is available. Outliers (>1.5 x IQR) are also pictured.

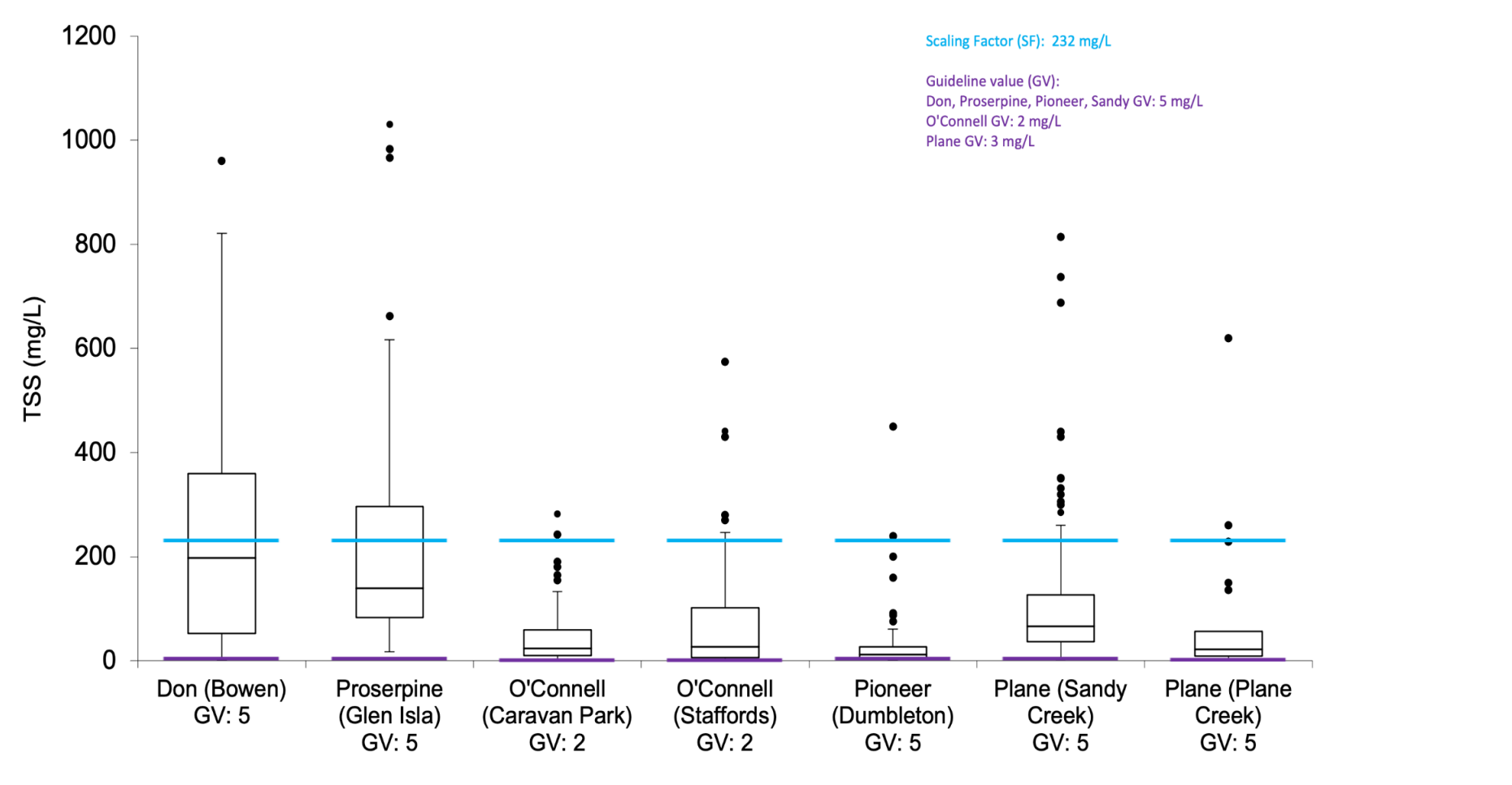

Figure B3. Box and whisker plot (box showing 20th, 50th and 80th percentiles, whiskers 1.5 x Interquartile range [IQR]) of sample TSS concentrations in the MWI basins. Scaling factors (SF) and guideline values (GV) are provided for each basin, where information is available. Outliers (>1.5 x IQR) are also pictured.

Appendix B.2 – Basins – Freshwater Flow Indicator Tool Scores and Hydrographs

Table B2. Flow measure scores and summary scores for freshwater flow across the MWI Region, weighted by catchment area for the 2019-20 reporting year. Flow measures are scored between 1-5 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																			**49.6**	**Dry**
CattleCk@Gargett	125004B	1.0	5	5	4	4	3	3	4	5	5	5	4.0	61	326	326	0.15	8.9		
BlacksCk@Whitefords	125005A	0.9	2	2	5	5	4	5	5	2	5	5	3.4	49	509	702	0.32	15.5		
FinchHattonCk@GorgeRd	125006A	1.5	4	5	5	5	4	1	4	4	5	5	4.0	61	35	35	0.02	1.0		
PioneerR@MiraniWeirTW	125007A	1.0	4	4	5	5	4	4	5	4	5	5	4.0	61	1211	885	0.40	24.3		
PioneerR@DumbletonWeirTW	125016A	0.9	1	1	1	5	4	1	4	4	5	5	1.0	0	1488	277	0.12	0.0		
Plane Basin																			**43.0**	**Average**
SandyCreek@Homebush	126001A	0.7	5	5	1	4	1	5	1	5	5	5	3.1	43	326	326	1.00	43.0		

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

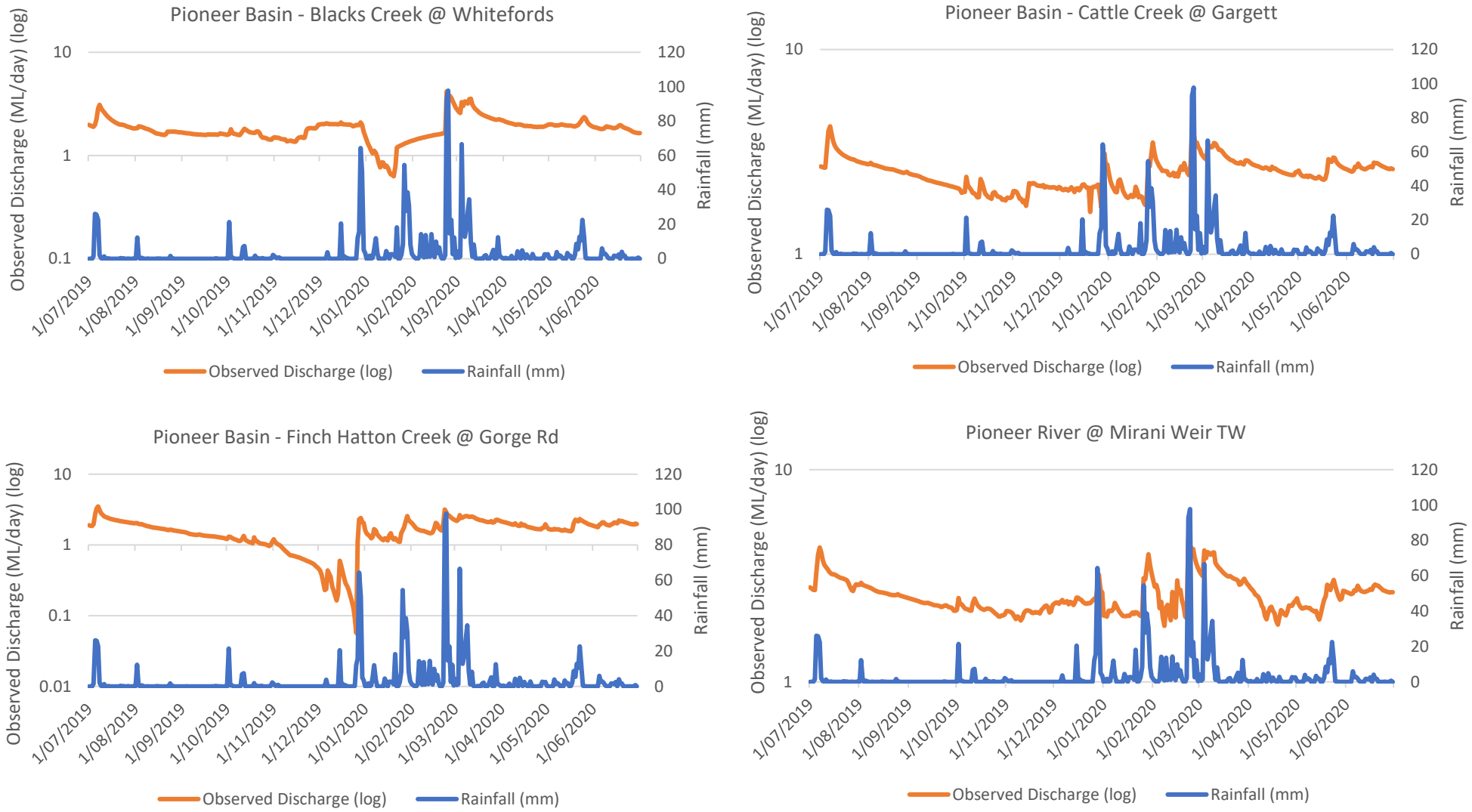

Figure B4. Hydrographs for gauging stations in the Pioneer and Plane basins. Observed discharge (ML/day) is plotted on a log scale, against rainfall (mm) over the 2019-20 reporting year. Data gaps represent periods of no flow, not missing data.

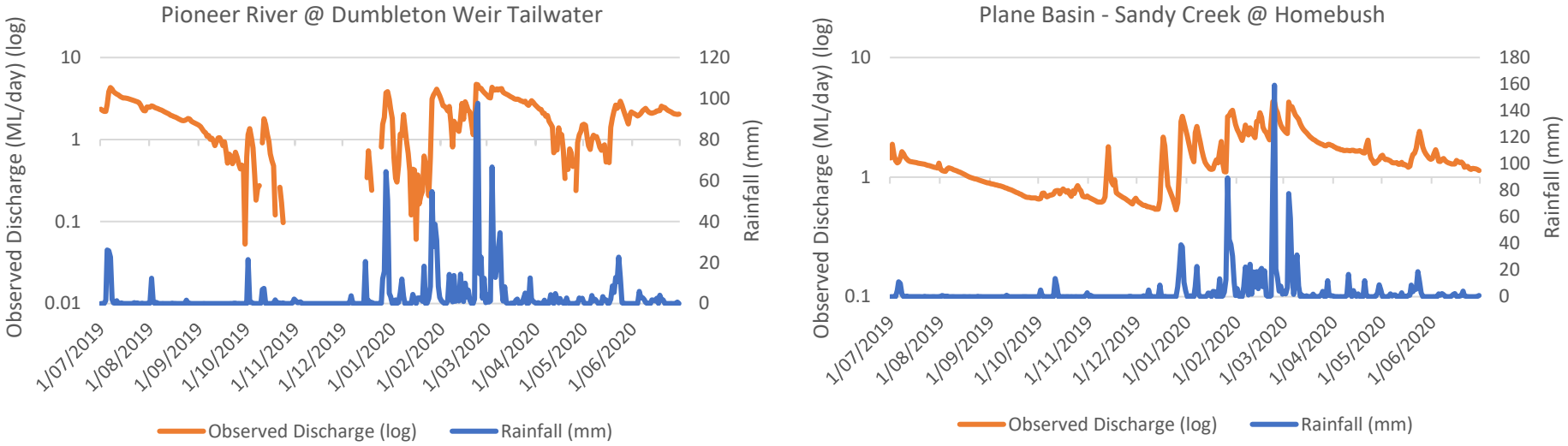

Figure B4 continued. Hydrographs for gauging stations in the Pioneer and Plane basins. Observed discharge (ML/day) is plotted on a log scale, against rainfall (mm) over the 2019-20 reporting year. Data gaps represent periods of no flow, not missing data.

Appendix B.3 – Assessing Multiple Freshwater Monitoring Sites & Individual Indicators

Assessing Multiple Freshwater Monitoring Sites:

Based on the recommendation provided by the TWG in March 2019, data collected from multiple independent monitoring sites are to be aggregated using a weighted average, based on the relative catchment area upstream of each sampling site. In the MWI Region, two such instances occur; two monitoring stations are located along the O'Connell River within the O'Connell Basin and two monitoring stations are located within the Plane Basin, with one site situated on the Plane River and one on Sandy Creek.

Methods of calculation are presented in Table B3-B6 below for DIN, FRP, TSS and pesticides, respectively. For further information on assessing multiple freshwater monitoring sites, email info@healthyriverstoreef.org.au. The scores for each site for the O'Connell and Plane basins in the 2020 Report Card are shown below.

Table B3. Calculation of proportional contribution to scores for multiple monitoring sites within the O'Connell Basin for the 2019 Report Card, 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 Staffords	342	342	0.41
Total area measured		**825**	

Table B4. Calculation of weighted site-level scores and total scores (sum of the weighted site-level scores) for DIN, FRP, TSS and Pesticide indicators.

Site (O'Connell Basin)	DIN	FRP	TSS	Pesticides (PRM)
Caravan Park standard score	60.0	62.3	58.8	10.0
Caravan Park x weighting	**35.1**	**36.5**	**34.4**	**6.0**
Staffords standard score	62.3	62.5	60.4	8.0
Staffords x weighting	**25.8**	**25.9**	**25.0**	**3.2**
TOTAL (sum of weighted scores)	**61.0**	**62.4**	**59.4**	**9.2 (score = 45)**

Table B5. 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 (km²)	Adjusted catchment area (km²)	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**	

Table B6. Calculation of weighted site-level scores and total scores (sum of the weighted site-level scores) for DIN, FRP, TSS and pesticide indicators.

Site (Plane Basin)	DIN	FRP	TSS	Pesticide risk (PRM)
Sandy Creek standard score	32.9	55.9	59.7	33.4
Sandy Creek x weighting	**25.8**	**43.8**	**46.8**	**26.2**
Plane Creek standard score	59.3	60.3	59.4	5.8
Plane Creek x weighting	**12.8**	**13.0**	**12.9**	**1.3**
TOTAL (sum of weighted scores)	**38.6**	**56.9**	**59.6**	**27.4 (score = 19)**

Individual Water Quality Indicator Tables:

Indicators are aggregated to form *indicator categories*, which are in turn used to create overall water quality grades for each waterway. For concision and consistency, some indicator scores and grades are not displayed next to relevant grades from previous years on their own, instead being aggregated first into an indicator category and then displayed. Those indicators have been listed in the tables below with previous years' grades for comparison.

Table B7. DIN indicator scores within freshwater basins for the 2020 Report Card, compared to 2016 – 2019 reporting years.

	2020 Report Card		2019	2018	2017	2016
Basin	DIN		DIN			
Don	52		58	55	42	
Proserpine*						
O'Connell	60		56	59	60	61
Pioneer	41		33	46	35	46
Plane	38		41	23	30	44

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

Table B8. FRP indicator scores within freshwater basins for the 2020 Report Card, compared to 2016 – 2019 reporting years.

Basin	2020 Report Card FRP	2019 FRP	2018 FRP	2017 FRP	2016 FRP
Don	40	74	69	24	
Proserpine*					
O'Connell	62	59	59	60	59
Pioneer	60	60	61	55	57
Plane	56	34	25	17	34

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

*Water quality data (excluding pesticides) was not available in the Proserpine Basin. See the 2020 Methods Report[2] for more information.

Appendix B.4 – Site-level Scores for Additional Freshwater Basin Sites

Additional sites in the O'Connell and Plane basins were included into the MWI Report Card calculations for the third consecutive year. Site-level scores are presented in Tables B9, B10 and B11 below.

Table B9. Results for the sediment indicator category (based on a measure of TSS) for sites in the O'Connell and Plane basins for the 2020 Report Card (2019-20 data), compared to 2019 and 2018.

Freshwater Basin	Sediment		
	2020	2019	2018
O'Connell Basin			
O'Connell River (Caravan Park)	58	58	56
O'Connell River (Stafford's Crossing)	60	60	48
Plane Basin			
Plane (Sandy Creek)	59	55	54
Plane (Plane Creek)	59	56	58

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 B10. Results for the nutrients indicator category (based on a measure of DIN and FRP) for sites in O'Connell and Plane basins for water quality in freshwater basins for the 2020 Report Card (2019-20 data) compared to 2018 and 2019 scores.

Freshwater Basin	2020 Report Card		2019 Report Card		2018 Report Card	
	DIN	FRP	DIN	FRP	DIN	FRP
O'Connell Basin						
O'Connell River (Caravan Park)	60	62	55	58	59	59
O'Connell River (Staffords Crossing)	62	62	56	60	59	59
Plane Basin						
Plane (Sandy Creek)	32	55	37	29	12	15
Plane (Plane Creek)	59	60	52	53	61	61

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

Table B11. Results for the pesticides indicator (based on a measure of 22 pesticides) for sites in O'Connell and Plane basins for water quality in freshwater basins for the 2019 Report Card (2018-19 data) compared to 2018.

Freshwater Basin	2020 Report Card		2019	2018
	% Species Protected	Standardised Pesticide Score	Standardised Pesticide Score	
O'Connell Basin				
O'Connell River (Caravan Park)	92.3	50	50	59
O'Connell River (Staffords Crossing)	89.7	23	48	59
Plane Basin				
Plane (Sandy Creek)	66.6	17	17	15
Plane (Plane Creek)	93.8	58	55	61

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 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

Appendix B.5 – Basins – 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 B12, below. Notably, the back-calculated scores for 2013 are the same as those for the most recent 2019 assessment.

Table B12. 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.

Appendix C – Estuarine Environment

Appendix C.1 – Pesticide Study Sites in Detail

The number of samples used to derive the pesticide score has increased since measurements were last reported for this indicator in 2017. Historically, the pesticide monitoring program for estuaries was limited to monthly grab samples collected throughout the wet season period (six months), when runoff levels, which transport pesticides from land to the receiving waterway, are expected to be higher. For the 2019-20 reporting year, approximately three grab samples were collected per month; one via the existing ambient monitoring program and two via a supplementary monitoring program led by the Partnership. However, restrictions associated with the COVID-19 pandemic prevented two of these monthly samples from being collected between April to June 2020. The location of monitoring sites is outlined in further detail, below.

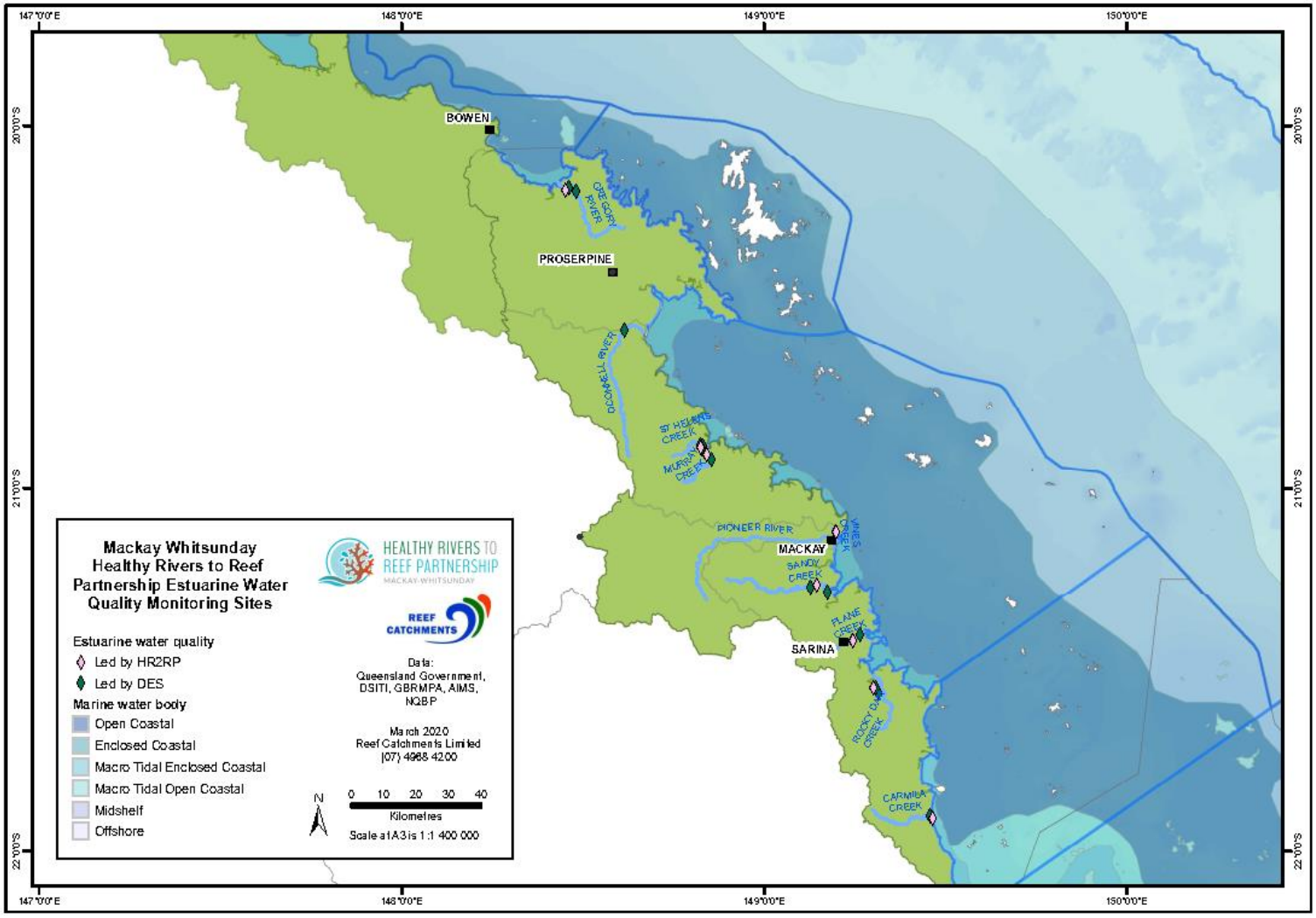

Figure C1. Locations of monitoring sites for estuarine water quality sampling, including DIN, FRP, turbidity, DO, chl-*a* and pesticides in the MWI Region. Black squares and circles indicate towns.

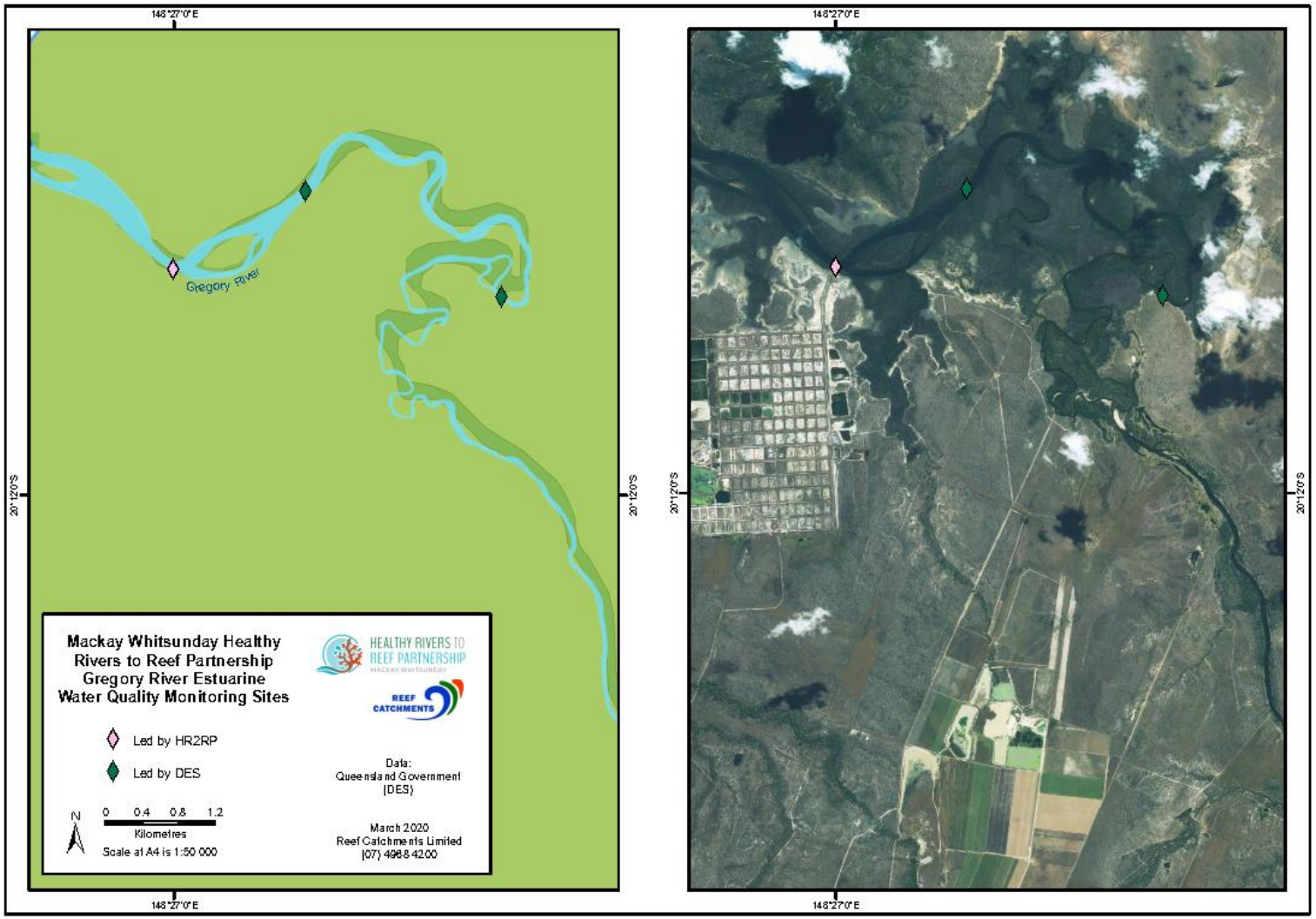

Figure C2. Locations of monitoring sites for estuarine sampling of pesticides in the Gregory River. Sites are overlaid on a reference map and a satellite map, respectively. The estuary mouth is located to the northwest, beyond the boundary of the map.

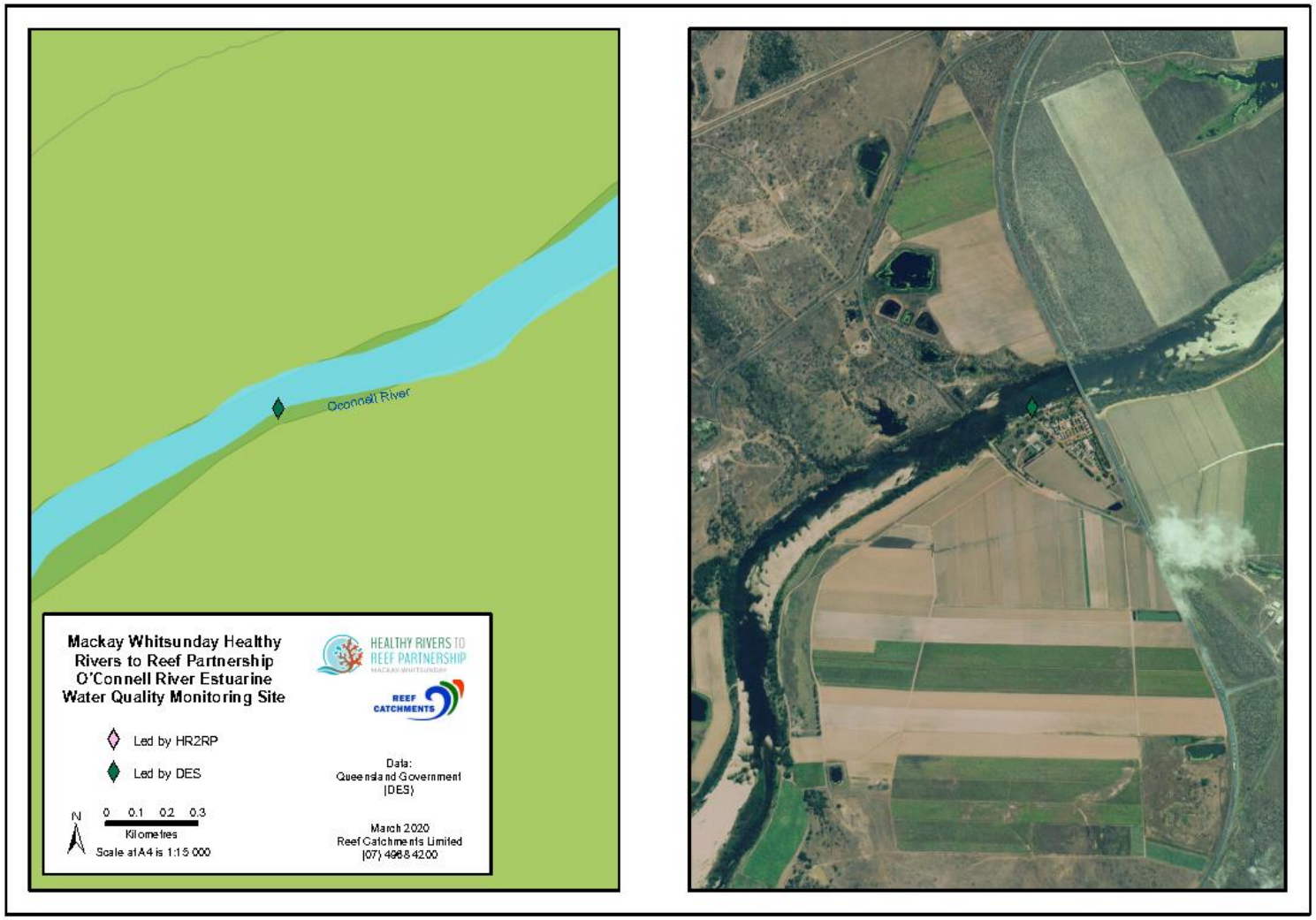

Figure C3. Locations of monitoring site(s) for estuarine sampling of pesticides in the O'Connell River. Sites are overlaid on a reference map and a satellite map, respectively. The estuary mouth is located approximately to the northeast, beyond the boundary of the map.

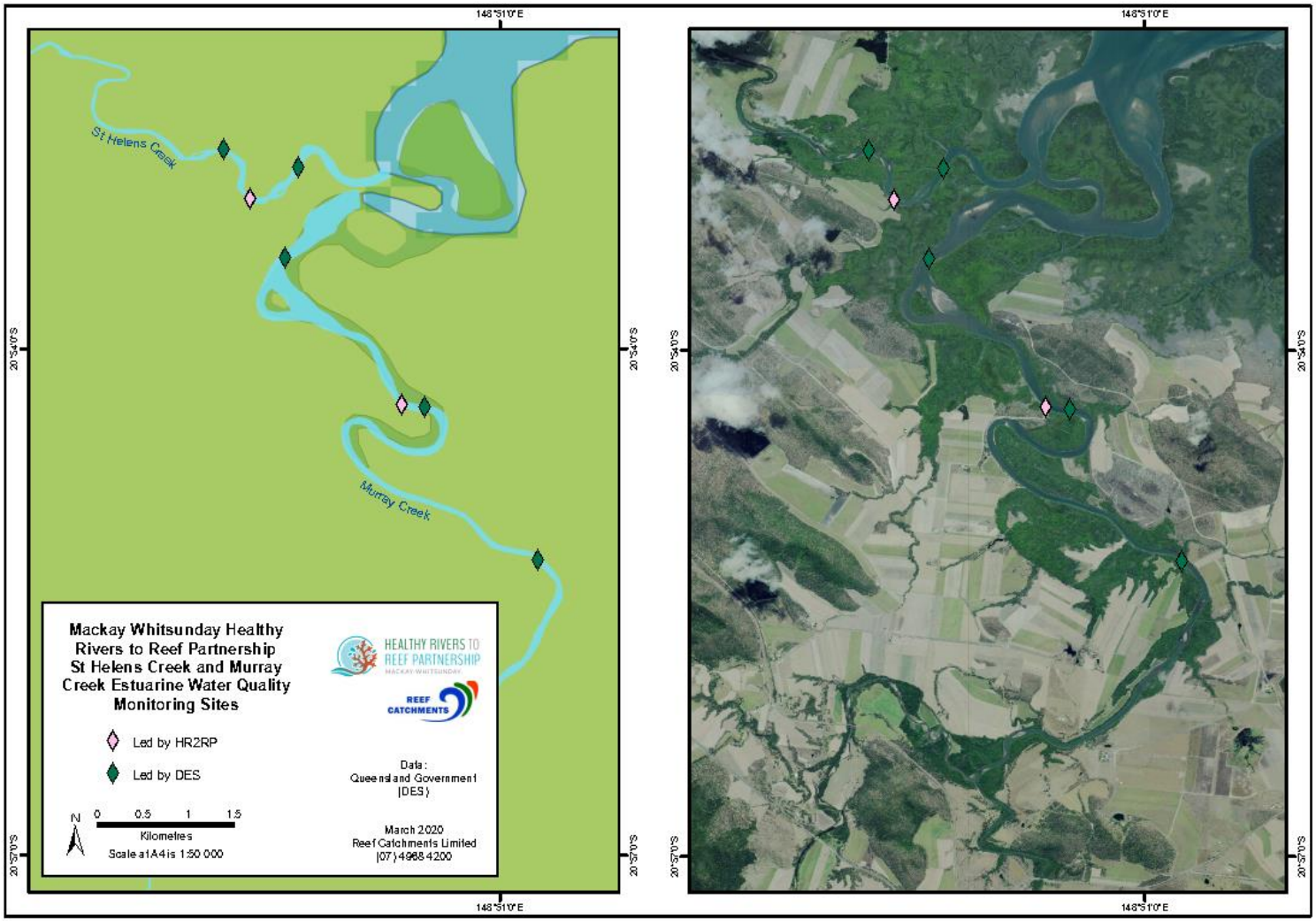

Figure C4. Locations of monitoring sites for estuarine sampling of pesticides in St Helens Creek/Murray Creek. Sites are overlaid on a reference map and a satellite map, respectively. The estuary mouth is located to the north, beyond the boundary of the map.

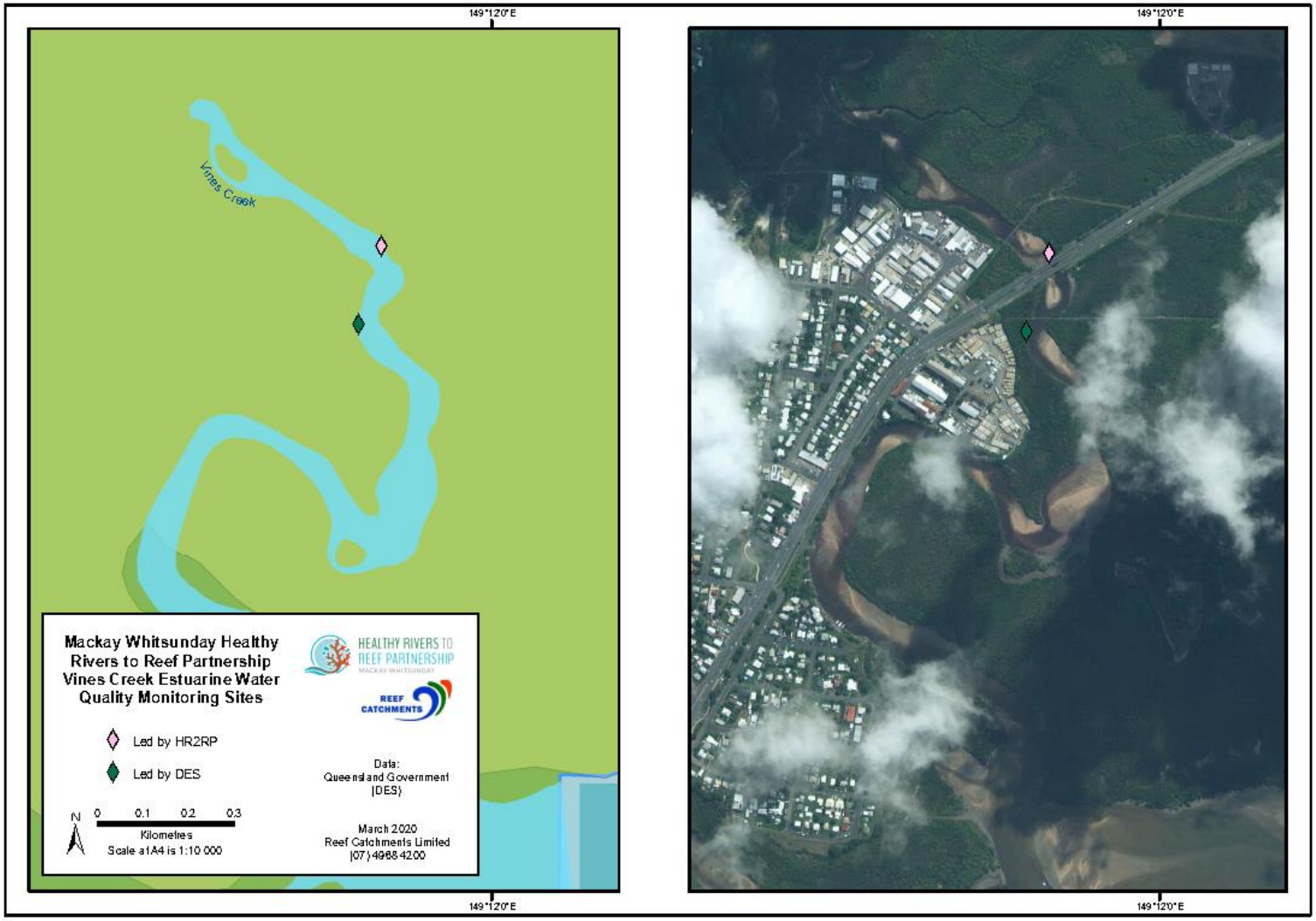

Figure C5. Locations of monitoring sites for estuarine sampling of pesticides in Vines Creek. Sites are overlaid on a reference map and a satellite map, respectively. The estuary mouth is located to the south, beyond the boundary of the map.

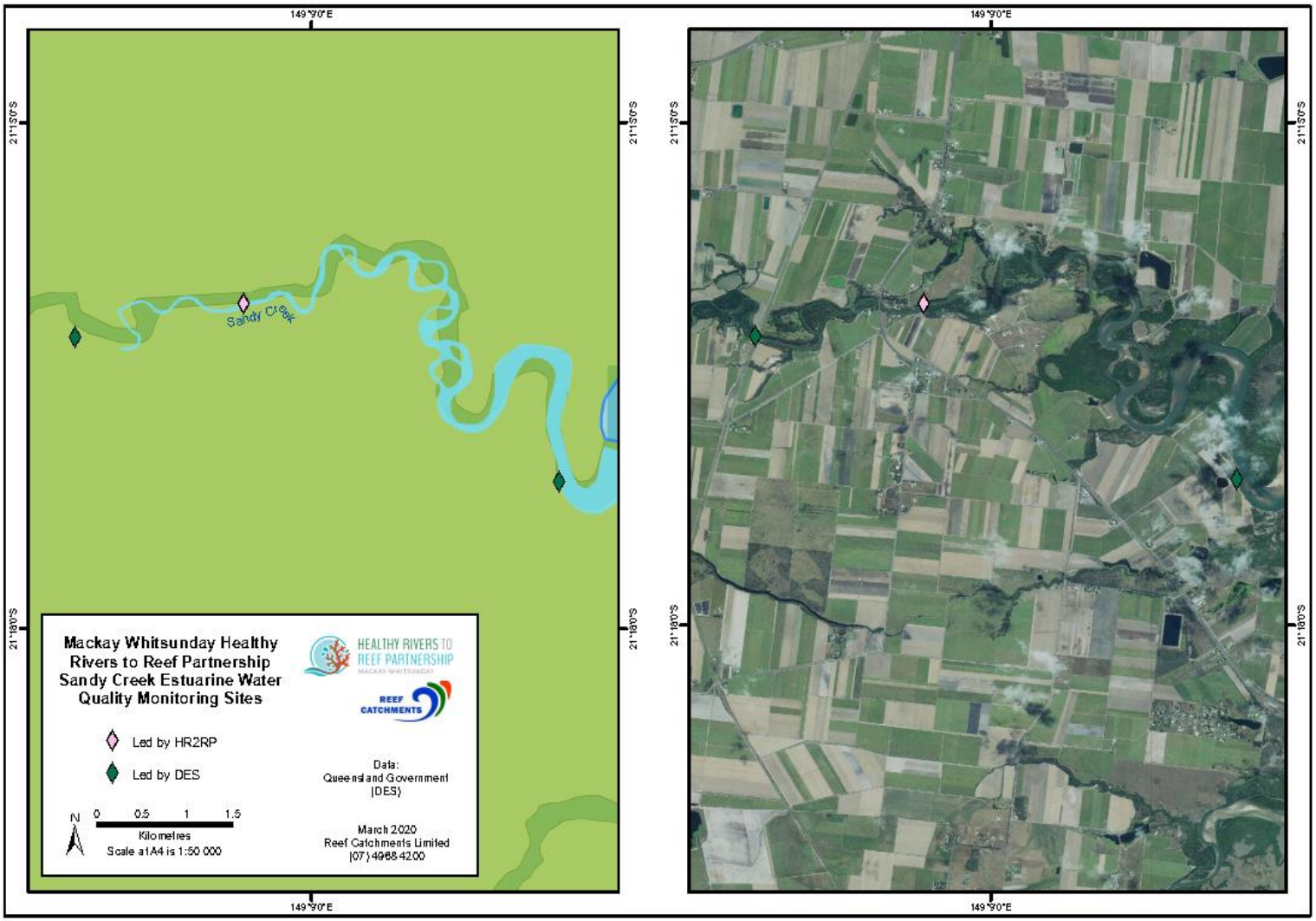

Figure C6. Locations of monitoring sites for estuarine sampling of pesticides in Sandy Creek. Sites are overlaid on a reference map and a satellite map, respectively. The estuary mouth is located to the east, beyond the boundary of the map.

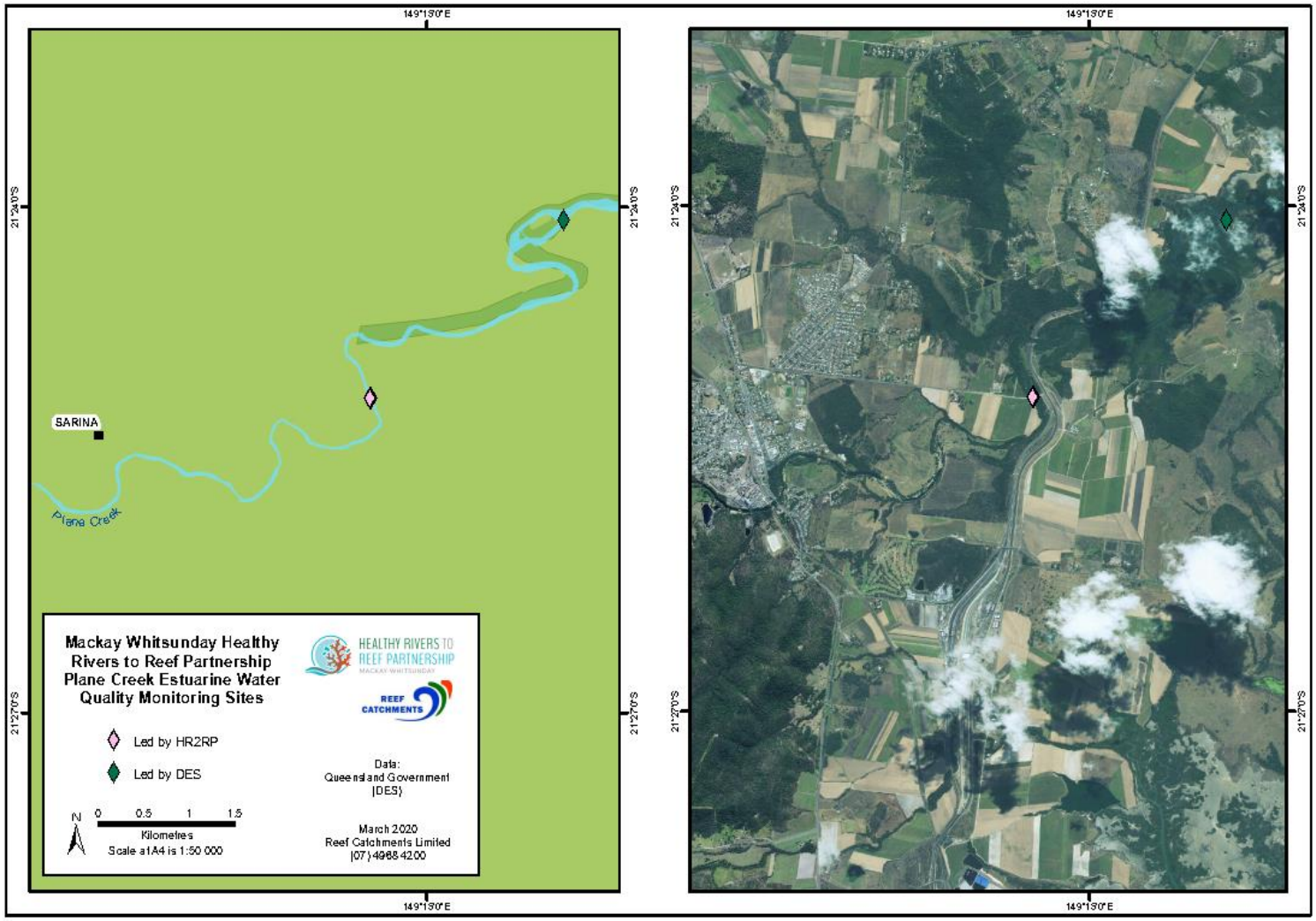

Figure C7. Locations of monitoring sites for estuarine sampling of pesticides in Plane Creek. Sites are overlaid on a reference map and a satellite map, respectively. The estuary mouth is located to the northeast, beyond the boundary of the map.

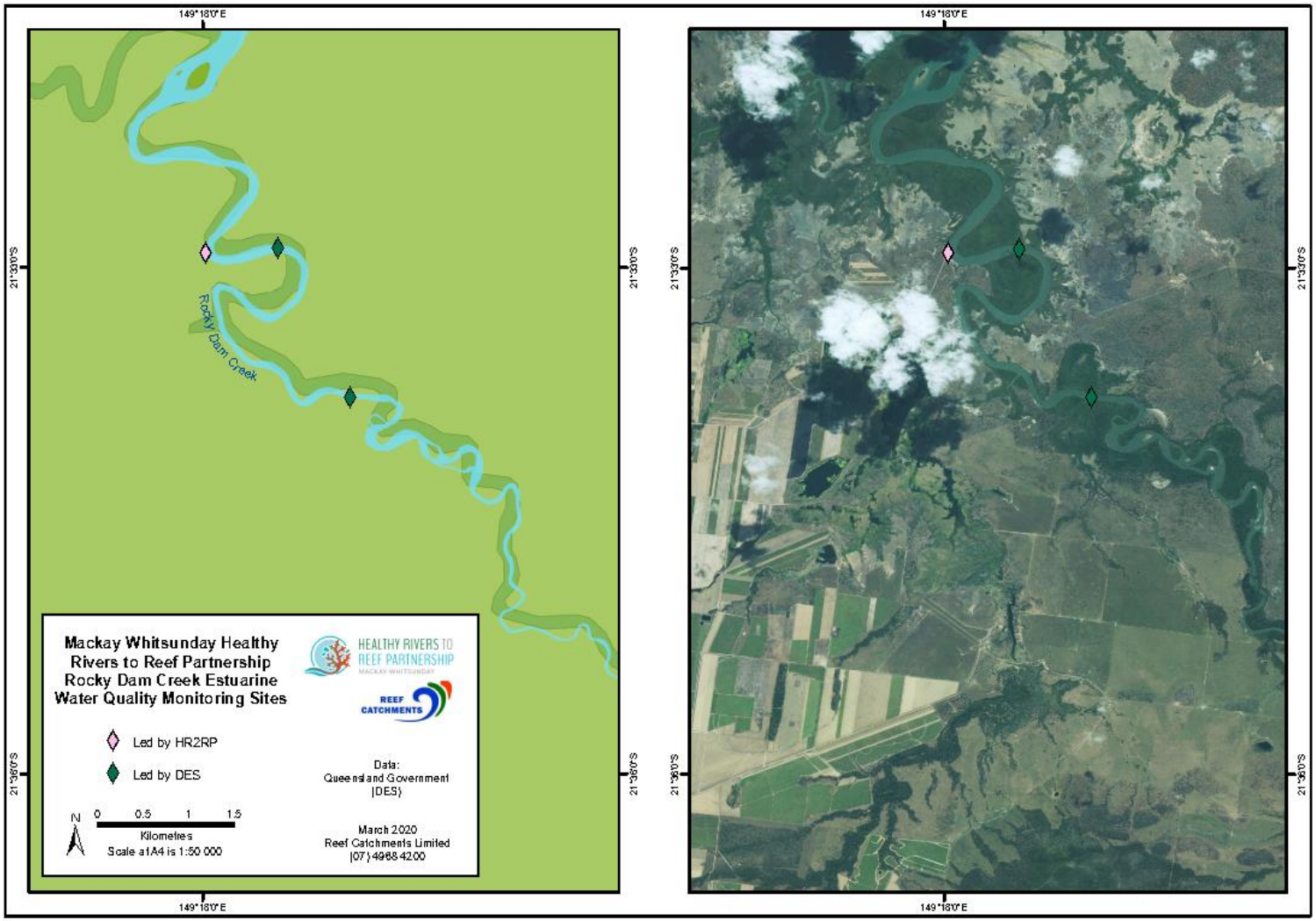

Figure C8. Locations of monitoring sites for estuarine sampling of pesticides in Rocky Dam Creek. Sites are overlaid on a reference map and a satellite map, respectively. The estuary mouth is located to the northwest, beyond the boundary of the map.

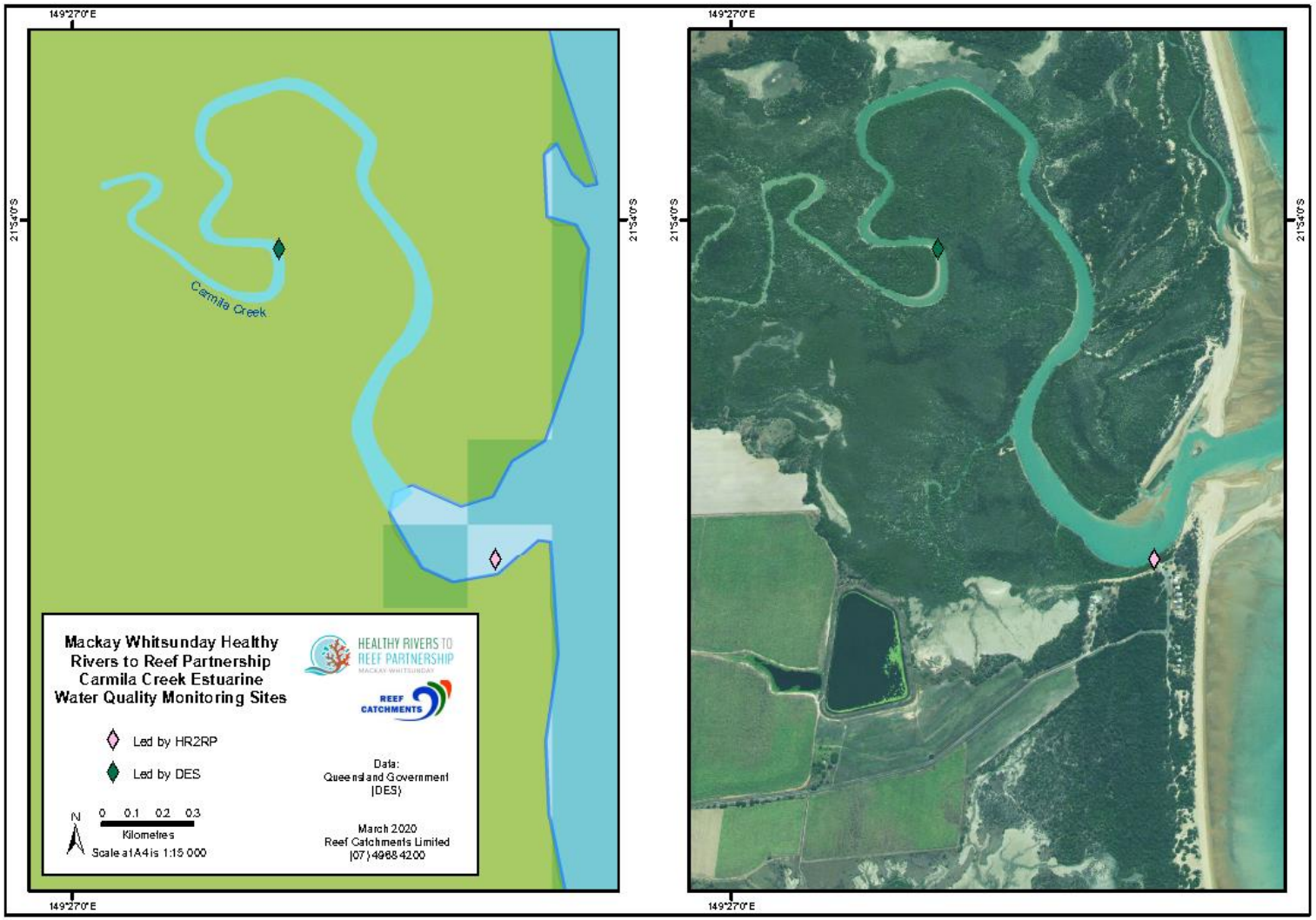

Figure C9. Locations of monitoring sites for estuarine sampling of pesticides in Carmila Creek. Sites are overlaid on a reference map and a satellite map, respectively. The estuary mouth is located to the east, as shown.

Appendix C.2 – Estuaries – Summary Statistics, Boxplots, and Individual Indicator Tables

Table C1. Summary statistics for monitored water quality in the MWI estuary reporting areas, from July 2019 to June 2020. Summary statistics are presented to three decimal places. Presented alongside summary statistics are guideline values, which represent the adopted statistic for comparison. In the estuaries, the 50th percentile (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 5.1 km from mouth	Chl-*a*	9	1	1	1	1	2	4	Median	2 µg/L
	DIN	10	0.016	0.004	0.004	0.000	0.011	0.068	Median	0.018 mg/L
	FRP	10	0.01	0.00	0.01	0.01	0.02	0.04	Median	0.03 mg/L
	Turbidity	10	4	1	1	3	3	24	Median	10 mg/L
	DO	10	76	57	67	80	82	87	Median	70-105 %
Gregory River 9.9 km from mouth	Chl-*a*	9	1	0	1	1	2	3	Median	2 µg/L
	DIN	9	0.046	0.005	0.010	0.010	0.100	0.142	Median	0.018 mg/L
	FRP	9	0.02	0.01	0.02	0.02	0.03	0.04	Median	0.03 mg/L
	Turbidity	9	5	2	3	4	6	14	Median	10 mg/L
	DO	9	77	51	72	83	85	93	Median	70-105 %
O'Connell River 7.5 km from mouth	Chl-*a*	9	5	1	2	3	5	18	Median	2 µg/L
	DIN	9	0.100	0.003	0.004	0.060	0.120	0.420	Median	0.018 mg/L
	FRP	9	0.01	0.00	0.01	0.01	0.02	0.03	Median	0.03 mg/L

Table C1. Summary statistics for monitored water quality in the MWI estuary reporting areas, from July 2019 to June 2020. Summary statistics are presented to three decimal places. Presented alongside summary statistics are guideline values, which represent the adopted statistic for comparison. In the estuaries, the 50th percentile (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
	Turbidity	9	6	2	3	5	7	10	Median	10 mg/L
	DO	9	112	102	108	110	114	131	Median	70-105 %
St Helens Creek 7.5 km from mouth	Chl-*a*	0	NA	NA	NA	NA	NA	NA	Median	2 µg/L
	DIN	0	NA	NA	NA	NA	NA	NA	Median	0.018 mg/L
	FRP	0	NA	NA	NA	NA	NA	NA	Median	0.03 mg/L
	Turbidity	9	9	5	7	8	11	11	Median	10 mg/L
	DO	9	89	60	86	93	99	101	Median	70-105 %
St Helens Creek 8.9km from mouth	Chl-*a*	9	2	1	1	2	3	5	Median	2 µg/L
	DIN	9	0.066	0.012	0.020	0.064	0.085	0.179	Median	0.018 mg/L
	FRP	9	0.01	0.01	0.01	0.01	0.01	0.01	Median	0.03 mg/L
	Turbidity	9	9	7	8	8	10	11	Median	10 mg/L
	DO	9	92	62	89	96	102	104	Median	70-105 %
Murray Creek 10.0 km from mouth	Chl-*a*	0	NA	NA	NA	NA	NA	NA	Median	2 µg/L
	DIN	0	NA	NA	NA	NA	NA	NA	Median	0.018 mg/L
	FRP	0	NA	NA	NA	NA	NA	NA	Median	0.03 mg/L

Table C1. Summary statistics for monitored water quality in the MWI estuary reporting areas, from July 2019 to June 2020. Summary statistics are presented to three decimal places. Presented alongside summary statistics are guideline values, which represent the adopted statistic for comparison. In the estuaries, the 50th percentile (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
	Turbidity	9	7	1	3	7	9	14	Median	10 mg/L
	DO	9	87	50	82	85	100	108	Median	70-105 %
Murray Creek 12.5 km from mouth	Chl-*a*	9	3	1	1	3	5	7	Median	2 µg/L
	DIN	9	0.180	0.004	0.007	0.156	0.280	0.420	Median	0.018 mg/L
	FRP	9	0.02	0.00	0.00	0.03	0.03	0.04	Median	0.03 mg/L
	Turbidity	9	11	1	5	7	12	38	Median	10 mg/L
	DO	9	89	46	81	83	105	120	Median	70-105 %
Murray Creek 16.5 km from mouth	Chl-*a*	9	3	1	2	3	4	5	Median	2 µg/L
	DIN	9	0.170	0.004	0.011	0.170	0.233	1.533	Median	0.018 mg/L
	FRP	9	0.03	0.01	0.02	0.03	0.04	0.04	Median	0.03 mg/L
	Turbidity	9	14	2	2	16	17	33	Median	10 mg/L
	DO	9	86	51	82	88	95	107	Median	70-105 %
Vines Creek 2.0 km from mouth	Chl-*a*	9	2	1	2	2	3	6	Median	2 µg/L
	DIN	9	0.324	0.051	0.138	0.260	0.470	0.800	Median	0.018 mg/L
	FRP	9	0.01	0.00	0.01	0.01	0.02	0.03	Median	0.03 mg/L

Table C1. Summary statistics for monitored water quality in the MWI estuary reporting areas, from July 2019 to June 2020. Summary statistics are presented to three decimal places. Presented alongside summary statistics are guideline values, which represent the adopted statistic for comparison. In the estuaries, the 50th percentile (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
	Turbidity	9	7	2	4	6	7	19	Median	10 mg/L
	DO	9	91	67	83	88	98	135	Median	70-105 %
Sandy Creek 4.5 km from mouth	Chl-*a*	9	4	1	1	2	7	10	Median	5 µg/L
	DIN	9	0.044	0.004	0.004	0.007	0.054	0.244	Median	0.018 mg/L
	FRP	9	0.02	0.01	0.02	0.02	0.02	0.04	Median	0.06 mg/L
	Turbidity	9	16	3	6	11	18	41	Median	NA
	DO	9	89	73	86	87	90	111	Median	70-105%
Sandy Creek 13.5 km from mouth	Chl-*a*	9	9	0	3	7	12	26	Median	5 µg/L
	DIN	9	0.713	0.072	0.240	0.760	1.000	1.407	Median	0.018 mg/L
	FRP	9	0.08	0.01	0.04	0.05	0.09	0.16	Median	0.06 mg/L
	Turbidity	9	18	6	11	17	24	35	Median	NA
	DO	9	84	59	67	71	84	141	Median	70-105%
Plane Creek 6.0km from mouth	Chl-*a*	9	3	0	1	2	2	11	Median	5 µg/L
	DIN	9	0.006	0.004	0.004	0.004	0.004	0.016	Median	0.018 mg/L
	FRP	9	0.01	0.00	0.01	0.01	0.01	0.02	Median	0.06 mg/L

Table C1. Summary statistics for monitored water quality in the MWI estuary reporting areas, from July 2019 to June 2020. Summary statistics are presented to three decimal places. Presented alongside summary statistics are guideline values, which represent the adopted statistic for comparison. In the estuaries, the 50th percentile (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
	Turbidity	9	7	4	5	6	6	22	Median	NA
	DO	9	94	75	88	95	101	107	Median	70-105%
Plane Creek 9.0km from mouth	Chl-*a*	9	6	2	4	7	8	12	Median	5 µg/L
	DIN	9	0.048	0.004	0.008	0.028	0.063	0.153	Median	0.018 mg/L
	FRP	9	0.04	0.02	0.03	0.04	0.04	0.08	Median	0.06 mg/L
	Turbidity	9	8	2	4	7	9	69	Median	NA
	DO	9	105	67	96	108	113	140	Median	70-105%
Rocky Dam Creek 8.9km from mouth	Chl-*a*	9	6	1	3	4	7	55	Median	5 µg/L
	DIN	9	0.177	0.004	0.026	0.105	0.166	0.703	Median	0.018 mg/L
	FRP	9	0.04	0.02	0.03	0.03	0.04	0.06	Median	0.06 mg/L
	Turbidity	9	82	18	28	36	135	265	Median	NA
	DO	9	89	60	92	95	97	102	Median	70-105%
Rocky Dam Creek 12.9km from mouth	Chl-*a*	9	6	2	3	5	9	14	Median	5 µg/L
	DIN	9	0.150	0.004	0.024	0.081	0.165	0.664	Median	0.018 mg/L
	FRP	9	0.03	0.01	0.02	0.03	0.04	0.04	Median	0.06 mg/L

Table C1. Summary statistics for monitored water quality in the MWI estuary reporting areas, from July 2019 to June 2020. Summary statistics are presented to three decimal places. Presented alongside summary statistics are guideline values, which represent the adopted statistic for comparison. In the estuaries, the 50th percentile (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
	Turbidity	9	81	9	32	34	90	280	Median	NA
	DO	9	87	56	92	93	94	99	Median	70-105%
Carmila Creek 3.4km from mouth	Chl-*a*	9	5	1	2	3	8	13	Median	5 µg/L
	DIN	9	0.131	0.005	0.010	0.026	0.207	0.557	Median	0.018 mg/L
	FRP	9	0.05	0.03	0.03	0.05	0.06	0.08	Median	0.06 mg/L
	Turbidity	9	36	14	17	21	21	160	Median	NA
	DO	9	101	70	86	96	127	142	Median	70-105%

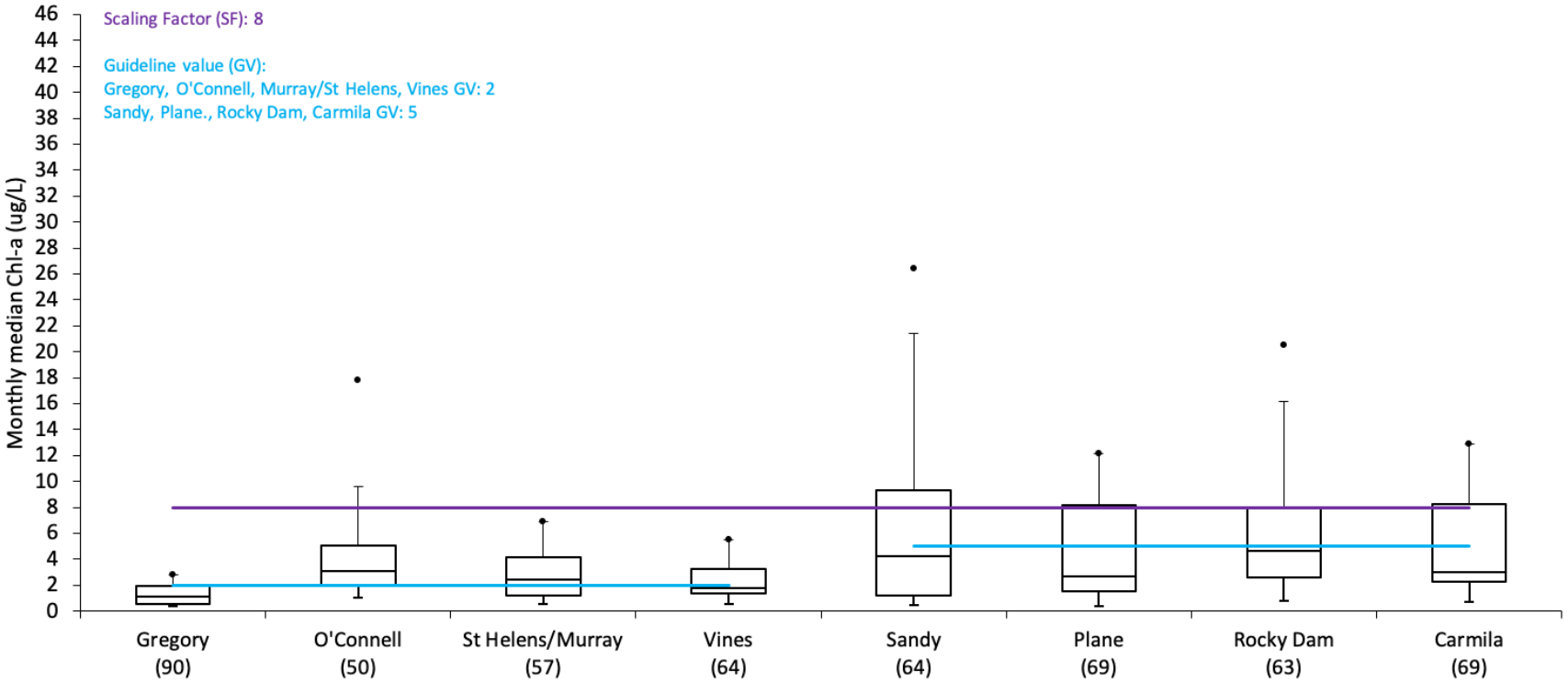

Figure C10. Box and whisker plot (box showing 20th, 50th and 80th percentiles, whiskers 1.5 x Interquartile range [IQR]) of monthly chlorophyll-*a* concentrations in the MWI estuaries for 2019-20. Scaling factors (SF) and guideline values (GV) are provided for each estuary, where information is available. Outliers are also pictured. Indicator scores are shown in brackets after the estuary names.

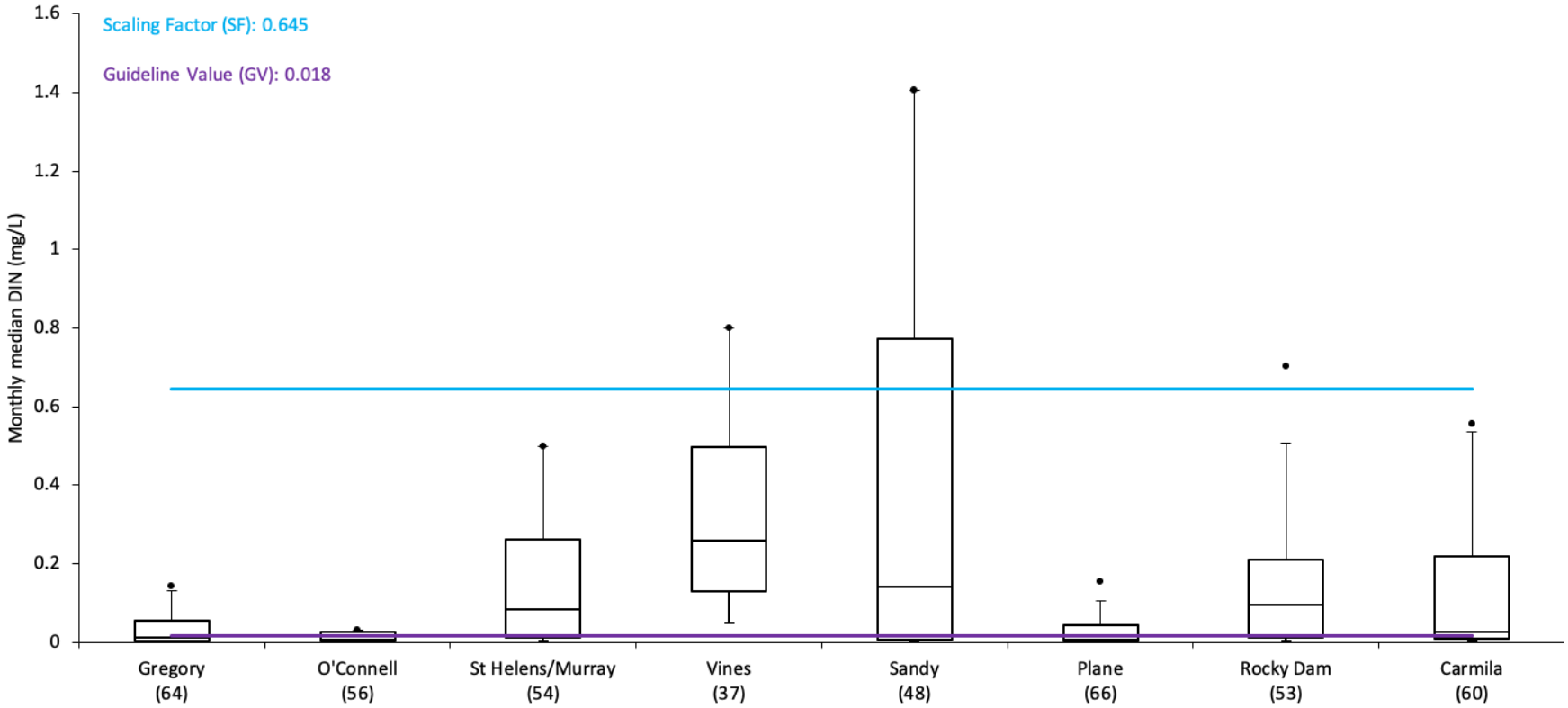

Figure C10. Box and whisker plot (box showing 20th, 50th and 80th percentiles, whiskers 1.5 x Interquartile range [IQR]) of DIN concentrations in the MWI estuaries for 2019-20. Scaling factors (SF) and guideline values (GV) are provided for each estuary, where information is available. Outliers are also pictured. Indicator scores are shown in brackets after the estuary names.

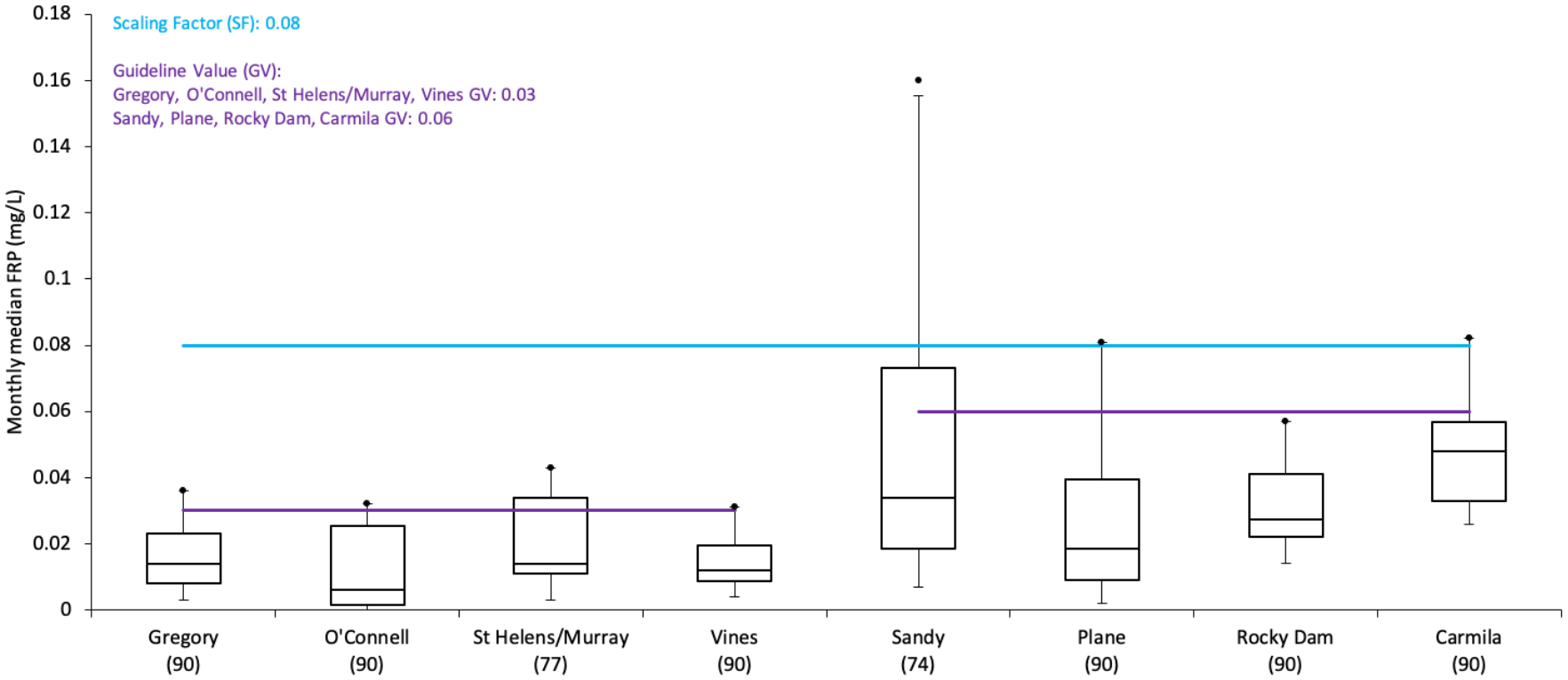

Figure C11. Box and whisker plot (box showing 20th, 50th and 80th percentiles, whiskers 1.5 x Interquartile range [IQR]) of FRP concentrations in the MWI estuaries for 2019-20. Scaling factors (SF) and guideline values (GV) are provided for each estuary, where information is available. Outliers are also pictured. Indicator scores are shown in brackets after the estuary names.

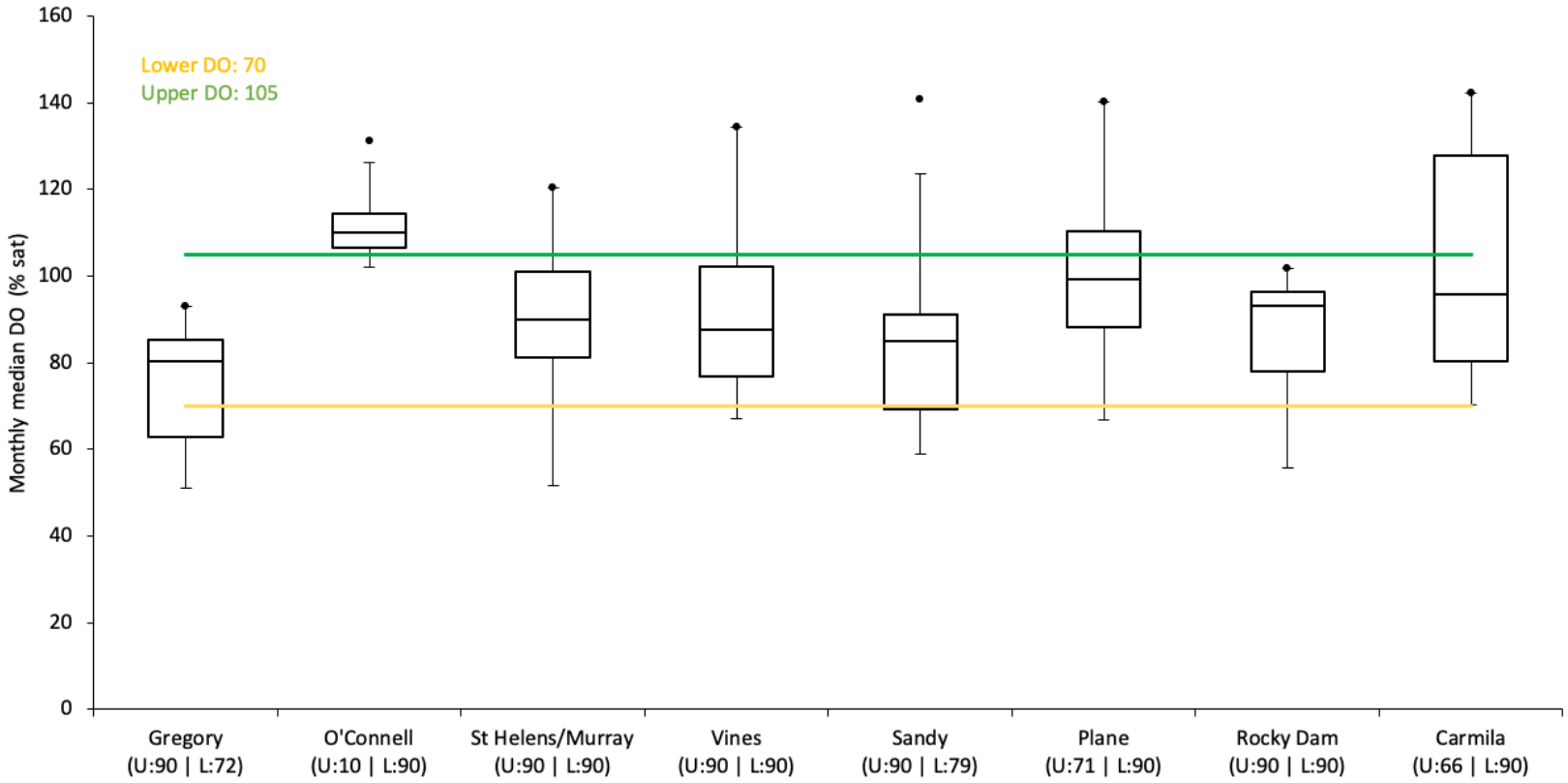

Figure C12. Box and whisker plot (box showing 20th, 50th and 80th percentiles, whiskers 1.5 x Interquartile range [IQR]) of DO concentrations (reported as % saturation) in the MWI estuaries for 2019-20. Scaling factors (SF) and guideline values (GV) are provided for each estuary, where information is available. Outliers are also pictured. Indicator scores are shown in brackets after the estuary names.

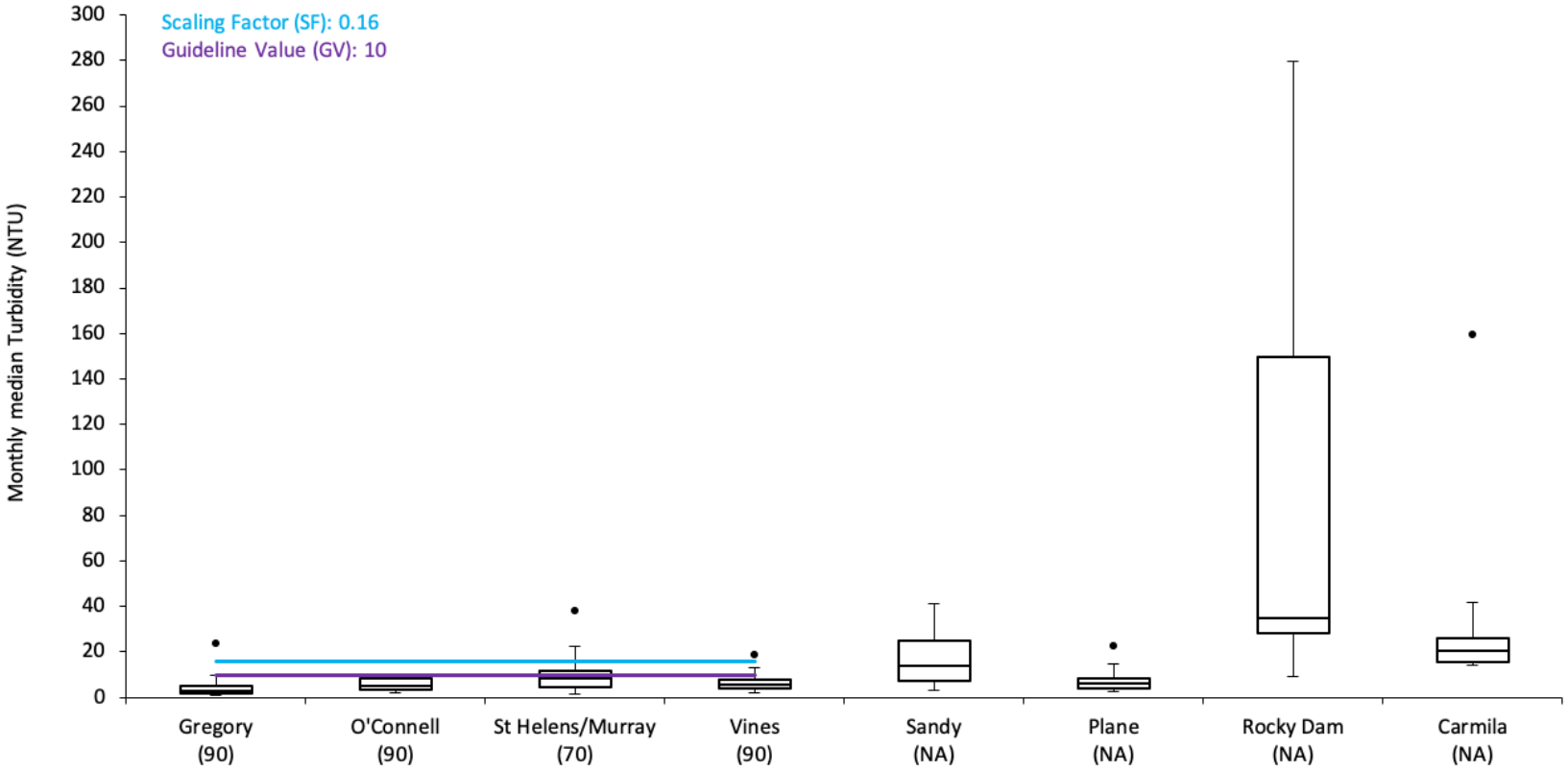

Figure C13. Box and whisker plot (box showing 20th, 50th and 80th percentiles, whiskers 1.5 x Interquartile range [IQR]) of turbidity levels in the MWI estuaries for 2019-20. Scaling factors (SF) and guideline values (GV) are provided for each estuary, where information is available. Outliers are also pictured. Indicator scores are shown in brackets after the estuary names. For the Sandy, Plane, Rocky Dam and Carmila Creek estuaries, guideline values for turbidity were too variable to be derived.

Individual Water Quality Indicator Tables:

The following are tables representing FRP, DIN, turbidity, and DO indicator scores from the 2016 – 2020 Report Cards. For the messages associated with these score changes, please see Sections 3.1.1 and 3.1.3 above.

Table C2. DIN indicator scores within estuaries for the 2020 Report Card, compared to the 2016 – 2019 Report Cards.

	2020 Report Card	2019	2018	2017	2016
Estuary	DIN	DIN			
Gregory River	64	90	59	66	66
O'Connell River	56	53	57	59	60
St Helens/Murray Creek	54	48	47	46	47
Vines Creek	37	30	45	29	32
Sandy Creek	48	32	43	33	28
Plane Creek	66	62	59	61	59
Rocky Dam Creek	53	47	46	43	42
Carmila Creek	60	52	59	49	50

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

Table C3. FRP indicator scores within estuaries for the 2020 Report Card, compared to the 2016 – 2019 Report Cards

	2020 Report Card	2019	2018	2017	2016
Estuary	FRP	FRP			
Gregory River	90	90	90	90	90
O'Connell River	90	90	90	90	90
St Helens/Murray Creek	77	71	65	62	73
Vines Creek	90	69	90	72	90
Sandy Creek	74	73	65	65	64
Plane Creek	90	90	90	90	90
Rocky Dam Creek	90	90	90	90	90
Carmila Creek	90	90	90	90	76

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

Table C4. Turbidity indicator scores within estuaries for the 2020 Report Card, compared to the 2016 – 2019 Report Cards.

	2020 Report Card	2019	2018	2017	2016
Estuary	Turbidity	Turbidity			
Gregory River	90	81	90	90	90
O'Connell River	90	77	4	72	25
St Helens/Murray Creek	70	30	9	30	14
Vines Creek	90	64	64	55	90
Sandy Creek					
Plane Creek					
Rocky Dam Creek					
Carmila Creek					

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

Table C5. Lower DO indicator scores within estuaries for the 2020 Report Card, compared to the 2016 – 2019 Report Cards.

Estuary	2020 Report Card	2019	2018	2017	2016
	Lower DO	Lower DO			
Gregory River	72	90	69	79	79
O'Connell River	90	90	90	90	90
St Helens/Murray Creek	90	90	90	90	90
Vines Creek	90	65	90	77	90
Sandy Creek	79	90	78	90	77
Plane Creek	90	90	90	90	90
Rocky Dam Creek	90	90	90	90	90
Carmila Creek	90	90	90	90	90

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

Table C6. Upper DO indicator scores within estuaries for the 2020 Report Card, compared to the 2016 – 2019 Report Cards.

Estuary	2020 Report Card	2019	2018	2017	2016
	Upper DO	Upper DO			
Gregory River	90	90	90	90	90
O'Connell River	10	27	0	53	11
St Helens/Murray Creek	90	90	90	90	90
Vines Creek	90	90	90	73	90
Sandy Creek	90	90	90	90	90
Plane Creek	71	67	90	90	68
Rocky Dam Creek	90	90	90	90	90
Carmila Creek	66	62	0	0	90

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

Appendix C.3 – Estuaries – Revision to Riparian Extent and Mangrove/Saltmarsh Extent Scores

Scores for estuarine vegetation extent (riparian and mangrove/saltmarsh) were last updated in the 2019 Report Card. Due to updates to the source mapping, 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, riparian and mangrove/saltmarsh extent scores were back-calculated for the 2013 assessment, using updated maps which depict condition in 2013. The results for back-calculated riparian extent scores are provided in Table C7, below.

Table C7. Results for riparian and mangrove/saltmarsh extent loss since pre-development (%), hectares remaining and standardised riparian and mangrove & saltmarsh extent in estuaries in the 2020 Report Card (2013-14 data). Hectares were rounded to the nearest whole number.

	2020 Report Card				2019 Report Card	
	Mangrove/Saltmarsh Extent		Riparian Extent			
Estuary	Hectares lost since pre-clearing	% loss since pre-clearing	Hectares lost since pre-clearing	% loss since pre-clearing	Standardised Mangrove/ Saltmarsh Extent	Standardised Riparian Extent
Gregory River	96.2	3.2	9.4	4.9	**87**	**81**
O'Connell River	108.9	4.0	40.5	57.2	**84**	**17**
St Helens/Murray Creek	-6.5*	-0.2*	54.2	17.1	**100**	**58**
Vines Creek	114.0	15.6	8.6	18.1	**60**	**56**
Sandy Creek	408.2	14.0	70.0	38.3	**63**	**32**
Plane Creek	26.1	2.2	23.0	17.0	**91**	**58**
Rocky Dam Creek	432.2	7.1	11.9	4.7	**76**	**82**
Carmila Creek	29.0	6.9	0.0	0.0	**77**	**100**

Riparian and mangrove/saltmarsh 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 riparian and mangrove/saltmarsh extent 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-development.

Appendix D – Inshore and Offshore Marine Environments

The scores and graphs presented below are for the inshore and offshore zones for the MWI 2020 Report Card. Boxplots are presented for inshore water quality indicators and summary statistics are tabulated for individual sites. Site-level scores are also presented for both the inshore and offshore zones for water quality, coral and seagrass indicators, compared to previous years.

Appendix D.1 – Water Quality Index (Inshore Zones)

Appendix D.1.1 – Nutrients, Chlorophyll-*a* and Water Clarity

Appendix D.1.1.1 – Boxplots

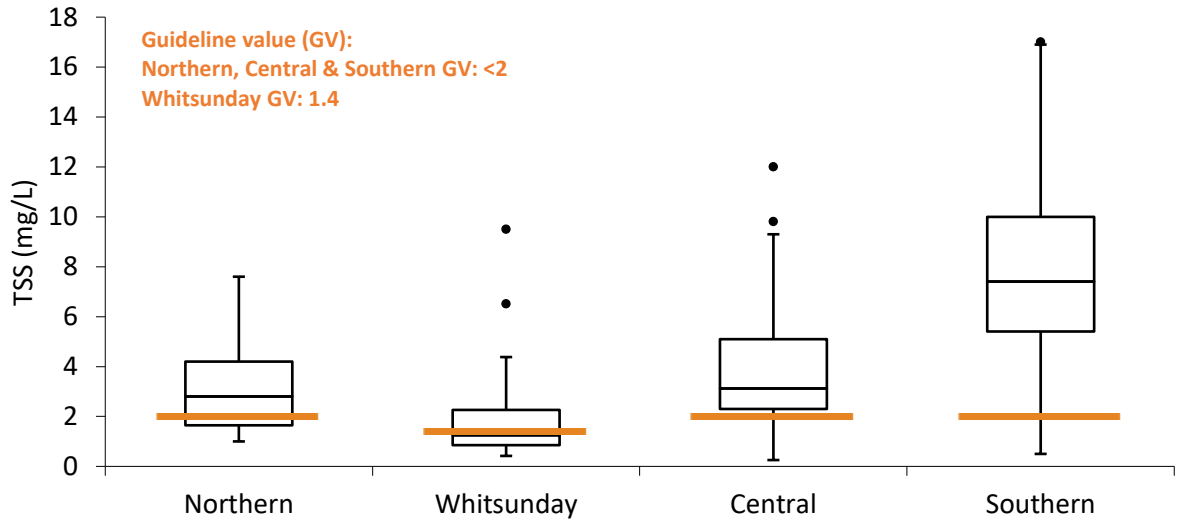

Figure D1. Box and whiskers plot (box 25th, 50th and 75th percentiles, whiskers 1.5x interquartile range [IQR]) for all total suspended solids (TSS) samples taken from relevant inshore zones in the MWI Region for 2019-20. Where relevant, outliers (>1.5x IQR) are also pictured. Guideline values (GV) for each zone are represented by the horizontal orange lines, where multiple GVs are scheduled within a zone, the most conservative level was adopted for the purpose of graphical presentation.

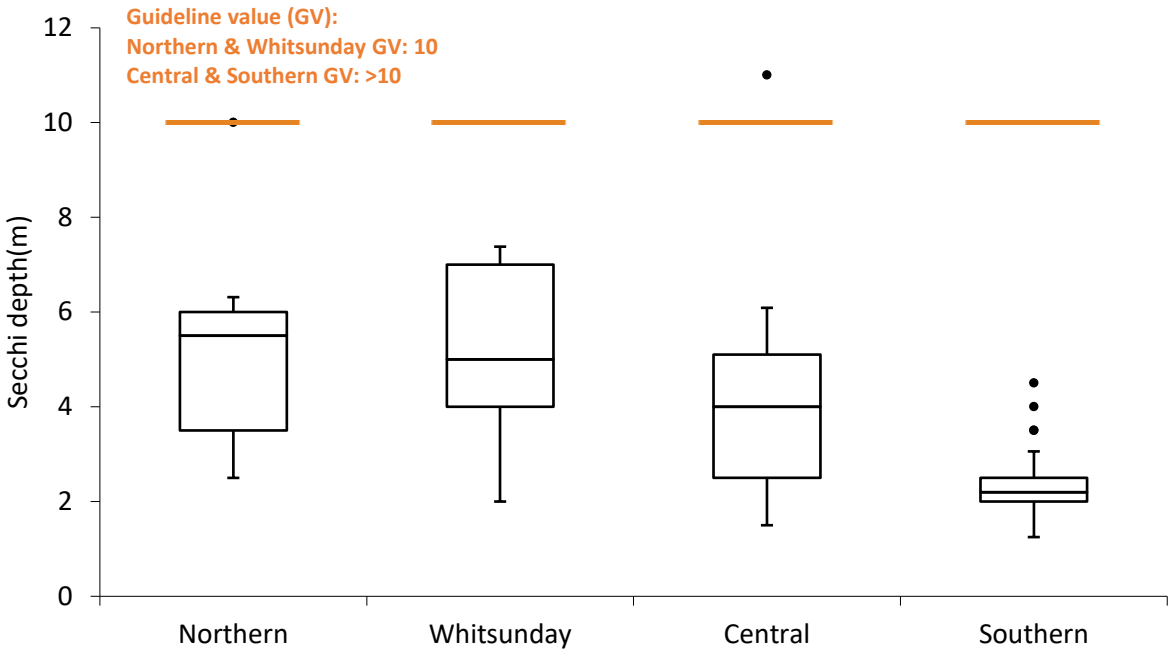

Figure D2. Box and whiskers plot (box 25th, 50th and 75th percentiles, whiskers 1.5x interquartile range [IQR]) for all secchi depth (m) samples taken from relevant inshore zones in the MWI Region for 2019-20. Where relevant, outliers (>1.5x IQR) are also pictured. Guideline values (GV) for each zone are represented by the horizontal orange lines. Higher secchi depth values relate to higher water clarity.

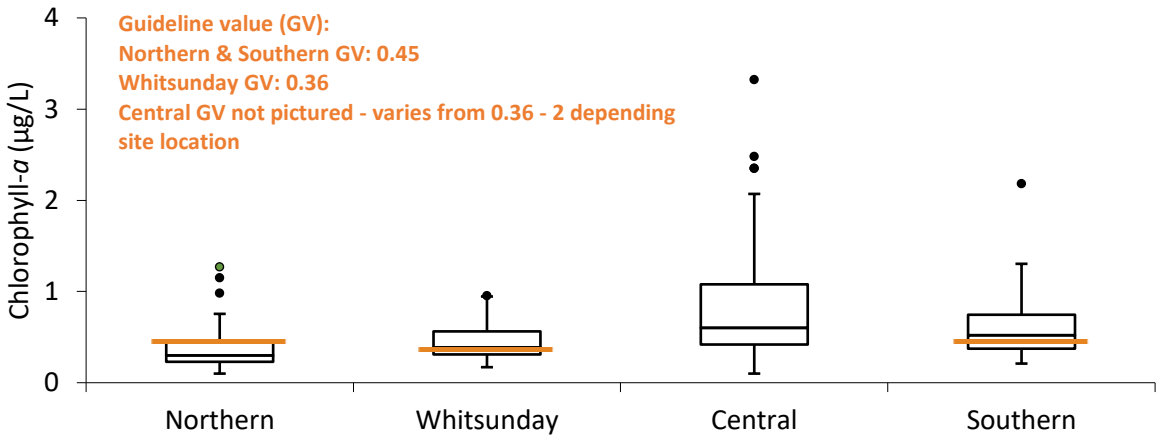

Figure D3. Box and whiskers plot (box 25th, 50th and 75th percentiles, whiskers 1.5x interquartile range [IQR]) for all chlorophyll-*a* samples taken from relevant zones in the MWI Region for 2019-20. Where relevant, outliers (>1.5x IQR) are also pictured. Guideline values (GV) for Northern, Central and Southern Zones are represented by the horizontal orange lines; Central GV is not pictured as it varies from 0.36-2.00 µg/L depending on site location.

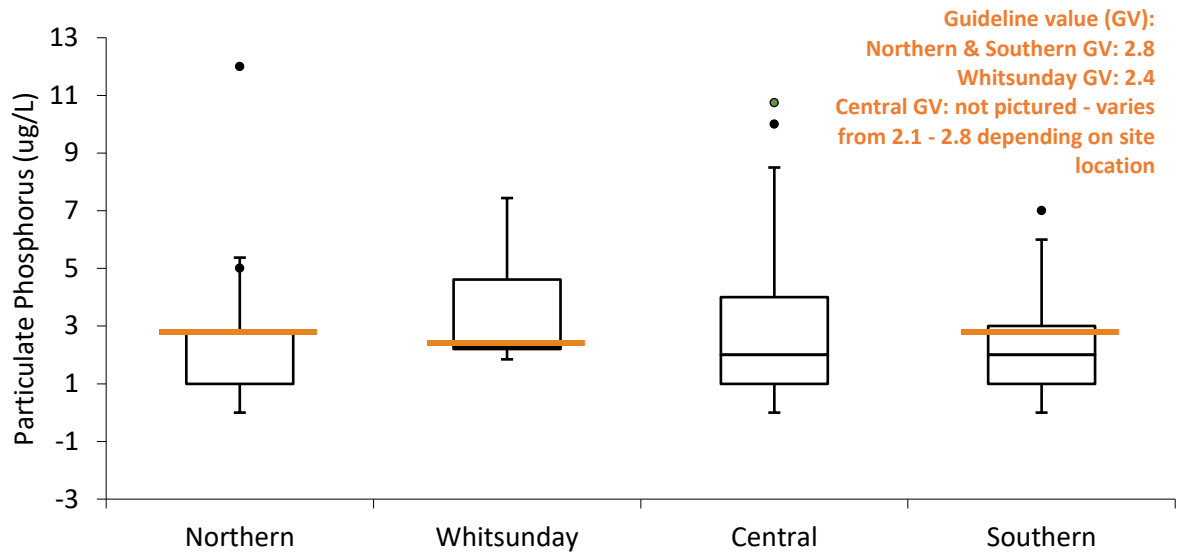

Figure D4. Box and whiskers plot (box 25th, 50th and 75th percentiles, whiskers 1.5x interquartile range [IQR]) for all particulate phosphorus samples taken from relevant inshore zones in the MWI Region for 2019-20. Where relevant, outliers (>1.5x IQR) are also pictured (the Northern Zone had an additional outlier (32.00) which is not displayed to aid in interpretation). Guideline values (GV) for Northern, Whitsunday and Southern Zones are represented by the horizontal orange lines; Central GV is not pictured as it varies from 2.1-2.8 µg/L depending on site location.

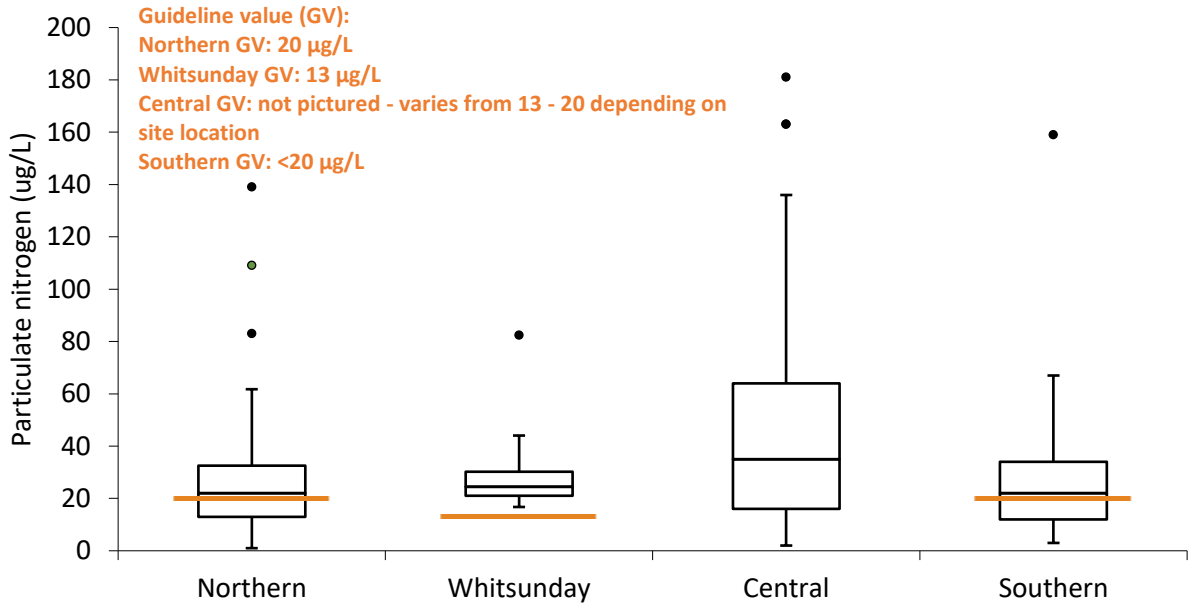

Figure D5. Box and whiskers plot (box 25th, 50th and 75th percentiles, whiskers 1.5x interquartile range [IQR]) for all particulate nitrogen samples taken from relevant inshore zones in the MWI Region for 2019-20. Where relevant, outliers (>1.5x IQR) are also pictured (the Northern Zone has one additional outlier of 412 µg/L that is not pictured). Guideline values (GV) for Northern, Whitsunday and Southern Zones are represented by the horizontal orange lines; Central GV is not pictured as it varies from 13-20 µg/L depending on site location.

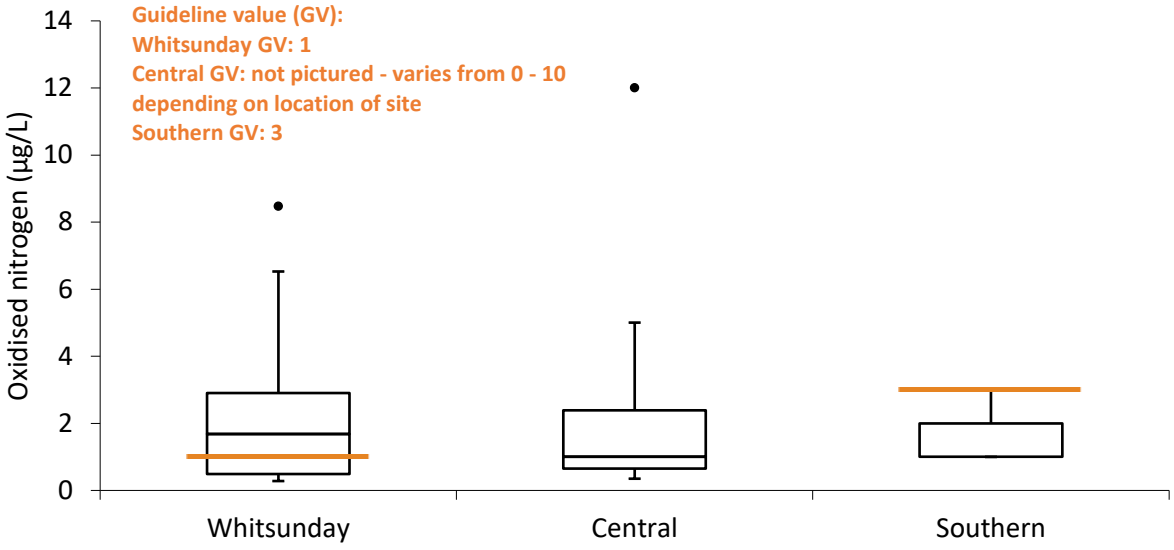

Figure D6. Box and whiskers plot (box 25th, 50th and 75th percentiles, whiskers 1.5x interquartile range [IQR]) for all oxidised nitrogen (NOx) samples taken from relevant inshore zones in the MWI Region for 2019-20. Outliers (>1.5x IQR) are also pictured. Guideline values (GV) for the Whitsunday and Southern Zones are represented by the horizontal orange lines; Central GV is not pictured as it varies from 0-10 µg/L depending on site location.

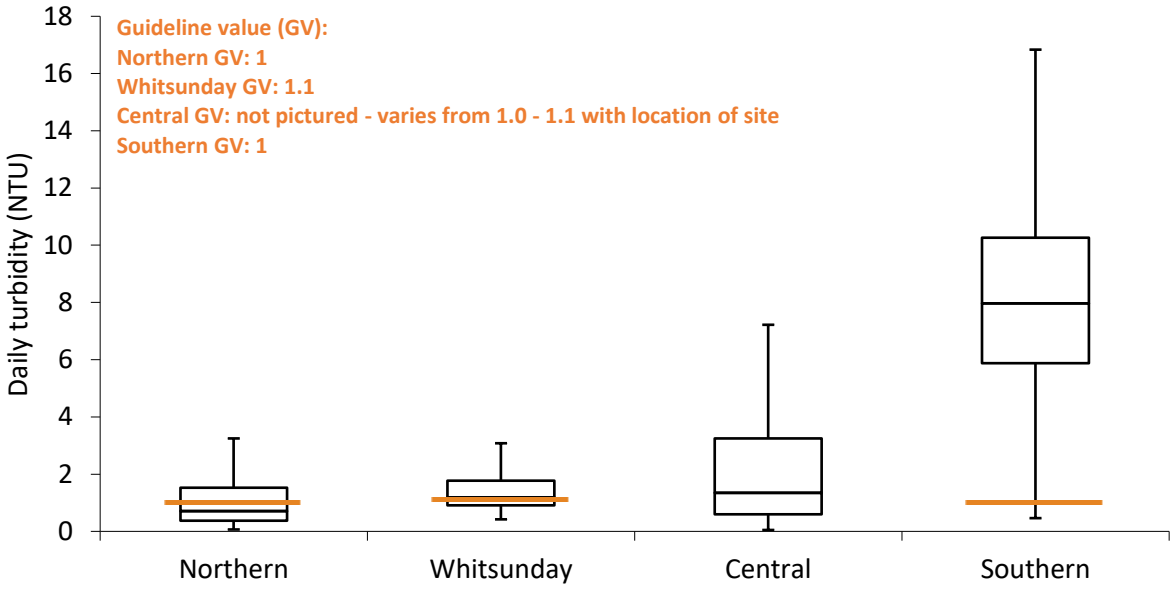

Figure D7. Box and whiskers plot (box 25th, 50th and 75th percentiles, whiskers 1.5x interquartile range) for daily turbidity taken from relevant inshore zones in the MWI Region for 2019-20. Guideline values (GV) for the Northern, Whitsunday and Southern Zones are represented by the horizontal orange lines; Central GVs vary from 1 – 12 NTU depending on site location and season (wet vs dry), and are therefore not pictured. Outliers (>1.5x IQR) are not pictured due to an excessive number of measures (n=103 for Northern, n = 82 for Whitsunday, n = 204 for Central and n=6 for Southern).

Appendix D.1.1.2 – Site-level Indicator Breakdowns (Northern Zone)

Table D1. Northern Zone (Ports Monitoring Program (Abbot Point)) 2019-20 FY indicator and indicator category scores (unstandardised) compared to scores for the 2016-2019 Report Cards.

Indicator Category	**Nutrients**				**Chl-*a***	**Water Clarity**			
Indicators	NOx	PN	PP	**Overall**		TSS	Secchi	Turbidity	**Overall**
AP_AMB1		0.08	0.54	**0.31**	**0.76**	-0.57	-0.94	0.39	**-0.37**
AP_AMB2		0.22	1.00	**0.61**	**0.19**	-0.97	-1.00	-0.91	**-0.96**
AP_AMB3		-1.00	-0.41	**-0.70**	**0.11**	-0.89	-1.00	0.35	**-0.52**
AP_AMB4		-1.00	-1.00	**-1.00**	**-0.18**	-0.77	-0.87	0.67	**-0.32**
AP_AMB5		-0.57	0.90	**0.16**	**0.57**	0.10	-0.72	1.00	**0.13**
2020 Report Card		-0.45	0.21	**-0.12**	**0.29**	-0.62	-0.91	0.30	**-0.41**
2019		-0.76	0.46	**-0.15**	**-0.07**	-0.25	-0.89	-0.07	**-0.41**
2018		0.57	0.82	**0.69**	**0.01**		-0.97	-0.45	**-0.71**
2017	-0.22				**0.72**	0.27		-0.62	**-0.18**
2016	0.33				**0.74***	-0.04		-0.72	**-0.35***

*Scores for chl-*a* and TSS were based on only one sample taken in May 2016.

Scoring range: Very Poor = <-0.66 to -1 | Poor = <-0.33 to -0.66 | Moderate = <0 to -0.33 | Good = 0 to 0.5 | Very Good = >0.5 to 1 | No score/data gap

Table D2. Summary statistics for water quality indicators in the Northern Zone sites from July 2019 to June 2020. 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)	7	19	10	15	18	21	34	Mean	20
	PP (µg/L)	7	1.9	0.5	1.0	2.0	2.5	4.0	Mean	2.8
	Chl-*a* (µg/L)	7	0.27	0.10	0.18	0.29	0.34	0.43	Mean	0.45
	TSS (mg/L)	7	3	1	2	2	4	6	Mean	2
	Secchi (m)	7	5	3	5	6	6	7	Mean	10
	Turb (NTU)	231*	1	0	0	1	1	5	Median	1
AP_AMB2 (Spoil Grounds)	NOx (µg/L)								Mean	3
	PN (µg/L)	7	17	2	7	10	19	58	Mean	20
	PP (µg/L)	7	1.0	0.0	1.0	1.0	1.0	2.0	Mean	2.8
	Chl-*a* (µg/L)	7	0.39	0.10	0.23	0.25	0.49	0.98	Mean	0.45
	TSS (mg/L)	7	4	2	3	3	5	8	Mean	2
	Secchi (m)	7	4	3	3	4	5	8	Mean	10
	Turb (NTU)	217*	3	0	1	2	4	9	Median	1
AP_AMB3 (Elliot River)	NOx (µg/L)								Mean	3
	PN (µg/L)	7	58	1	21	32	96	139	Mean	20
	PP (µg/L)	7	3.7	1.0	1.5	2.0	4.0	12.0	Mean	2.8
	Chl-*a* (µg/L)	7	0.42	0.20	0.35	0.42	0.48	0.65	Mean	0.45
	TSS (mg/L)	7	4	1	2	4	5	7	Mean	2
	Secchi (m)	7	5	3	4	5	6	6	Mean	10
	Turb (NTU)	203*	1	0	0	1	2	20	Median	1
AP_AMB4 (Camp Is.)	NOx (µg/L)								Mean	3
	PN (µg/L)	7	78	10	17	21	36	412	Mean	20
	PP (µg/L)	7	6.1	1.0	1.0	2.0	3.0	32.0	Mean	2.8

Table D2. Summary statistics for water quality indicators in the Northern Zone sites from July 2019 to June 2020. 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
	Chl-*a* (µg/L)	7	0.51	0.26	0.33	0.37	0.50	1.27	Mean	0.45
	TSS (mg/L)	7	3	1	2	3	5	6	Mean	2
	Secchi (m)	8	6	3	4	5	7	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)	7	30	9	23	29	33	59	Mean	20
	PP (µg/L)	7	1.5	0.0	0.3	1.0	2.0	5.0	Mean	2.8
	Chl-*a* (µg/L)	7	0.30	0.10	0.10	0.10	0.29	1.15	Mean	0.45
	TSS (mg/L)	7	2	1	1	2	3	3	Mean	2
	Secchi (m)	7	6	4	6	6	7	8	Mean	10
	Turb (NTU)	186*	0	0	0	0	1	1	Median	1

*While turbidity loggers were deployed for the entire 2019-20 reporting period (366 days), 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, and the COVID-19 lockdown.

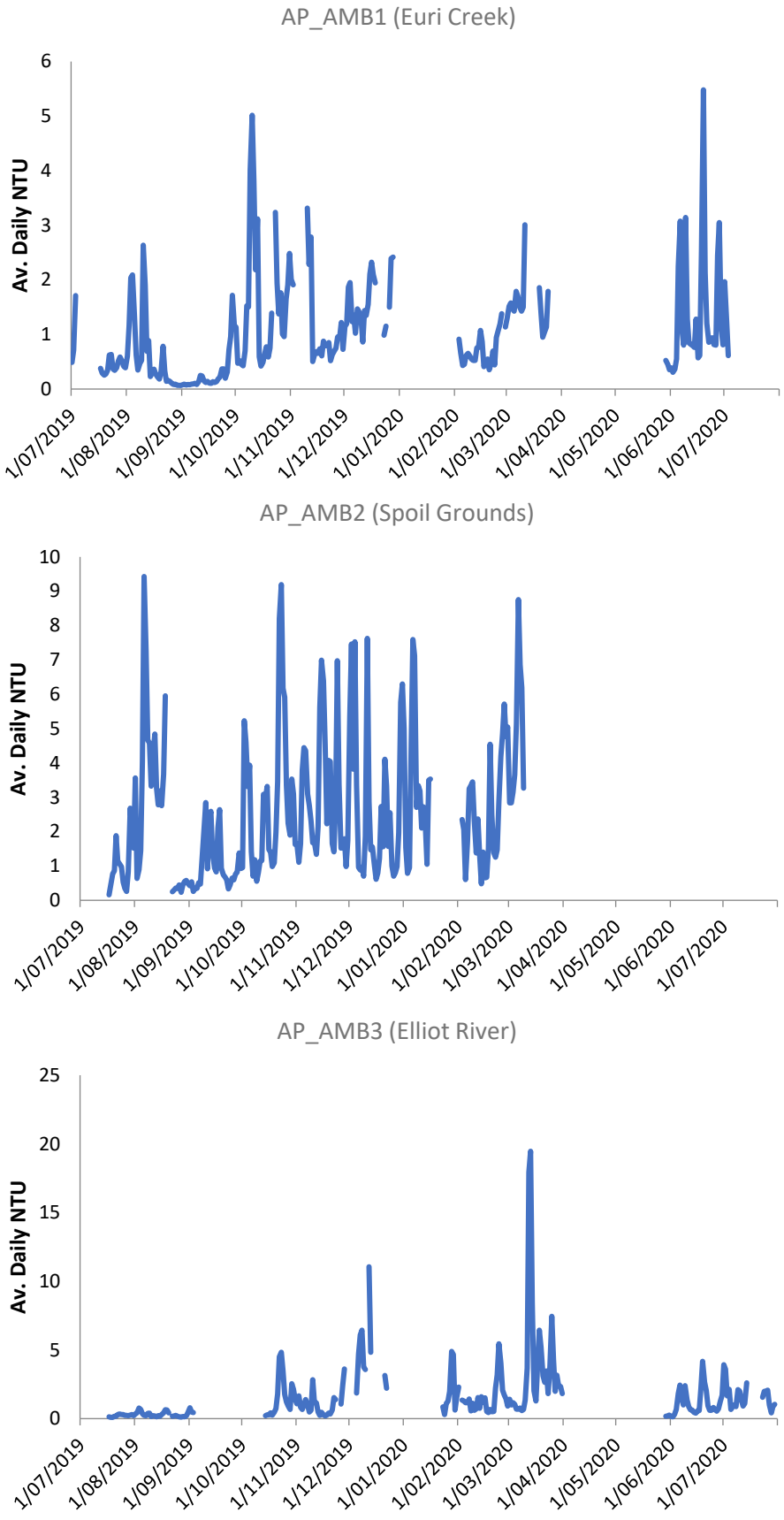

Figure D8. Daily average turbidity (NTU) from the Northern Zone loggers as part of the Ports Monitoring Program (Abbot Point) for the 2019-20 reporting year.

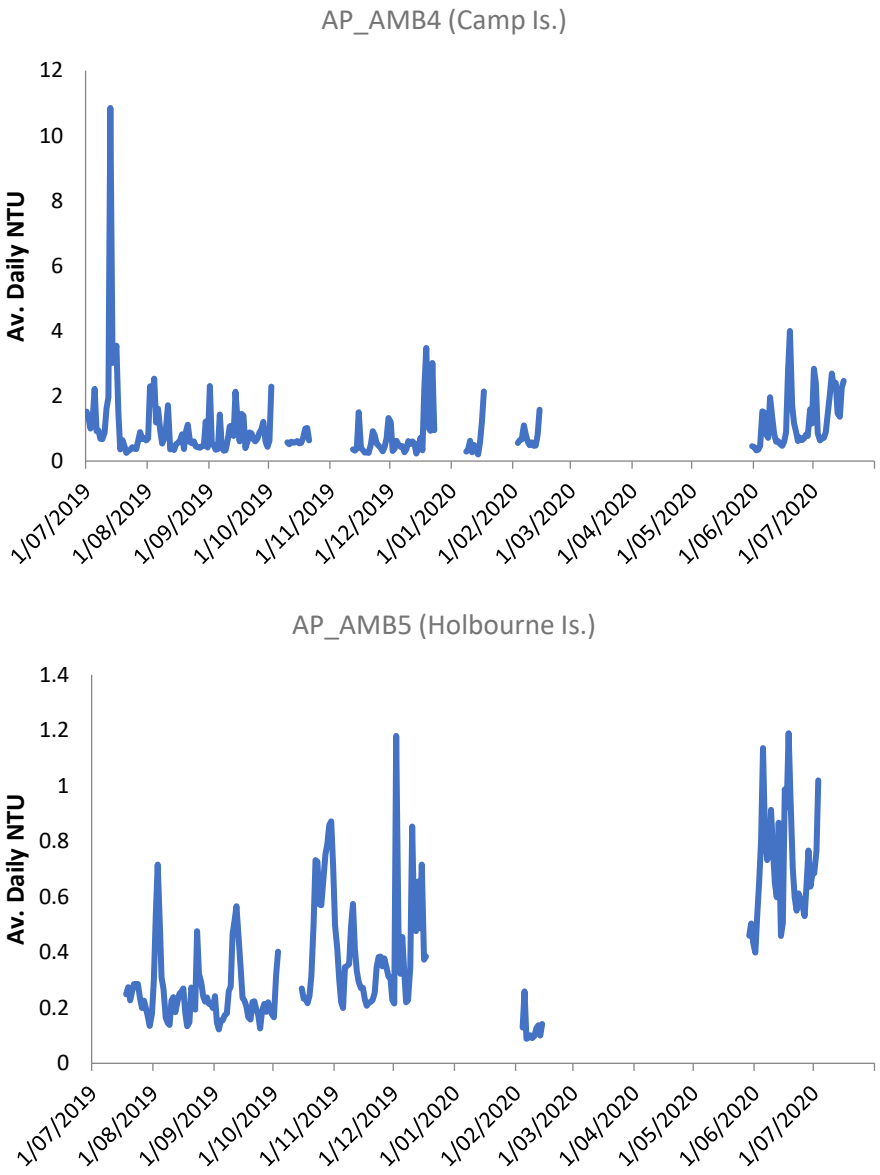

Figure D8 continued. Daily average turbidity (NTU) from the Northern Zone loggers as part of the Ports Monitoring Program (Abbot Point) for the 2019-20 reporting year.

Appendix D.1.1.3 – Site-level Indicator Breakdowns (Whitsunday Zone)

Table D3. Whitsunday Zone (MMP) 2019-20 indicator and indicator category scores (unstandardised) compared to scores for the 2016-2019 Report Cards.

Indicator Category	**Nutrients**				**Chl-*a***	**Water Clarity**			
Indicators	NOx	PN	PP	**Overall**		TSS	Secchi	Turbidity	**Overall**
Double Cone Is. (WHI1)	0.38	-0.85	0.10	**-0.12**	**-0.11**	0.39	-0.84	-0.05	**-0.17**
Pine Is. (WHI4)	-0.75	-1.00	0.07	**-0.56**	**-0.31**	-0.60	-1.00	-0.36	**-0.65**
Seaforth Is. (WHI5)	-0.69	-0.91	-0.05	**-0.55**	**-0.11**	0.17	-0.92	-0.05	**-0.27**
2020 Report Card	-0.35	-0.92	0.04	**-0.41**	**-0.18**	-0.01	-0.92	-0.16	**-0.36**
2019	-0.04	-0.80	-0.96	**-0.60**	**-0.81**	-0.73	-0.36	-0.92	**-0.67**
2018	-0.34	-0.83	-0.26	**-0.48**	**-0.63**	0.11	-0.95	-0.65	**-0.50**
2017	-1.00	-1.00	-0.98	**-0.98**	**-0.99**	-0.67	-1.00	-0.32	**-0.65**
2016	-0.31	-1.00	-0.31	**-0.54**	**-0.12**	0.14	-0.85	-0.43	**-0.38**

Scoring range: Very Poor = <-0.66 to -1 | Poor = <-0.33 to -0.66 | Moderate = <0 to -0.33 | Good = 0 to 0.5 | Very Good = >0.5 to 1 | No score/data gap

Table D4. Summary statistics for water quality indicators in the Whitsunday Zone sites from July 2019 to June 2020. Presented alongside statistics are guideline values, including the statistic that was compared to the guideline (where three values are listed, the median is compared to the middle of the listed 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
Double Cone Island	NOx (µg/L)	5	2	0	1	1	2	4	Median	0-1-2
	PN (µg/L)	5	34	17	21	23	25	82	Median	12-13-15
	PP (µg/L)	5	3.1	1.9	2.1	2.2	4.0	5.3	Median	1.8-2.4-2.8
	Chl-*a* (µg/L)	5	0.36	0.17	0.23	0.39	0.47	0.55	Median	0.25-0.36-0.54
	TSS (mg/L)	5	2.1	0.5	0.6	1.1	1.6	6.5	Median	0.9-1.4-2.3
	Secchi (m)	5	6	3	4	7	7	8	Mean	10
	Turb (NTU)	366*	1.4	0.6	0.9	1.1	1.6	6.8	Median	0.7-1.1-2.1
Pine Island	NOx (µg/L)	5	3	0	2	2	2	8	Median	0-1-2
	PN (µg/L)	5	28	17	21	26	32	42	Median	12-13-15
	PP (µg/L)	5	3.1	2.2	2.3	2.3	2.5	6.4	Median	1.8-2.4-2.8
	Chl-*a* (µg/L)	5	0.54	0.32	0.38	0.45	0.58	0.95	Median	0.25-0.36-0.54
	TSS (mg/L)	5	3.1	0.6	1.2	2.1	2.4	9.5	Median	0.9-1.4-2.3
	Secchi (m)	5	4	2	4	4	5	6	Mean	10
	Turb (NTU)	297*	2.0	0.4	0.9	1.4	2.3	11.9	Median	0.7-1.1-2.1
Seaforth Island	NOx (µg/L)	5	2	0	0	2	3	5	Median	0-1-2
	PN (µg/L)	5	25	20	22	24	29	32	Median	12-13-15
	PP (µg/L)	5	4.1	1.9	2.2	2.5	6.6	7.4	Median	1.8-2.4-2.8
	Chl-*a* (µg/L)	5	0.46	0.21	0.30	0.39	0.60	0.78	Median	0.25-0.36-0.54
	TSS (mg/L)	5	2.0	0.4	1.1	1.2	1.9	5.3	Median	0.9-1.4-2.3
	Secchi (m)	5	5	3	4	6	7	7	Mean	10
	Turb (NTU)	366*	1.5	0.5	0.9	1.1	1.7	8.9	Median	0.7-1.1-2.1

*While turbidity loggers were deployed for the entire 2019-20 reporting period (366 days), 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, and the COVID-19 lockdown.

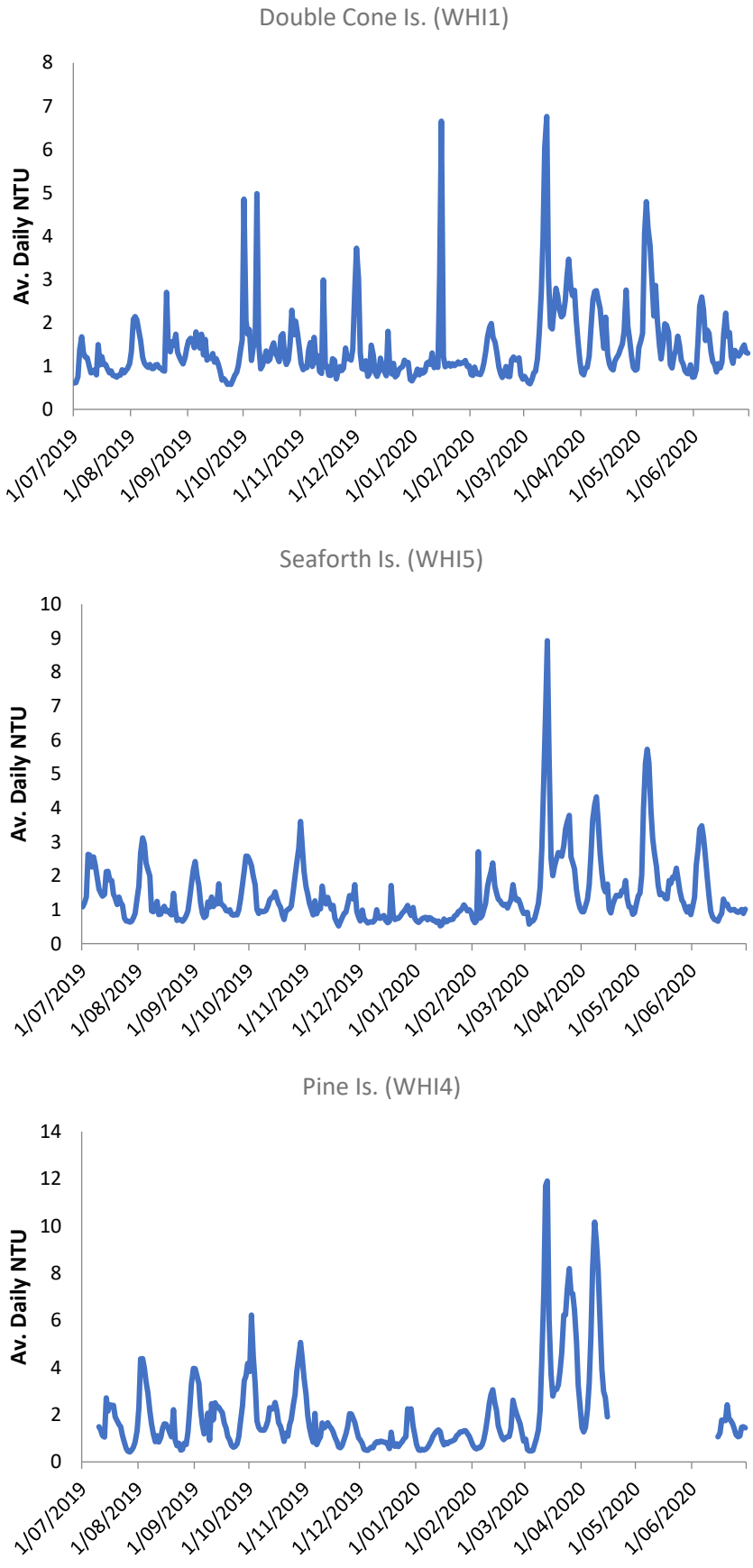

Figure D9. Daily average NTU from Whitsunday MMP loggers for the 2019-20 reporting year.

Appendix D.1.1.4 – Site-level Indicator Breakdowns (Central Zone)

Table D5. Central Zone (Ports Monitoring Program (Mackay/Hay Point) and MMP) indicator and indicator category scores (unstandardised) for 2019-20 compared to scores for the 2016-2019 Report Cards. For some sites guideline values for turbidity were scored for the wet (Nov-Apr) and dry (May-Oct) season; the average of these scores is used for the turbidity score in the water clarity index. Note, the 2020 Report Card does not include MKY_AMB11 in the calculation of scores for the first time.

Indicator Category	**Nutrients**				**Chl-*a***	**Water Clarity**					
Indicator	NOx	PN	PP	**Overall**		TSS	Secchi	Turbidity			**Overall**
								Final	Dry	Wet	
MKY_AMB1		-1.00	0.13	**-0.43**	**-1.00**	-1.00	-1.00	-1.00			**-1.00**
MKY_AMB2		-1.00	-0.10	**-0.55**	**-0.61**	-1.00	-1.00	0.76	0.51	1.00	**-0.41**
MKY_AMB3B		-0.93	0.26	**-0.34**	**-1.00**	-0.67	-0.89	1.00			**-0.19**
MKY_AMB5		-0.99	0.20	**-0.40**	**-0.83**	-0.88	-1.00	1.00	1.00	1.00	**-0.29**
MKY_AMB6B		-1.00	-0.56	**-0.78**	**-1.00**	-1.00	-1.00				**-1.00**
MKY_AMB8		-1.00	0.95	**-0.02**	**-0.95**	-0.28	-0.98	1.00	1.00	1.00	**-0.09**
MKY_AMB10		-1.00	0.41	**-0.30**	**-0.66**	-0.76	-1.00	-0.53			**-0.76**
MKY_AMB12	-1.00	-0.42	0.07	**-0.45**	**-0.51**	-0.70	-0.96	0.94			**-0.24**
O'Connell River Mouth (WHI6)	1.00				**0.41**						
Repulse Is. Dive Mooring (WHI7)	0.03	-1.00	-0.87	**-0.61**	**-0.49**	-0.86	-1.00	-1.00			**-0.95**
2020 Report Card	0.01	-0.93	0.06	**-0.43**	**-0.66**	-0.79	-0.98	0.27	0.84	1.00	**-0.55**
2019	0.03	-0.80	-0.36	**-0.56**	**-0.40**	-0.90	-0.80	-0.01	0.88	0.44	**-0.67**
2018	0.42	0.01	0.08	**0.08**	**-0.56**	-0.93	-0.81	-0.02	0.82	1.00	**-0.50**
2017	0.00	0.13	-0.19	**-0.10**	**-0.53**	-1.00	-0.98	-0.20	-0.78	0.77	**-0.59**
2016	0.41	-0.67	-0.17	**-0.35**	**-0.38**	-0.43	0.00	-0.15	0.91	-0.19	**-0.20**

Scoring range: Very Poor = <-0.66 to -1 | Poor = <-0.33 to -0.66 | Moderate = <0 to -0.33 | Good = 0 to 0.5 | Very Good = >0.5 to 1 | No score/data gap

Table D6. Summary statistics for water quality indicators in the Central Zone sites from July 2019 to June 2020. Presented alongside statistics are guideline values, including the statistic that was compared to the guideline (where three values are listed, the median is compared to the middle of the listed 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 %ile	Median	75th %ile	Maximum	Guidelines	
									Comparison Statistic	Guideline Value
WHI6 (O'Connell River mouth)	NOx (µg/L)	5	2	1	1	1	1	9	Median	2-4-10
	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	1.1	0.7	0.8	1.0	1.3	1.9	Median	0.8-1.3-2.0
	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	2	0	1	1	3	6	Median	0-1-2
	PN (µg/L)	5	42	22	30	41	51	66	Median	12-13-15
	PP (µg/L)	5	4.7	2.2	4.1	4.4	6.1	6.6	Median	1.8-2.4-2.8
	Chl-*a* (µg/L)	5	0.44	0.20	0.37	0.50	0.51	0.61	Median	0.25-0.36-0.54
	TSS (mg/L)	5	3.6	0.3	1.5	2.5	3.1	10.6	Median	0.9-1.4-2.3
	Secchi (m)	5	5	2	2	3	6	11	Mean	10
	Turb (NTU)	366*	3.6	0.6	1.5	2.6	4.4	27.7	Median	0.7-1.1-2.1
MKY_AMB1 (FW Point)	NOx (µg/L)									
	PN (µg/L)	9	48	3	19	49	61	105	Mean	<20
	PP (µg/L)	9	2.6	1.0	1.0	2.0	4.0	5.0	Mean	<2.8
	Chl-*a* (µg/L)	9	1.00	0.26	0.50	0.55	0.87	3.32	Mean	<0.45
	TSS (mg/L)	9	5.4	1.9	2.8	5.6	8.2	9.8	Mean	<2.0
	Secchi (m)	77	3	2	2	3	4	4	Mean	>10
	Turb (NTU)	232*	8.2	0.2	1.4	3.2	9.8	73.1	Median	<1
MKY_AMB2 (Hay Reef)	NOx (µg/L)									
	PN (µg/L)	9	46	8	13	35	62	105	Mean	<20
	PP (µg/L)	9	3.0	1.0	2.0	2.0	3.0	8.0	Mean	<2.8
	Chl-*a* (µg/L)	9	0.69	0.38	0.42	0.60	0.76	1.26	Mean	<0.45
	TSS (mg/L)	9	4.9	2.0	2.7	4.4	5.7	12.0	Mean	<2.0
	Secchi (m)	7	3	2	3	4	4	5	Mean	>10
	Turb (NTU)	239*	13.2	0.3	1.2	2.4	5.7	216.5	Median	D = 1-2-8; W = 5-12-33
	NOx (µg/L)									

MKY_AMB3B (Round Top Is.)	PN (µg/L)	9	38	9	20	31	40	105	Mean	<20
	PP (µg/L)	9	2.3	0.0	1.0	2.0	3.0	5.0	Mean	<2.8
	Chl-*a* (µg/L)	9	0.92	0.32	0.38	0.50	0.92	2.48	Mean	<0.45
	TSS (mg/L)	9	3.2	1.1	2.1	3.1	3.9	7.1	Mean	<2.0
	Secchi (m)	8	5	3	4	5	7	8	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)	9	40	2	13	18	71	109	Mean	<20
	PP (µg/L)	9	2.4	1.0	2.0	2.0	3.0	6.0	Mean	<2.8
	Chl-*a* (µg/L)	9	0.80	0.10	0.46	0.66	1.13	1.79	Mean	<0.45
	TSS (mg/L)	9	3.7	1.4	2.4	2.8	3.1	7.9	Mean	<2.0
	Secchi (m)	8	5	3	4	5	5	6	Mean	>10
	Turb (NTU)	166*	2.6	0.1	0.4	1.0	2.8	30.5	Median	D = 1-2-8; W = 5-12-33
MKY_AMB6B (Dudgeon Point)	NOx (µg/L)									
	PN (µg/L)	8	50	16	24	36	46	163	Mean	<20
	PP (µg/L)	8	4.1	2.0	3.0	4.0	5.0	7.0	Mean	<2.8
	Chl-*a* (µg/L)	8	1.10	0.42	0.53	1.06	1.71	1.77	Mean	<0.45
	TSS (mg/L)	8	6.9	3.4	5.8	7.9	8.2	9.0	Mean	<2.0
	Secchi (m)	6	3	2	2	2	3	6	Mean	>10
	Turb (NTU)								Median	D = 1-2-8; W = 5-12-33
MKY_AMB8 (Spoil Grounds)	NOx (µg/L)									
	PN (µg/L)	9	56	10	20	23	87	163	Mean	<20
	PP (µg/L)	9	1.4	0.0	1.0	1.0	2.0	3.0	Mean	<2.8
	Chl-*a* (µg/L)	9	0.87	0.10	0.39	0.60	1.12	2.35	Mean	<0.45
	TSS (mg/L)	9	2.4	1.0	1.8	2.3	2.4	4.4	Mean	<2.0
	Secchi (m)	8	5	3	4	5	6	9	Mean	>10
	Turb (NTU)	207*	1.0	0.2	0.4	0.6	1.1	10.2	Median	D = 1-2-8; W = 5-12-33
MKY_AMB10 (Victor Is.)	NOx (µg/L)									
	PN (µg/L)	8	41	7	13	27	75	94	Mean	<20
	PP (µg/L)	8	2.0	1.0	1.0	1.5	2.3	5.0	Mean	<2.8
	Chl-*a* (µg/L)	8	0.61	0.10	0.29	0.63	0.85	1.08	Mean	<0.45
	TSS (mg/L)	8	3.6	2.1	2.6	3.1	3.9	7.2	Mean	<2.0
	Secchi (m)	7	3	2	2	3	4	4	Mean	>10
	Turb (NTU)	195*	3.8	0.1	0.9	1.4	3.4	138.7	Median	<1
MKY_AMB12 (Keswick Is.)	NOx (µg/L)	8	3	1	1	1	2	12	Median	0-0-1
	PN (µg/L)	9	30	4	16	24	33	78	Median	14-18-24

	PP (µg/L)	9	2.4	0.0	1.0	2.0	3.0	10.0	Median	1.6-2.1-3
	Chl-*a* (µg/L)	9	0.64	0.10	0.38	0.44	0.63	1.63	Mean	≤0.45
	TSS (mg/L)	9	2.8	1.0	2.4	2.6	3.6	4.7	Median	1.1-1.6-2.4
	Secchi (m)	8	5	3	5	6	6	6	Mean	10
	Turb (NTU)	213*	0.6	0.1	0.3	0.5	0.8	2.7	Median	<1

*While turbidity loggers were deployed for the entire 2019-20 reporting period (366 days), 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, and the COVID-19 lockdown.

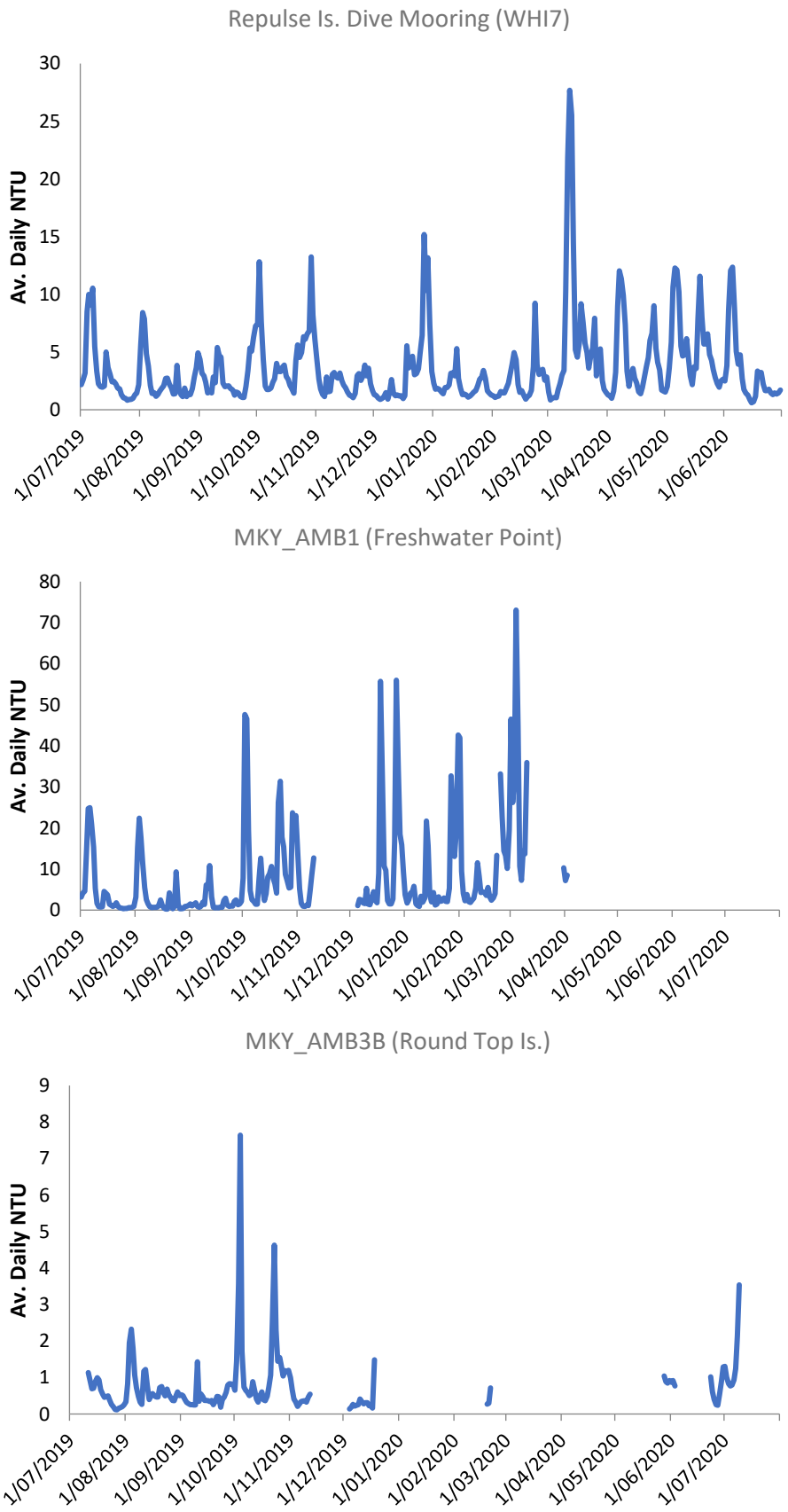

Figure D10. Daily average NTU from the Central Zone loggers from the MMP and Ports Monitoring Program (Mackay and Hay Point) for the 2019-20 reporting year.

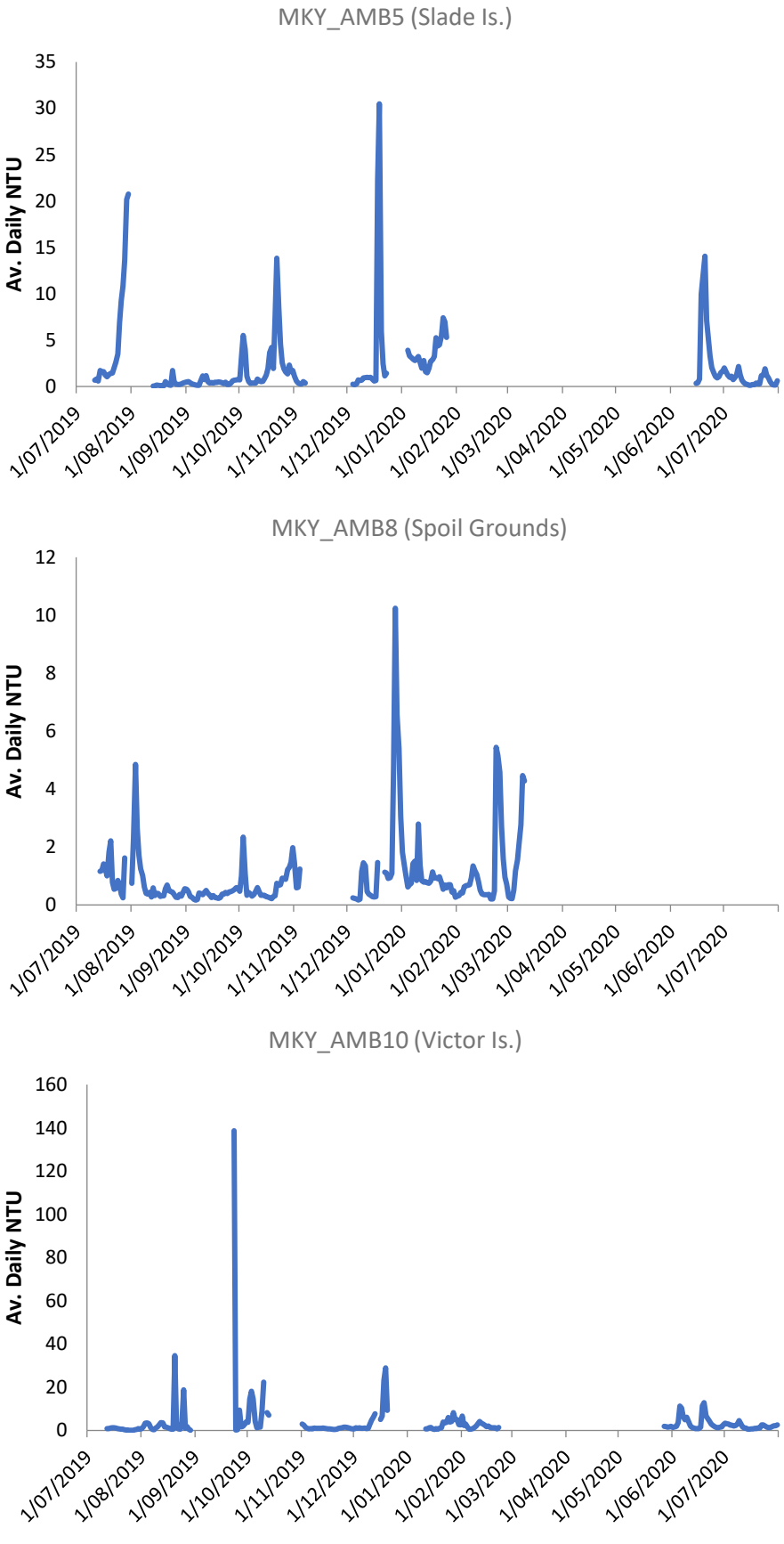

Figure D10 continued. Daily average NTU from the Central Zone loggers from the MMP and Ports Monitoring Program (Mackay and Hay Point) for the 2019-20 reporting year.

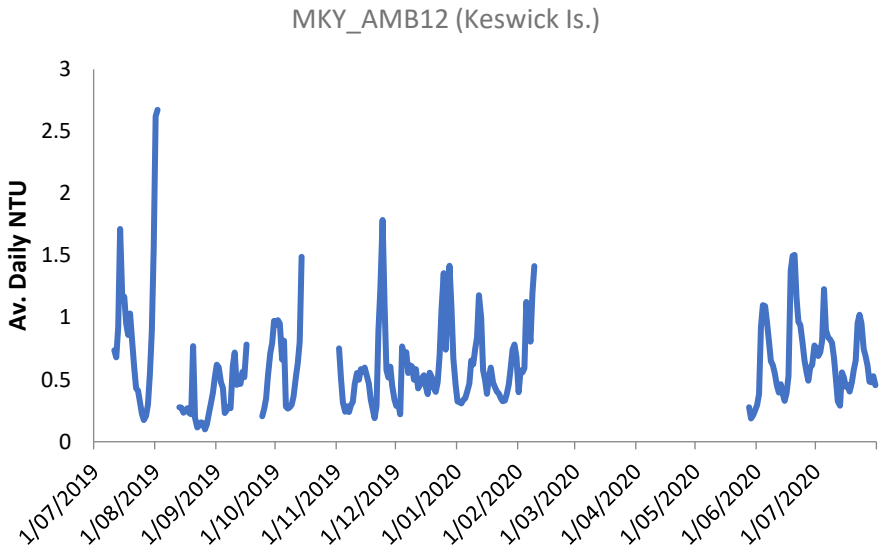

Figure D10 continued. Daily average NTU from the Central Zone loggers from the MMP and Ports Monitoring Program (Mackay and Hay Point) for the 2019-20 reporting year.

Appendix D.1.1.5 – Site-level Indicator Breakdowns (Southern Zone)

Table D7. Southern Zone (Partnership-funded program) indicator and indicator category scores (unstandardised) for 2019-20 compared to scores reported for the first time in the 2018 Report Card.

Indicator Category	**Nutrients**				**Chl-*a***	**Water Clarity**			
Indicator	NOx	PN	PP	**Overall**		TSS	Secchi	Turbidity	**Overall**
MKY_CAM1	1.00	-1.00	0.26	**0.09**	**-0.58**	-1.00	-1.00	-1.00	**-1.00**
MKY_CAM2	0.58	-0.26	-0.05	**0.09**	**-0.02**	-1.00	-1.00		**-1.00**
MKY_CAM3	1.00	-0.32	0.71	**0.46**	**-0.93**	-1.00	-1.00		**-1.00**
2020 Report Card	0.86	-0.53	0.31	**0.21**	**-0.51**	-1.00	-1.00	-1.00	**-1.00**
2019	0.61	-0.22	-0.57	**-0.06**	**-0.43**		-1.00	-1.00	**-1.00**
2018	-0.19	-0.15	-0.22	**-0.19**	**-0.70**		-1.00	-1.00	**-1.00**

Scoring range: Very Poor = <-0.66 to -1 | Poor = <-0.33 to -0.66 | Moderate = <0 to -0.33 | Good = 0 to 0.5 | Very Good = >0.5 to 1 | No score/data gap

Table D8. Summary statistics for water quality indicators in the Southern Zone for marine sites from July 2018 to June 2019. Presented alongside statistics are guideline values, including the statistic that was compared to the guideline (where three values are listed, the median is compared to the middle of the listed 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 %ile	Median	75th %ile	Maximum	Guidelines	
									Comparison Statistic	Guideline Value
MKY_CAM1	NOx (µg/L)	8	2	1	1	1	2	3	Median	3
	PN (µg/L)	9	40	3	16	17	50	159	Mean	<20
	PP (µg/L)	9	2.3	1.0	2.0	2.0	3.0	4.0	Mean	<2.8
	Chl-*a* (µg/L)	8	0.68	0.25	0.44	0.59	0.84	1.26	Mean	<0.45
	TSS (mg/L)								Mean	<2
	Secchi (m)	8	2	1	2	2	2	4	Mean	>10
	Turb (NTU)	232*	10	0	5	9	13	52	Mean	<1
MKY_CAM2	NOx (µg/L)	7	2	1	2	2	3	3	Median	3
	PN (µg/L)	9	24	3	7	22	32	64	Mean	<20
	PP (µg/L)	9	2.9	1.0	2.0	3.0	3.0	7.0	Mean	<2.8
	Chl-*a* (µg/L)	9	0.46	0.21	0.31	0.42	0.53	0.75	Mean	<0.45
	TSS (mg/L)								Mean	<2
	Secchi (m)	8	3	2	2	3	3	4	Mean	>10
	Turb (NTU)								Mean	<1
MKY_CAM3	NOx (µg/L)	5	2	1	1	1	2	3	Median	3
	PN (µg/L)	7	25	12	13	22	25	65	Mean	<20
	PP (µg/L)	7	1.7	0.0	1.0	1.0	2.5	4.0	Mean	<2.8
	Chl-*a* (µg/L)	5	0.86	0.37	0.42	0.52	0.81	2.18	Mean	<0.45
	TSS (mg/L)								Mean	<2
	Secchi (m)	5	3	2	2	2	3	5	Mean	>10
	Turb (NTU)								Mean	<1

*While turbidity loggers were deployed for the entire 2019-20 reporting period (366 days), 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, and the COVID-19 lockdown.

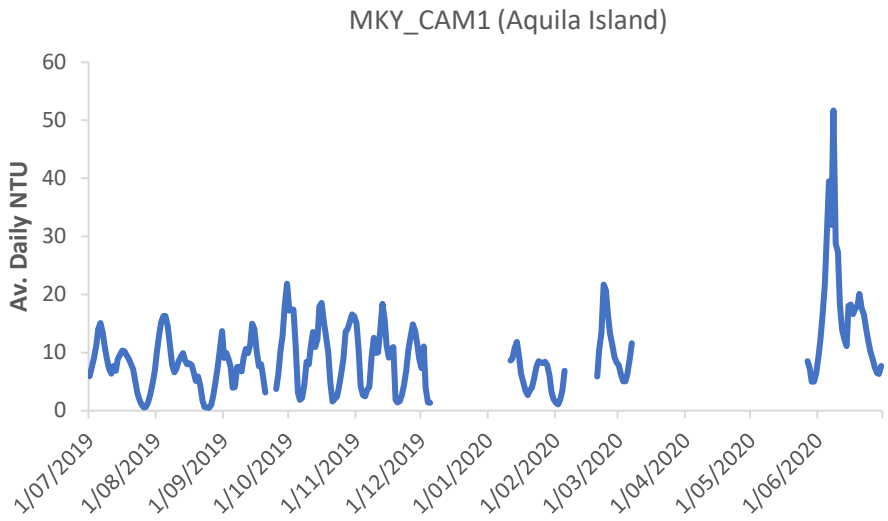

Figure D11. Daily average NTU from the Southern Zone logger at Aquila Island as part of the Partnership-funded Southern Inshore Monitoring Program for the 2019-20 reporting year.

Appendix D.1.2 – Pesticides

Table D9. Results 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 2020 Report Card, compared to the 2017-2019 Report Cards. The Pesticide Risk Metric reported for each passive sampler site is the maximum % species affected value out of *n* deployments per site. Note, Flat Top Is. was previously known as Round Top Is. MMP = Marine Monitoring Program, SIP = Southern Inshore Monitoring Program.

2020 Report Card								2019	2018	2017
Zone	**Sample Type**	**Program**	**Site/s**	**Sample Timing and Size (*n*)**	**Value Obtained**	**Pesticide Risk Metric (% Species Protected)**	**Pesticide Score**	**Pesticide Score**		
Northern	Grab *(used for reference only)*	Ports	AP_AMB1, AP_AMB2, AP_AMB3, AP_AMB4, AP_AMB5	Aug 2019 and May 2020 (2 samples per site)		100	100	99		
Whitsunday										
Central	Passive	MMP	Repulse Bay	07/11/2019 – 17/04/2020 (4 deployments)	Max	99	**74**	60	54	50
			Flat Top Island	07/11/2019 – 13/12/2019 16/01/2020 – 13/02/2020 (2 deployments)	Max	97				
			Sandy Creek	07/11/2019 – 13/12/2019 16/01/2020 – 13/02/2020 (2 deployments)	Max	97				
	Grab *(used for reference only)*	Ports	MKY_AMB1, MKY_AMB2, MKY_AMB3B, MKY_AMB5, MKY_AMB6B, MKY_AMB8, MKY_AMB10, MKY_AMB11, MKY_AMB12	Aug 2019 and May 2020 (2 samples per site)		100	100	99		
Southern	Passive	SIP	Aquila Island	01/11/2019 – 02/04/2020 (3 deployments)	Max	98	**75**	100		

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

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

Appendix D.2 – Coral Index

Appendix D.2.1 – Northern Zone

Table D10. Coral indicator scores for 2019-20 in the Northern Zone (Ports Coral Monitoring Program (Abbot Point)).

Region	Reef	Depth (m)	Cover	Macroalgae	Juvenile	Change	Composition	Coral Index
Northern	Camp Is. - East	2	0.11	0.00	0.07	0.15		**0.08**
	Camp Is. - West	2	0.25	0.00	0.18	0.44		**0.21**
	Holbourne Is. - East	2	0.04	1.00	0.05	0.37		**0.36**
	Holbourne Is. - East	5	0.16	0.96	0.04	0.37		**0.38**
	Holbourne Is. - West	2	0.02	1.00	0.02	0.46		**0.38**
	Holbourne Is. - West	5	0.08	1.00	0.08	0.00		**0.29**
	2020 Report Card score: Poor		**0.11**	**0.66**	**0.07**	**0.30**		**0.28**
	2019: Poor		0.14	0.62	0.08	0.30		**0.29**
	2018: Poor		0.12	0.61	0.07	0.20		**0.25**
	2017: Poor		0.14	0.67	0.12			**0.31**
	2016: Moderate		0.40	0.67	0.29			**0.45**
	2015: no score							
	2014: no data							

Coral index scoring range: Very Poor = 0 - 0.20 | Poor = >0.20 - 0.40 | Moderate = >0.40 - 0.60 | Good = >0.60 - 0.80 | Very Good = >0.80 | No score/data gap

Appendix D.2.2 – Whitsunday Zone

Table D11. Weighting process for combining RCA and MMP data for the Whitsunday Zone, taking into account reduced sample size in the RCA program.

Zone	Program	Reef	Site (or depth (m))	Coral Cover Score	Weighting	Weighting to Apply	Weighted Coral Cover Score
Whitsunday	MMP	Border Is.	5	0.47	1.00	0.05	0.02
		Daydream Is.	2	0.01	1.00	0.05	0.00
		Daydream Is.	5	0.04	1.00	0.05	0.00
		Dent Is.	2	0.35	1.00	0.05	0.02
		Dent Is.	5	0.46	1.00	0.05	0.02
		Double Cone Is.	2	0.03	1.00	0.05	0.00
		Double Cone Is.	5	0.27	1.00	0.05	0.01
		Hayman Is.	5	0.13	1.00	0.05	0.01
		Hook Is.	2	0.11	1.00	0.05	0.01
		Hook Is.	5	0.32	1.00	0.05	0.02
		Langford Is.	5	0.20	1.00	0.05	0.01
		Pine Is.	2	0.09	1.00	0.05	0.01
		Pine Is.	5	0.23	1.00	0.05	0.01
		Seaforth Is.	2	0.27	1.00	0.05	0.01
		Seaforth Is.	5	0.27	1.00	0.05	0.01
		Shute Harbour	2	0.65	1.00	0.05	0.03
		Shute Harbour	5	0.33	1.00	0.05	0.02
	RCA	Daydream Is.	Lovers Cove	0.05	0.32	0.02	0.00
		Daydream Is.	Mermaids Cove	0.02	0.32	0.02	0.00
		Hayman Is. Reefs	Blue Pearl Bay	0.29	0.32	0.02	0.00
		Hook Is.	Butterfly Bay	0.46	0.32	0.02	0.01
		Hook Island	Luncheon Bay	0.07	0.32	0.02	0.00
		Whitsunday Is.	Peter's Bay	0.61	0.45	0.02	0.01
					19.03	**1.00**	Summed Weighted Coral Cover Score: **0.25**

Table D12. Coral indicator scores for 2019-20 in the Whitsunday Zone. The 2019-20 overall coral index for the Whitsunday Zone is calculated using MMP and RCA coral cover data for the first time (only MMP data were used prior to this Report Card). Weighted cover is calculated as per Table D11, where the cover indicator score is recalculated using weightings to reflect the reliability of the data. Weighted cover scores for each site are then summed to give the overall weighted cover indicator score.

Region	Program	Reef/Site	Depth (m)	Cover	Weighted Cover	Macroalgae	Juvenile	Change	Composition	Coral Index
Whitsunday	MMP	Border Is.	5	0.47	0.02	1.00	0.33	0.47	0.00	**0.45**
		Daydream Is.	2	0.01	0.00	0.00	0.41	0.00	0.00	**0.08**
		Daydream Is.	5	0.04	0.00	0.00	1.00	0.00	0.00	**0.21**
		Dent Is.	2	0.35	0.02	0.74	0.21	0.25	0.00	**0.31**
		Dent Is.	5	0.46	0.02	0.26	0.23	0.27	0.00	**0.25**
		Double Cone Is.	2	0.03	0.00	0.00	0.15	0.29	0.00	**0.09**
		Double Cone Is.	5	0.27	0.01	0.00	0.20	0.00	0.00	**0.09**
		Hayman Is.	5	0.13	0.01	1.00	0.22	0.20	0.00	**0.31**
		Hook Is.	2	0.11	0.01	0.06	0.32		0.00	**0.12**
		Hook Is.	5	0.32	0.02	0.14	0.20		0.50	**0.29**
		Langford Is.	5	0.20	0.01	1.00	0.28	0.00	0.00	**0.30**
		Pine Is.	2	0.09	0.01	0.00	0.33	0.00	0.50	**0.18**
		Pine Is.	5	0.23	0.01	0.00	0.23	0.33	0.00	**0.16**
		Seaforth Is.	2	0.27	0.01	0.00	0.31	0.25	0.50	**0.26**
		Seaforth Is.	5	0.27	0.01	0.00	0.50	0.55	1.00	**0.46**
		Shute Harbour	2	0.65	0.03	0.54	0.35	0.70	1.00	**0.65**
		Shute Harbour	5	0.33	0.02	0.28	0.51	0.47	1.00	**0.52**
	RCA	Lovers Cove	-	0.04	0.00					
		Mermaids Cove	-	0.01	0.00					
		Blue Pearl Bay	-	0.22	0.01					
		Butterfly Bay	-	0.37	0.01					
		Luncheon Bay	-	0.08	0.00					
		Peter's Bay	-	0.46	0.01					
2020 Report Card score: Poor					**0.25***	**0.30**	**0.34**	**0.25**	**0.27**	**0.28***
		2019: Poor		0.22		0.51	0.22	0.24	0.29	**0.30**
		2018: Moderate		0.32		0.60	0.32	0.37	0.47	**0.42**
		2017: Moderate		0.37		0.93	0.34	0.43	0.53	**0.52**
		2016: Good		0.68		0.76	0.62	0.40	0.59	**0.61**
		2015: Moderate		0.64		0.74	0.60	0.40	0.53	**0.58**
		2014: Moderate		0.61		0.74	0.61	0.39	0.44	**0.56**

Coral index scoring range: Very Poor = 0 - 0.20 | Poor = >0.20 - 0.40 | Moderate = >0.40 - 0.60 | Good = >0.60 - 0.80 | Very Good = >0.80 | No score/data gap

*Calculated with the weighted RCA coral cover data.

Appendix D.2.3 – Central Zone

Table D13. Coral indicator scores for 2019-20 in the Central Zone (Ports Coral Monitoring Program (Hay Point).

Region	Reef	Depth (m)	Cover	Macroalgae	Juvenile	Change	Composition	Coral Index
Central	Keswick	<1	0.47	0.00	0.02	0.28		**0.19**
	Round	<1	0.33	0.26	0.28	0.51		**0.35**
	Slade	<1	0.31	0.23	0.35	0.43		**0.33**
	Victor	<1	0.28	0.11	0.23	0.32		**0.23**
2020 Report Card score: Poor			**0.35**	**0.15**	**0.22**	**0.38**		**0.28**
		2019: Poor	0.38	0.00	0.13	0.39		**0.23**
		2018: Poor	0.36	0.00	0.16	0.39		**0.23**
		2017: Poor	0.35	0.01	0.18	0.40		**0.23**
		2016: Poor	0.44	0	0.15	0.64		**0.31**
		2015: no score	0.42		0.39			
		2014: no score						

Coral index scoring range: Very Poor = 0 - 0.20 | Poor = >0.20 - 0.40 | Moderate = >0.40 - 0.60 | Good = >0.60 - 0.80 | Very Good = >0.80 | No score/data gap

Appendix D.2.4 – Southern Zone

Table D14. Coral indicator scores for 2019-20 in the Southern Zone (Partnership-funded program (aligning to MMP)) coral monitoring program.

Region	Reef	Depth (m)	Cover	Macroalgae	Juvenile	Change	Composition	Coral Index
Southern	Pine Peak	2	0.21	0.00	0.07			**0.09**
	Pine Peak	5	0.37	0.00	0.06			**0.14**
	Pine Islets	2	0.07	0.00	0.12			**0.06**
	Pine Islets	5	0.33	0.00	0.29			**0.20**
	Henderson Island	2	0.85	0.00	0.17			**0.34**
	Henderson Island	5	0.88	0.00	0.10			**0.33**
	Connor Island	2	0.57	0.00	0.19			**0.25**
	Connor Island	5	0.60	0.00	0.35			**0.32**
	Temple Island	1	0.45	0.00	0.18			**0.21**
	Aquila Island	1	0.36	0.00	0.12			**0.16**
2020 Report Card score: Poor			**0.47**	**0.00**	**0.17**			**0.21**
		2019: Very Poor	0.49	0.00	0.13			**0.20**

Coral index scoring range: Very Poor = 0 - 0.20 | Poor = >0.20 - 0.40 | Moderate = >0.40 - 0.60 | Good = >0.60 - 0.80 | Very Good = >0.80 | No score/data gap

Appendix D.2.5 – Offshore Zone

Table D15. Weighting process for combining RCA and LTMP/RAP data for the Offshore Zone, taking into account reduced sample size in the RCA program.

Zone	Program	Reef	Site (or depth (m))	Coral Cover Score	Weighting	Weighting to Apply	Weighted Coral Cover Score
Offshore	LTMP/RAP	19131S	6-9m	0.56	1.00	0.06	0.03
		19138S	6-9m	0.48	1.00	0.06	0.03
		20104S	6-9m	0.78	1.00	0.06	0.05
		20348S	6-9m	0.14	1.00	0.06	0.01
		20353S	6-9m	0.47	1.00	0.06	0.03
		21060S	6-9m	0.07	1.00	0.06	0.00
		21062S	6-9m	0.04	1.00	0.06	0.00
		21064S	6-9m	0.09	1.00	0.06	0.01
		21591S	6-9m	0.35	1.00	0.06	0.02
		Hyde Reef	6-9m	0.45	1.00	0.06	0.03
		Penrith Is.	6-9m	0.26	1.00	0.06	0.02
		Pompey Reef (1)	6-9m	0.20	1.00	0.06	0.01
		Pompey Reef (2)	6-9m	0.41	1.00	0.06	0.03
		Rebe Reef	6-9m	0.35	1.00	0.06	0.02
		Slate Reef	6-9m	0.49	1.00	0.06	0.03
		Tern Reef	6-9m	0.37	1.00	0.06	0.02
	RCA	Hardy Reef	6-9m	0.58	0.45	0.03	0.02
					16.45	**1.00**	Summed Weighted Coral Cover Score: **0.35**

Table D16. Coral indicator scores for 2019-20 in the Offshore Zone. The 2019-20 overall coral index for this zone is calculated using LTMP, RAP and RCA coral cover data for the first time (only LTMP and RAP data were used prior to this Report Card). Weighted cover is calculated as per Table D15, where the cover indicator score is recalculated using weightings to reflect the reliability of the data. Weighted cover scores for each site are then summed to give the overall weighted cover indicator score.

Region	Program	Reef	Depth	Cover	Weighted Cover	Macroalgae	Juvenile	Change	Composition	Coral Index
Offshore	LTMP/RAP	19131S	6-9m	0.56	0.03		1.00	0.51		**0.69**
		19138S		0.48	0.03		1.00	0.51		**0.67**
		20104S		0.78	0.05		1.00	0.50		**0.76**
		20348S		0.14	0.01		1.00	0.00		**0.57**
		20353S		0.47	0.03		1.00	0.40		**0.63**
		21060S		0.07	0.00		1.00	0.39		**0.49**
		21062S		0.04	0.00		1.00	0.00		**0.35**
		21064S		0.09	0.01		1.00	0.00		**0.36**
		21591S		0.35	0.02		1.00	0.45		**0.60**
		Hyde Reef		0.45	0.03		1.00	0.56		**0.67**
		Penrith Island		0.26	0.02		0.28	0.53		**0.36**
		Pompey Reef (1)		0.20	0.01		1.00	0.00		**0.60**
		Pompey Reef (2)		0.41	0.03		1.00	0.43		**0.61**
		Rebe Reef		0.35	0.02		1.00	0.55		**0.63**
		Slate Reef		0.49	0.03		1.00	0.44		**0.64**
		Tern Island		0.37	0.02		0.92	0.58		**0.62**
	RCA	Hardy Reef		0.49	0.02					
		2020 Report Card score: Moderate			**0.35**		**0.95**	**0.35**		**0.55**
		2019: Moderate		0.32			0.93	0.41		**0.55**
		2018: Moderate		0.33			0.93	0.41		**0.56**
		2017: Moderate		0.36			0.98	0.38		**0.60**
		2016: Moderate		0.32			0.95	0.42		**0.57**
		2015: Moderate		0.34			0.87	0.38		**0.53**
		2014: Moderate		0.32			0.68	0.33		**0.54**

Coral index scoring range: Very Poor = 0 - 0.20 | Poor = >0.20 - 0.40 | Moderate = >0.40 - 0.60 | Good = >0.60 - 0.80 | Very Good = >0.80 | No score/data gap

Appendix D.3 – Seagrass Index

Table D17. Inshore seagrass sampling design and indicator results for the 2019-20 reporting year. Indicators are based on data collected from the Marine Monitoring Program (MMP) or Queensland Ports Seagrass Monitoring Program (QPSMP). Note, seagrass scores in the Southern Zone will be reported for the first time in the 2021 Report Card.

Zone	Habitat	Depth	Location/Meadow	Meadow/Site	MMP			QPSMP			Overall Site/Meadow Score	Overall Zone Score
					Abundance	Reproductive Effort	Nutrient Status	Biomass	Area	Species Comp.		
Northern	Coastal	Inshore	Abbot Pt.	API3				89	69	77	69	61
				API5				75	100	80	75	
				API9				41	70	97	41	
				APD1				67		0	34	
				APD2				85		94	85	
		Subtidal		APD3				57		94	57	
				APD4				91		78	85	
		Intertidal	Bowen	BW1 and 2*	44						44	
Whitsunday	Reef	Intertidal	Hydeaway Bay	HB1 and 2*	75						75	35
			Hamilton Is. 1	HM1	25	0	11				12	
			Hamilton Is. 2	HM2	0	50					25	
		Subtidal	Tongue Bay	TO1 and 2^	13						13	
			Lindeman Island	LN1 and 2	25	50	47				41	
	Coastal	Intertidal	Pioneer Bay	PI2 and 3*	44						44	
Central	Coastal	Intertidal	Midge Point	MP2 and 3	100	0	59				53	60
			St. Helens Beach	SH1*#	42						42	
		Subtidal	Newry Bay	NB1 and 2^	63						63	
	Estuarine	Intertidal	Sarina Inlet	SI1 and 2	6	13	38				19	
	Coastal	Intertidal/subtidal	Dudgeon Pt.	DP1				79	86	90	79	
		Subtidal	St. Bees Island	SB10				66	89	86	66	
			Keswick Island	KW14				73	73	93	73	
			Hay Point	HPD1				86	87	100	86	
Southern	Coastal	Intertidal	Clairview	CV1 and 2*	13						13	Not used

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 | Not applicable

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