Wetland condition monitoring methods

Reef Water Quality Report Card 2023–2025

Reef 2050 Water Quality Improvement Plan

Australian Government

Queensland Government

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CONTENTS

Wetland condition monitoring

Introduction

The Great Barrier Reef Catchment Area (GBRCA) Wetland Condition Monitoring Program (the Program) within the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program tracks progress towards the improved wetland condition objective of the Reef 2050 Water Quality Improvement Plan. This report describes the methods used to produce the wetland condition results for the Reef Water Quality Report Card 2023–2025 reporting period.

All previous Wetland condition monitoring reports are available at Reef Water Quality Report Card. Baseline data for pressure on wetland values and the state of wetland values were reported in the 2016 report card. Wetland condition (anthropogenic pressure on wetlands and the state of wetland environmental values) was reported in the 2018 report card, along with an analysis of change between 2016 and 2018. Change in wetland condition between 2018 and 2020 and between the 2016 baseline study and 2020 were reported in the 2020 report card. Wetland condition at the GBRCA-wide and Natural Resource Management (NRM) region scales and temporal change in scores were reported in the 2021 and 2022 report card.

The Program's design, data collection and analysis methods used to score wetland condition are summarised below. Analysis methods follow those outlined in the 2022 methods report (Australian and Queensland governments 2024), with minor updates as described below. For further detail on the program design, see Tilden and Vandergragt (2022).

Program design and data analysis

Survey design and sampling strategy

The Program focuses on the target subpopulation of natural, freshwater floodplain wetlands in high density aggregations in the GBRCA (**Error! Reference source not found.**). A spatially balanced random sample of wetlands from the subpopulation is drawn using Generalised Randomised Tessellation Stratification (GRTS; Stevens and Olsen 2023, 2024) and surveyed according to an augmented serially alternating panel design. Panels are groups of wetlands with the same schedule of repeat assessments across years.

Initially, about 40 wetlands were surveyed each year (

Table 1). Sampling effort then increased over time in most Natural Resource Management (NRM) regions to enable reporting at both GBRCA-wide and NRM region scales (

Table 1). In total, the Program has surveyed 225 wetlands since 2016, some annually, others every four years.

*Table 1. The Program's augmented serially alternating panel design for allocating monitoring resources through time, as followed 2016–2025. Numbers in the cells show the number of wetlands allocated to panels and thus monitored**

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Panel 1	21	22	21	21	28	36	50	50	28	35
Panel 2	20		20				44			
Panel 3		20		20				48		
Panel 4					27				28	
Panel 5						32				31
Annual Total	41	42	41	41	55	68	94	98	56	66

* The number of wetlands in panels has changed over time to enable NRM region scale reporting, and due to some changes associated with variation in monitoring resources or attrition and replacement of participating wetlands.

Data collection

Wetland assessment data are collected in two ways:

- desktop analysis based on imagery and spatial data using a range of data sets for 15 indicators primarily related to the pressure index (Sutcliffe et al. 2022)
- field-based data collection methods for nine indicators primarily related to state (Johns et al. 2022).

At the GBR-wide scale, annual status assessments are based on the data gathered from wetlands since 2016[1], focussing on 2025 as the most recent survey year in the reporting period.

At the NRM region scale, the status assessments are primarily based on data gathered from wetlands surveyed in 2023, as more wetlands were monitored that year than in any other year to date. As such, individual NRM regions in 2023 are represented by the reporting period's largest available sample size (20 wetlands each surveyed in the Wet Tropics, Burdekin, Fitzroy and Burnett Mary NRM regions, 16 in Cape York and 2 in Mackay Whitsunday). Wetland condition is not reported for the Mackay Whitsunday NRM region due to sample size constraints, but data from that region contributes to condition assessments at the GBRCA-wide scale. Given 20 wetlands in the Fitzroy NRM region have been surveyed annually since 2020, annual status is also reported for 2024 and 2025 (in addition to 2023). Status in the Cape York NRM region is also reported for 2024 (in addition to 2023) as 16 wetlands were surveyed there in both years.

Wetland Tracker subindices and overall indices of wetland condition

The condition assessment tool, Wetland Tracker (Wet Tropics) produces overall scores for anthropogenic pressure on wetlands and the state of wetland environmental values, plus scores for four pressure class (PC) subindices, and four wetland environmental value (WEV) subindices of state:

- PC1: based on 3 indicators of pest introductions (e.g. plant pests and animals changing a wetland)
- PC2: based on 3 indicators of habitat modification (e.g. loss of natural vegetation around a wetland)
- PC3: based on 3 indicators of water regime change (e.g. natural wetland water levels being altered by a dam or levee)
- PC4: based on 5 indicators of pollutant inputs (e.g. land use associated with the likelihood of sediment and nutrients going into a wetland).
- WEV1: based on 2 indicators of biotic integrity (the biological health and diversity of the wetland)
- WEV2: based on 2 indicators of local physical integrity (the wetland's natural physical state and integrity)
- WEV3: based on 4 indicators of local hydrology (the wetland's natural hydrological cycle)
- WEV4: based on 2 indicators of connectivity (the natural interaction of the wetland with other ecosystems including other wetlands).

Scoring individual wetlands and at broader scales

A three-step process is followed to generate the wetland condition scores for each of the pressure and state subindices and overall indices.

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[1] Note that in 2020 and 2021, field assessments could not be conducted in the Cape York NRM region due to COVID19 restrictions. The NRM region's 2020 and 2021 field indicator scores were imputed based on previous years' data.

Step 1. Indicator scores for individual wetlands

The 14 pressure and 10 state indicators are each assessed on an ordinal scale with integer scores ranging from one to five (Table 2).

Table 2. Indicator scoring scale

Condition	Very low pressure/Very good state	Low pressure/ Good state	Moderate pressure/ Moderate state	High pressure/ Poor state	Very high pressure/ Very poor state
Score (individual wetlands)	1	2	3	4	5

Step 2. Subindex and overall index scores for individual wetlands

Indicator scores are integrated via a boosted averaging method into numeric scores ranging from one to five for each of the eight subindices and for two overall indices of pressure and state (Tilden and Vandergragt 2022; *Table 3*).

All state indicators contribute to the overall state index, all pressure indicators contribute to the overall pressure index. Only the indicators specific to each subindex contribute to that subindex.

Step 3. Subindex and overall index scores for the GBRCA and NRM regions

Numeric scores ranging from one to five for each subindex and overall index are estimated at the GBRCA-wide and NRM region scales using model-assisted methods that retain design-based inference and account for frame error and missing data due to nonresponse. The scores are reported as decimal values, with the one to five score range being indicative of very low to very high pressure on wetlands, or a very good to very poor state of wetland environmental values (Table 3).

Table 3. Subindex and overall index scoring scale

Condition	Very low pressure/ Very good state	Low pressure/ Good state	Moderate pressure/ Moderate state	High pressure/ Poor state	Very high pressure/ Very poor state
Score (individual wetlands and broader scales)	<1.50	≥ 1.50 to <2.50	≥ 2.50 to <3.50	≥ 3.50 to <4.50	≥ 4.50

Frame error occurs when some of the wetlands in the GRTS sample do not actually belong to the target subpopulation (e.g. they might have been converted from historically estuarine to freshwater wetlands by bunding). Frame error is addressed by adjusting the design weights used to account for the panel design and unequal probability that a site is selected for surveying. Adjusting the weights by NRM region ensures that the sample of wetlands in each NRM region represents the actual target subpopulation of wetlands in each NRM region. Specifically, the weight for a wetland in any one NRM region and year is the inverse of the probability of its inclusion in the sample for that NRM region and year, as per the Horvitz–Thompson estimator (Horvitz and Thompson 1952; Cordy 1993).

The Program’s monitoring data also contain missing observations resulting from nonresponse, which occurs when a wetland due to be surveyed cannot be surveyed for some reason. Such wetlands are called nonresponding wetlands, while those that are surveyed are called responding wetlands. Reasons for nonresponse are recorded annually and include physical inaccessibility (e.g., due to geography), absence of landholder contact information, landholder declining participation, landholder postponing participation, and no reply from landholder. When this occurs, the nonresponding wetland is replaced by the next wetland in the Program's randomly generated sample of wetlands that can be surveyed and is in the same NRM region as the nonresponding wetland. As a result, the sample of wetlands on which data are collected represents the subpopulation of responding wetlands rather than wetlands from the entire target subpopulation, which represents a potential source of bias. To address this, multiple imputation (Little and Rubin, 2019) is used to 'fill in' the missing subindex and overall index scores of nonresponding wetlands before estimating scores at the GBRCA-wide and NRM region scales.

Initially it was assumed that the nonresponding wetlands for which landowners declined or postponed participation or did not reply to contact ('type A' wetlands) would score differently to those that were physically inaccessible or lacked landholder contact information ('type B' wetlands) and to responding wetlands, also that type B wetlands would score similarly to responding wetlands. Analysis of the 2022 desktop indicator and subindex scores for type A versus type B versus responding wetlands showed that in many cases, no evidence of a difference between scores was found. For indicators and subindices where evidence of differences were found, the direction of those differences was inconsistent and often counter to assumptions. For example, type A wetlands sometimes scored lower (better) than type B wetlands and responding wetlands, and type B wetlands sometimes scored higher (worse) than responding wetlands. As a result, all nonresponding wetland scores are treated as missing at random for the present report card. Imputed scores are drawn 10 times for each index and subindex from the truncated normal distribution within the bounds of the 95% confidence interval for the responding wetland mean (Rodwell et al. 2014). Previously the imputation step was conducted 40 times, however several studies suggest that more than 10 imputation steps are rarely required (Dumelle et al. 2025) and there is little to no difference in status estimates or their precision when using 10, 40 or 100 imputation steps on simulated Program data (Starceviche and Budekinshey 2022).

Frame-error corrected, design-based weighted-mean decimal estimates of wetland condition status, along with 95% confidence intervals, are then computed by year for each subindex and index using the scores from responding wetlands together with the imputed scores from nonresponding wetlands, via the Program's bespoke R package (Starcevich et al. 2025), which draws on functions in the spsurvey package (Dumelle et al. 2022). Status estimates are produced for each region and year that has a minimum sample size of 16 responding wetlands. Scores and their 95% confidence intervals are provided in the Appendix.

Backcasting data to maintain comparability across ten years of monitoring

Occasionally, it may be necessary to revise (backcast) some desktop and/or field indicator scores from previous years. Backcasting is done during quality assurance and quality control to address inaccuracies or data gaps in the mapping used for desktop indicator scores, and inadvertent errors in field indicator scores (e.g. that have become apparent with the availability of updated and/or corrected mapping or score evidence from the field).

Backcast indicator scores for 2016–2022 along with those for the current reporting period were analysed using the methods outlined above to produce the overall index and subindex scores reported in the online Reef Water Quality Report Card 2023–2025.

Based on the back-calculated results and considering the 95% confidence intervals (CIs) around the score estimates, there has been virtually no change in wetland condition (pressure or state) between years in the Great Barrier Reef catchment since 2016. Where sufficient data exists for comparisons between years within NRM regions, virtually no change is also observed (i.e. in the Cape York, Wet Tropics, Burdekin, Fitzroy and Burnett Mary NRM regions, taking the relevant 95% CIs into account). For example, the overall pressure score for the GBRCA of 2.90 falls within the 95% CI of the 2024 score (2.87–2.94).

Data confidence

A multi-criteria analysis is used to qualitatively score from one to five the confidence in each measure used in the Reef Water Quality Report Card, from low to high (Australian and Queensland governments 2024). The approach combines expert opinion and direct measures of error for program components where available.

Maturity of methods (weighting = 0.5)

Score 3 out of 3

The Wetland Tracker assessment tool (current Version 2.0, used since 2019) has been independently reviewed and published. Peer-reviewed model-assisted analytical methods that retain design based inference are used to account for frame error and missing data and to estimate annual status of wetland condition at multiple scales.

Validation (weighting = 1)

Score 2 out of 3

The assessment uses a combination of remotely sensed, ground-validated (score 2) and directly measured field survey data. The validity of indicators has been confirmed via literature review (Tilden et al. 2023).

Representativeness (weighting = 1)

Score 3 out of 3

The annual sample of wetlands has increased substantially by increasing sample sizes in NRM reporting regions. This has led to overall increase in the representativeness of the annual sample of wetlands contributing to GBRCA-wide analysis and reporting, and has enabled NRM region analysis and reporting. Power to detect trend in condition will continue to increase over time.

Directness (weighting = 1)

Score 2 out of 3

The Wetland Tracker assessment tool (Version 2.0) uses updated indicators and simplified scoring scales that have improved the directness of reporting. Measuring state can provide a direct indication of wetland condition.

Measurement error (weighting = 1)

Score 2 out of 3

The issue described in 2018, regarding loss of data precision due to overly complex scoring scales was addressed through the simplification of report card scoring and grading scales in the wetland assessment tool (Version 2.0). While it is still not possible to quantify the variance attributable to different sources of error in the data, a repeatability study was conducted in 2017 to identify sources of inter-operator variance, and versions of the assessment tool used from 2018 onward have focused on minimising this source of error variance.

Data confidence score

The sum of the above scores, taking into account their individual weightings, is 10.5. This equates to 4 stars on the 5-star scale of data confidence ranking (Table 4; Australian and Queensland governments 2024).

Table 4: Qualitative data confidence ranking, based on the sum of the weighted scores

Confidence score range	Ranking
≤ 6	One star

6.5 to 8	Two stars
8.5 to 9.5	Three stars
10 to 11.5	**Four stars**
≥ 12	Five stars

Glossary

Wetland condition scores: The wetland assessment method uses scores at three levels: **state indicators** are integrated into four **state subindices** based on wetland environmental values (WEVs), and **pressure indicators** are integrated into four **pressure class** (PC) **subindices**. All state and all pressure indicators are respectively integrated into an **overall state index** and an **overall pressure index**.

Augmented serially alternating design: A monitoring design consisting of a number of panels of sites (wetlands), where one panel is assessed every year (the augmented component of the design) and the remaining panels are assessed in different years on a regular and repeating schedule (the serially alternating component of the design).

Baseline: A baseline is the initial collection of data used for comparison with data acquired subsequently. In the case of the wetland condition monitoring component of the Reef Water Quality Report Card, baseline data were collected in 2015 and 2016 and reported in the Reef Water Quality Report Card 2016.

DPSIR framework: A causal framework for describing the interaction between society and the environment. Driver, Pressure, State, Impact, Response.

Non-response bias: Non-response bias occurs when randomly selected experimental units (e.g. wetlands) cannot be involved in a study (wetland assessment) in non-random ways meaningful to the phenomenon under study (wetland condition).

Panel: A panel is a group of wetlands with the same schedule of repeat assessments across years.

Power (to detect a change): In statistical testing, Power = $(1 - \beta)$, where β is the probability of making a Type II error, that is, failing to detect an effect when it is present.

Pressure: Pressure results from change in human activities like land use and directly affects the environment.

Spatially balanced random sample: A random sample whose sample sites are more or less evenly dispersed over the extent of the population being studied.

State: Characteristics, at a particular time, of ecosystem processes and the organisms and habitats that define, support and/or adversely affect ecosystem environmental values.

Index/indices and subindex/subindices: The Wetland Condition Monitoring Program assesses two indices of wetland condition, overall anthropogenic **pressure** on wetlands and overall **state** of wetland environmental values. There are eight subindices of wetland condition. Pressure subindices are classes of pressure (PCs) on wetlands: pest introduction, habitat modification, water regime change, and pollutant input pressures. State subindices are wetland environmental values (WEVs): biotic integrity, local physical integrity, local hydrology, and connectivity.

Wetland condition: Under the Program, wetland condition refers to the pressure on the natural environmental values of wetlands and the state of those values under a Driver, Pressure, State, Impact, Response (DPSIR) conceptual framework.

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Appendix: Scores and their 95% confidence intervals

Table 5 Overall state and state subindex scores (with lower and upper 95% confidence intervals: LCI and UCI, respectively) for the Great Barrier Reef catchment area (GBRCA)-wide scale, by year.

Region	Index	Year	Score	LCI	UCI
GBRCA	Overall state	2016	2.29	2.21	2.37
GBRCA	Overall state	2017	2.66	2.56	2.75
GBRCA	Overall state	2018	2.28	2.18	2.38
GBRCA	Overall state	2019	2.61	2.52	2.70
GBRCA	Overall state	2020	2.53	2.49	2.58
GBRCA	Overall state	2021	2.48	2.42	2.55
GBRCA	Overall state	2022	2.44	2.38	2.50
GBRCA	Overall state	2023	2.57	2.51	2.63
GBRCA	Overall state	2024	2.57	2.51	2.63
GBRCA	Overall state	2025	2.50	2.45	2.55
GBRCA	Biotic integrity	2016	2.04	1.92	2.16
GBRCA	Biotic integrity	2017	2.62	2.49	2.74
GBRCA	Biotic integrity	2018	2.19	2.06	2.31
GBRCA	Biotic integrity	2019	2.59	2.49	2.69
GBRCA	Biotic integrity	2020	2.40	2.33	2.46
GBRCA	Biotic integrity	2021	2.55	2.47	2.62
GBRCA	Biotic integrity	2022	2.41	2.33	2.49
GBRCA	Biotic integrity	2023	2.53	2.43	2.63
GBRCA	Biotic integrity	2024	2.59	2.49	2.68
GBRCA	Biotic integrity	2025	2.66	2.60	2.72
GBRCA	Connectivity	2016	2.34	2.24	2.45
GBRCA	Connectivity	2017	2.77	2.62	2.92
GBRCA	Connectivity	2018	2.40	2.28	2.51
GBRCA	Connectivity	2019	2.69	2.57	2.82
GBRCA	Connectivity	2020	2.72	2.65	2.80
GBRCA	Connectivity	2021	2.66	2.60	2.72
GBRCA	Connectivity	2022	2.58	2.53	2.62
GBRCA	Connectivity	2023	2.66	2.61	2.71
GBRCA	Connectivity	2024	2.55	2.50	2.60
GBRCA	Connectivity	2025	2.58	2.53	2.63
GBRCA	Hydrology	2016	1.82	1.68	1.96
GBRCA	Hydrology	2018	1.86	1.72	2.01
GBRCA	Hydrology	2021	2.06	1.96	2.16
GBRCA	Hydrology	2022	2.09	2.02	2.17
GBRCA	Hydrology	2019	2.10	1.93	2.28
GBRCA	Hydrology	2020	2.11	2.02	2.19
GBRCA	Hydrology	2025	2.12	2.06	2.19
GBRCA	Hydrology	2017	2.18	2.00	2.35
GBRCA	Hydrology	2024	2.22	2.11	2.34
GBRCA	Hydrology	2023	2.25	2.12	2.37
GBRCA	Physical integrity	2016	3.17	2.96	3.38

GBRCA	Physical integrity	2017	3.33	3.15	3.52
GBRCA	Physical integrity	2018	2.90	2.67	3.13
GBRCA	Physical integrity	2019	3.29	3.09	3.48
GBRCA	Physical integrity	2020	3.14	3.01	3.26
GBRCA	Physical integrity	2021	2.90	2.75	3.04
GBRCA	Physical integrity	2022	2.86	2.71	3.01
GBRCA	Physical integrity	2023	3.02	2.89	3.16
GBRCA	Physical integrity	2024	3.09	2.94	3.24
GBRCA	Physical integrity	2025	2.80	2.66	2.94

Table 6 Overall state and state subindex scores (with lower and upper 95% confidence intervals: LCI and UCI, respectively) for the natural resource management (NRM) regions (for regions and years where sufficient data are available to estimate scores).

Region	Index	Year	Score	LCI	UCI
Cape York	Biotic integrity	2023	1.59	1.36	1.83
Cape York	Biotic integrity	2024	1.62	1.41	1.84
Cape York	Connectivity	2023	1.05	0.97	1.13
Cape York	Connectivity	2024	1.00	1.00	1.01
Cape York	Hydrology	2023	1.22	0.92	1.51
Cape York	Hydrology	2024	1.22	0.97	1.46
Cape York	Overall state	2023	1.75	1.61	1.90
Cape York	Overall state	2024	1.76	1.64	1.88
Cape York	Physical integrity	2023	3.36	3.03	3.68
Cape York	Physical integrity	2024	3.38	3.01	3.76
Wet Tropics	Biotic integrity	2021	3.05	2.91	3.18
Wet Tropics	Biotic integrity	2022	3.08	2.99	3.18
Wet Tropics	Biotic integrity	2023	3.10	2.95	3.25
Wet Tropics	Connectivity	2021	3.51	3.35	3.66
Wet Tropics	Connectivity	2022	3.57	3.45	3.69
Wet Tropics	Connectivity	2023	3.46	3.30	3.63
Wet Tropics	Hydrology	2021	3.30	3.17	3.42
Wet Tropics	Hydrology	2022	3.22	3.14	3.31
Wet Tropics	Hydrology	2023	3.23	3.07	3.39
Wet Tropics	Overall state	2021	3.05	2.97	3.13
Wet Tropics	Overall state	2022	3.13	3.08	3.18
Wet Tropics	Overall state	2023	3.06	2.96	3.16
Wet Tropics	Physical integrity	2021	2.36	2.22	2.49
Wet Tropics	Physical integrity	2022	2.70	2.59	2.80
Wet Tropics	Physical integrity	2023	2.43	2.25	2.60
Burdekin	Biotic integrity	2022	3.27	3.19	3.36
Burdekin	Biotic integrity	2023	3.48	3.38	3.59
Burdekin	Connectivity	2022	3.05	2.93	3.18
Burdekin	Connectivity	2023	3.15	3.03	3.27
Burdekin	Hydrology	2022	2.97	2.82	3.12
Burdekin	Hydrology	2023	3.21	3.08	3.34
Burdekin	Overall state	2022	3.03	2.96	3.09
Burdekin	Overall state	2023	3.17	3.10	3.24
Burdekin	Physical integrity	2022	2.87	2.75	3.00
Burdekin	Physical integrity	2023	2.89	2.76	3.03
Fitzroy	Biotic integrity	2020	3.13	3.04	3.22
Fitzroy	Biotic integrity	2021	3.47	3.39	3.55
Fitzroy	Biotic integrity	2022	3.35	3.24	3.47
Fitzroy	Biotic integrity	2023	3.14	3.04	3.24
Fitzroy	Biotic integrity	2024	3.40	3.32	3.48
Fitzroy	Biotic integrity	2025	3.60	3.52	3.68
Fitzroy	Connectivity	2020	4.29	4.21	4.38

Fitzroy	Connectivity	2021	4.01	3.92	4.10
Fitzroy	Connectivity	2022	3.93	3.78	4.07
Fitzroy	Connectivity	2023	4.01	3.92	4.10
Fitzroy	Connectivity	2024	3.90	3.79	4.01
Fitzroy	Connectivity	2025	4.01	3.93	4.10
Fitzroy	Hydrology	2020	2.62	2.44	2.80
Fitzroy	Hydrology	2021	2.43	2.27	2.58
Fitzroy	Hydrology	2022	2.41	2.19	2.63
Fitzroy	Hydrology	2023	2.50	2.34	2.65
Fitzroy	Hydrology	2024	2.75	2.63	2.88
Fitzroy	Hydrology	2025	2.60	2.47	2.74
Fitzroy	Overall state	2020	3.29	3.21	3.36
Fitzroy	Overall state	2021	3.13	3.07	3.19
Fitzroy	Overall state	2022	3.05	2.95	3.16
Fitzroy	Overall state	2023	3.18	3.10	3.26
Fitzroy	Overall state	2024	3.29	3.22	3.36
Fitzroy	Overall state	2025	3.17	3.11	3.24
Fitzroy	Physical integrity	2020	3.51	3.37	3.66
Fitzroy	Physical integrity	2021	2.98	2.86	3.10
Fitzroy	Physical integrity	2022	2.86	2.67	3.06
Fitzroy	Physical integrity	2023	3.40	3.25	3.54
Fitzroy	Physical integrity	2024	3.45	3.32	3.57
Fitzroy	Physical integrity	2025	2.82	2.69	2.96
Burnett Mary	Biotic integrity	2022	2.41	2.25	2.57
Burnett Mary	Biotic integrity	2023	2.72	2.52	2.91
Burnett Mary	Biotic integrity	2025	2.52	2.36	2.69
Burnett Mary	Connectivity	2022	3.09	2.96	3.22
Burnett Mary	Connectivity	2023	3.40	3.25	3.54
Burnett Mary	Connectivity	2025	3.28	3.14	3.43
Burnett Mary	Hydrology	2022	2.85	2.71	2.99
Burnett Mary	Hydrology	2023	3.21	3.04	3.38
Burnett Mary	Hydrology	2025	2.84	2.68	3.00
Burnett Mary	Overall state	2022	2.60	2.52	2.67
Burnett Mary	Overall state	2023	2.84	2.74	2.95
Burnett Mary	Overall state	2025	2.62	2.52	2.73
Burnett Mary	Physical integrity	2022	2.03	1.92	2.14
Burnett Mary	Physical integrity	2023	2.03	1.82	2.24
Burnett Mary	Physical integrity	2025	1.84	1.68	2.00

Table 7 Overall pressure and pressure subindex scores (with lower and upper 95% confidence intervals: LCI and UCI, respectively) for the Great Barrier Reef catchment area (GBRCA)-wide scale, by year.

Region	Index	Year	Score	LCI	UCI
GBRCA	Overall pressure	2016	2.62	2.53	2.71
GBRCA	Overall pressure	2017	2.95	2.87	3.04
GBRCA	Overall pressure	2018	2.70	2.61	2.78
GBRCA	Overall pressure	2019	2.94	2.87	3.00
GBRCA	Overall pressure	2020	2.88	2.84	2.92
GBRCA	Overall pressure	2021	2.88	2.83	2.94
GBRCA	Overall pressure	2022	2.84	2.79	2.90
GBRCA	Overall pressure	2023	2.98	2.93	3.03
GBRCA	Overall pressure	2024	2.90	2.87	2.94
GBRCA	Overall pressure	2025	2.90	2.85	2.95
GBRCA	Habitat modification	2016	2.63	2.50	2.76
GBRCA	Habitat modification	2017	3.05	2.91	3.20
GBRCA	Habitat modification	2018	2.70	2.57	2.83
GBRCA	Habitat modification	2019	2.98	2.85	3.11
GBRCA	Habitat modification	2020	2.98	2.90	3.06
GBRCA	Habitat modification	2021	2.93	2.84	3.02
GBRCA	Habitat modification	2022	2.83	2.73	2.93
GBRCA	Habitat modification	2023	2.96	2.87	3.05
GBRCA	Habitat modification	2024	2.94	2.87	3.02
GBRCA	Habitat modification	2025	2.90	2.82	2.98
GBRCA	Pest introduction	2016	3.33	3.23	3.43
GBRCA	Pest introduction	2017	3.47	3.39	3.55
GBRCA	Pest introduction	2018	3.40	3.30	3.50
GBRCA	Pest introduction	2019	3.50	3.42	3.59
GBRCA	Pest introduction	2020	3.53	3.47	3.60
GBRCA	Pest introduction	2021	3.49	3.43	3.55
GBRCA	Pest introduction	2022	3.47	3.41	3.52
GBRCA	Pest introduction	2023	3.64	3.57	3.70
GBRCA	Pest introduction	2024	3.59	3.54	3.65
GBRCA	Pest introduction	2025	3.56	3.50	3.63
GBRCA	Pollutant input	2016	2.16	2.05	2.28
GBRCA	Pollutant input	2017	2.44	2.33	2.55
GBRCA	Pollutant input	2018	2.15	2.03	2.28
GBRCA	Pollutant input	2019	2.37	2.27	2.47
GBRCA	Pollutant input	2020	2.26	2.19	2.33
GBRCA	Pollutant input	2021	2.31	2.23	2.39
GBRCA	Pollutant input	2022	2.34	2.26	2.42
GBRCA	Pollutant input	2023	2.48	2.38	2.58
GBRCA	Pollutant input	2024	2.33	2.25	2.42
GBRCA	Pollutant input	2025	2.35	2.25	2.44
GBRCA	Water regime change	2016	2.53	2.37	2.69
GBRCA	Water regime change	2017	3.07	2.96	3.17
GBRCA	Water regime change	2018	2.73	2.62	2.83

GBRCA	Water regime change	2019	3.09	3.02	3.17
GBRCA	Water regime change	2020	2.99	2.94	3.04
GBRCA	Water regime change	2021	3.01	2.95	3.08
GBRCA	Water regime change	2022	2.93	2.88	2.98
GBRCA	Water regime change	2023	3.03	3.00	3.06
GBRCA	Water regime change	2024	2.97	2.93	3.01
GBRCA	Water regime change	2025	2.98	2.94	3.02

Table 8 Overall pressure and pressure subindex scores (with lower and upper 95% confidence intervals: LCI and UCI, respectively) for the natural resource management (NRM) regions (for regions and years where sufficient data are available to estimate scores).

Region	Index	Year	Score	LCI	UCI
Cape York	Habitat modification	2023	1.56	1.35	1.78
Cape York	Habitat modification	2024	1.61	1.47	1.74
Cape York	Overall pressure	2023	2.04	1.92	2.16
Cape York	Overall pressure	2024	1.94	1.86	2.01
Cape York	Pest introduction	2023	2.90	2.74	3.05
Cape York	Pest introduction	2024	2.62	2.53	2.71
Cape York	Pollutant input	2023	1.44	1.19	1.70
Cape York	Pollutant input	2024	1.28	1.07	1.48
Cape York	Water regime change	2023	2.42	2.37	2.46
Cape York	Water regime change	2024	2.38	2.34	2.41
Wet Tropics	Habitat modification	2021	3.86	3.72	3.99
Wet Tropics	Habitat modification	2022	3.95	3.85	4.04
Wet Tropics	Habitat modification	2023	3.84	3.69	3.98
Wet Tropics	Overall pressure	2021	3.58	3.51	3.66
Wet Tropics	Overall pressure	2022	3.66	3.61	3.71
Wet Tropics	Overall pressure	2023	3.53	3.44	3.62
Wet Tropics	Pest introduction	2021	3.89	3.81	3.96
Wet Tropics	Pest introduction	2022	3.95	3.88	4.01
Wet Tropics	Pest introduction	2023	3.78	3.68	3.88
Wet Tropics	Pollutant input	2021	3.43	3.33	3.54
Wet Tropics	Pollutant input	2022	3.57	3.51	3.63
Wet Tropics	Pollutant input	2023	3.37	3.24	3.50
Wet Tropics	Water regime change	2021	3.31	3.24	3.38
Wet Tropics	Water regime change	2022	3.30	3.24	3.36
Wet Tropics	Water regime change	2023	3.31	3.22	3.41
Burdekin	Habitat modification	2022	3.10	2.99	3.20
Burdekin	Habitat modification	2023	3.37	3.28	3.46
Burdekin	Overall pressure	2022	3.43	3.37	3.50
Burdekin	Overall pressure	2023	3.56	3.50	3.62
Burdekin	Pest introduction	2022	4.13	4.07	4.19
Burdekin	Pest introduction	2023	4.21	4.16	4.26
Burdekin	Pollutant input	2022	3.21	3.12	3.29
Burdekin	Pollutant input	2023	3.21	2.34	2.79
Burdekin	Water regime change	2022	3.43	3.35	3.51
Burdekin	Water regime change	2023	3.60	3.52	3.68
Fitzroy	Habitat modification	2020	4.23	4.14	4.32
Fitzroy	Habitat modification	2021	4.14	4.05	4.23
Fitzroy	Habitat modification	2022	3.97	3.84	4.11
Fitzroy	Habitat modification	2023	4.10	4.02	4.18
Fitzroy	Habitat modification	2024	4.11	4.04	4.17
Fitzroy	Habitat modification	2025	4.19	4.11	4.27
Fitzroy	Overall pressure	2020	3.62	3.59	3.66

Fitzroy	Overall pressure	2021	3.66	3.61	3.71
Fitzroy	Overall pressure	2022	3.55	3.48	3.63
Fitzroy	Overall pressure	2023	3.68	3.64	3.72
Fitzroy	Overall pressure	2024	3.69	3.65	3.72
Fitzroy	Overall pressure	2025	3.68	3.63	3.74
Fitzroy	Pest introduction	2020	3.79	3.71	3.87
Fitzroy	Pest introduction	2021	4.07	3.99	4.14
Fitzroy	Pest introduction	2022	4.06	3.97	4.14
Fitzroy	Pest introduction	2023	4.21	4.14	4.29
Fitzroy	Pest introduction	2024	4.16	4.08	4.23
Fitzroy	Pest introduction	2025	4.13	4.05	4.20
Fitzroy	Pollutant input	2020	3.05	3.00	3.11
Fitzroy	Pollutant input	2021	3.00	2.93	3.08
Fitzroy	Pollutant input	2022	3.05	2.98	3.13
Fitzroy	Pollutant input	2023	3.11	3.06	3.15
Fitzroy	Pollutant input	2024	3.09	3.05	3.14
Fitzroy	Pollutant input	2025	3.05	2.98	3.13
Fitzroy	Water regime change	2020	3.72	3.65	3.78
Fitzroy	Water regime change	2021	3.70	3.62	3.79
Fitzroy	Water regime change	2022	3.41	3.27	3.56
Fitzroy	Water regime change	2023	3.63	3.56	3.69
Fitzroy	Water regime change	2024	3.68	3.63	3.73
Fitzroy	Water regime change	2025	3.66	3.57	3.74
Burnett Mary	Habitat modification	2022	3.32	3.21	3.43
Burnett Mary	Habitat modification	2023	3.55	3.42	3.68
Burnett Mary	Habitat modification	2025	3.52	3.38	3.65
Burnett Mary	Overall pressure	2022	2.99	2.90	3.08
Burnett Mary	Overall pressure	2023	3.32	3.23	3.41
Burnett Mary	Overall pressure	2025	3.12	3.02	3.22
Burnett Mary	Pest introduction	2022	3.58	3.49	3.67
Burnett Mary	Pest introduction	2023	4.01	3.88	4.13
Burnett Mary	Pest introduction	2025	3.72	3.62	3.82
Burnett Mary	Pollutant input	2022	2.49	2.34	2.64
Burnett Mary	Pollutant input	2023	2.93	2.80	3.06
Burnett Mary	Pollutant input	2025	2.66	2.53	2.79
Burnett Mary	Water regime change	2022	2.80	2.66	2.94
Burnett Mary	Water regime change	2023	2.94	2.79	3.09
Burnett Mary	Water regime change	2025	2.79	2.64	2.93