WETLAND CONDITION 2022

GREAT BARRIER REEF CATCHMENT WETLAND CONDITION MONITORING PROGRAM

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Great Barrier Reef Catchment Wetland Monitoring Program

November 2023

Prepared by the Wetland Condition Science team, Ecosystem Survey & Mapping, Queensland Herbarium and Biodiversity Science, Department of Environment and Science.

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Executive summary

The Wetland Condition Monitoring Program (the Program) tracks progress towards an objective of improved wetland condition, focussing on natural, freshwater floodplain wetlands in major aggregations within the Great Barrier Reef catchment area (GBRCA). The Program uses a rapid assessment tool called Wetland Tracker to gather data on its sample of wetlands each year for a suite of 23 indicators. Indicators are aggregated into overall indices and subindices of pressure on and the state for each wetland. These data are then analysed to determine the annual status of wetland condition at the scale of the GBRCA and natural resource management (NRM) regions. Change over time (annual trend) in pressure on and the state of wetlands is also determined at the scale of the GBRCA.

This Wetland Condition 2022 report details the wetland condition assessment methods plus the status and trend results for the 2022 reporting year. Scores can range from 1 to 5, where 1 is the best score possible and 5 is the worst.

At the scale of the GBRCA, freshwater floodplain wetlands in the GRBCA received a 2022 score of 2.46 (95% confidence interval (CI): 2.41 to 2.52) for their overall state. No annual improvement or decline in overall state since 2016 was detected. These same wetlands received an overall GBRCA pressure score of 2.86 (95% CI: 2.81 to 2.91) for 2022. As with overall state, no annual increase or decrease in the overall pressure on these wetlands since 2016 was detected.

However, some change over time since 2016 was detected at the GBRCA-wide scale in wetland local physical integrity (small annual improvement) and biotic integrity (small annual decline) and in the pressure from water regime change (small annual increase).

The 2022 scores for the state of and pressure on freshwater floodplain wetlands at the NRM-region scale differed among the four NRM regions for which reporting has commenced (Wet Tropics, Burdekin, Fitzroy and Burnett Mary). In most cases, the scores for state and pressure indices and subindices for the Burnett Mary NRM region tended to be lower (i.e. better) than the respective scores for state and pressure indices and subindices for the three other NRM regions. In addition, the 2022 pressure index and subindex scores within each NRM region tended to be higher (i.e. worse) than the scores for state within each of the respective NRM regions, which was similar to the 2022 GBRCA-wide scale results.

Findings suggest that at the scale of the GBRCA, management actions focussed on protecting and re-establishing native vegetation in wetland riparian buffer areas should help to improve wetland biotic integrity and contribute to their improved connectivity. Actions to control pest animals and manage livestock access should contribute to improving wetland physical integrity. Finally, actions to reduce impacts of drainage modifications and artificial structures on surface flows should help to improve wetland hydrological integrity.

In terms of reducing overall pressure on wetlands in the GBRCA, management actions could focus on reducing pressures from pest species in wetlands and surrounding areas; reducing barriers to flow to restore natural water flow patterns; managing water abstraction and livestock access; restoring native vegetation in buffer areas and habitat corridors; and managing nutrient and sediment run-off.

The monitoring program is designed to detect improvement in wetland condition in response to management action undertaken at the landscape scale. Therefore, to detect via the monitoring program whether actions aimed at improving wetland condition in the GBRCA are having the desired effect, they should be implemented in the monitored wetland aggregations.

Introduction: assessing wetland condition

The Wetland Condition Monitoring Program (the Program) tracks progress towards the improved wetland condition objective of the Reef 2050 Long Term Sustainability Plan, including the Reef 2050 Water Quality Improvement Plan.

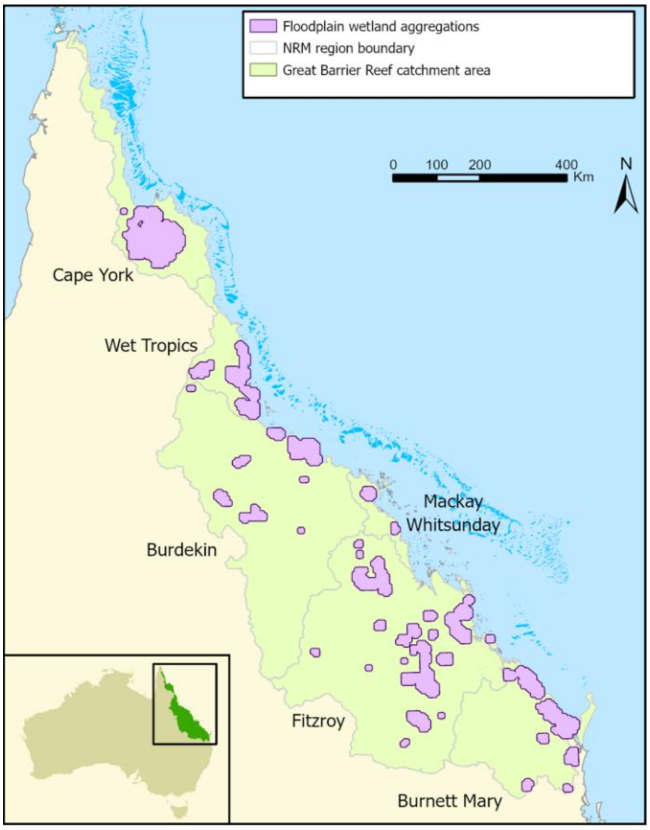


***Figure 1:** Major aggregations of freshwater floodplain wetlands and those assessed (in panels 1, 2 and 5) since last reported. See Box 1 for an explanation of panels.*

The Program focuses on monitoring the condition of natural, freshwater floodplain wetlands in major aggregations (**Figure 1**), using a rapid assessment tool called Wetland Tracker (Tilden and Vandergragt 2022). This enables the Program to monitor and report on *wetland condition*, defined as anthropogenic pressure on wetlands and the current state of their environmental values. Monitoring and reporting is done for natural resource management (NRM) regions within the Great Barrier Reef catchment area (GBRCA) as well as for the GBRCA overall.

The Program assesses and reports on two overall indices of wetland condition: overall anthropogenic pressure on and the overall state of wetlands. In addition, four standalone pressure subindices that describe specific types of anthropogenic pressure are assessed and reported on: pest plant and animal introductions, habitat modification, water regime change, and pollutant inputs. Likewise, four standalone subindices that describe wetland environmental values are assessed and reported on: biotic integrity, local physical integrity, local hydrology, and connectivity.

In sum, there are two overall indices, four pressure subindices and four state subindices, which are each calculated separately from suites of individual pressure and state indicators. Tilden et al. (2023) provide the evidence base supporting the conceptual and ecological links between the condition of freshwater wetlands and each of the Program’s pressure and state indicators and indices.

Data on the Program's indicators and indices of wetland condition have been collected since 2016, when the baseline pressure and state data for the GBRCA overall were reported as a component of the Reef 2050 Water Quality Report Card.

The present report details the wetland condition results and methods for the 2022 reporting year. The report includes results of an analysis of change over time since 2016 (annual trend) in wetland condition as well as the status of wetland condition at the GBRCA-wide and NRM region scales, using state-of-the-art data analysis methods.

Methods

Sampling design

The Program monitors a spatially balanced random sample of around 240 wetlands from the subpopulation of natural, freshwater floodplain wetlands in high density aggregations (**Figure 1, Table 1**). The sample is selected using a method known as Generalised Randomised Tessellation Stratified (GRTS) sampling (Stevens and Olsen 2003, 2004).

Table 1: *Panel design for the Great Barrier Reef catchments Wetland Monitoring Program*.*

Panel	Year									
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
1	20	20	20	20	28	36	50	50	50	50
2	20		20				44			
3		20		20				49		
4					27				49	
5						32				46
Year total	40	40	40	40	55	68	94	99	99	96
Total sample	**40**	**60**	**60**	**60**	**96**	**136**	**174**	**203**	**225**	**239**

*Some wetland sample sizes per panel differ slightly from the planned size due to factors such as attrition and replacement. For example, panel 1 originally comprised 21 wetlands, but only 19 of these have been assessed repeatedly; two have dropped out and been replaced. Since 2020, more wetlands have been added to panels as part of the NRM-region intensification process.

Wetlands are monitored according to a design schedule known as an 'augmented serially alternating panel design,' where panels are groups of wetlands that have the same revisit schedule across years. The Program has five panels, each comprising about fifty wetlands from across the NRM regions. One panel of wetlands is surveyed every year and the remaining panels are surveyed every four years on a rotating basis, such that around 100 wetlands are surveyed in total each year from across two panels

(**Table 1**). At the end of every four years, all participating wetlands in the Program have been sampled, and the four-year schedule starts again.

The number of wetlands surveyed annually (~100) is an increase from the 40 wetlands surveyed each year for the first few years of the Program (**Table 1**). The increase has happened gradually since 2020 to enable assessment and reporting of wetland condition at the NRM region scale for the Wet Tropics, Burdekin, Fitzroy and Burnett Mary NRM regions, in addition to the assessment and reporting at the GBRCA-wide scale.

Intensification has not occurred in Mackay Whitsunday or Cape York NRM regions due to constrained sample size and logistical constraints, respectively.

Data collection and scoring for individual wetlands

Wetland Tracker indicators

The Program's condition assessment tool, Wetland Tracker, outlines the field and desktop-based methods used to collect data from wetlands, score each indicator, and generate subindex and overall index scores for each wetland. For each wetland:

- Desktop analysis based on imagery and spatial data from a range of datasets is analysed to score 15 indicators that are primarily related to pressure on wetlands (Sutcliffe et al. 2022).
- Field-based data collection is conducted to score nine indicators that are primarily related to the state of wetlands (Johns et al. 2022).

Each indicator is given an integer score on an ordinal scale ranging from 1 to 5, inclusive, where 1 is the best score possible and 5 is the worst (**Table 2**).

Table 2: *Indicator score scaling.*

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**
Indicator scores (individual wetlands)	1	2	3	4	5

Note that field assessments could not be conducted in the Cape York NRM region in 2020 or 2021 due to COVID19 restrictions. The 2020 and 2021 field indicator scores for Cape York wetlands were imputed based on data from previous years.

Wetland Tracker indices

For each wetland, the indicator scores are then aggregated into subindex numeric scores ranging from 1 to 5, inclusive, for each of the eight subindices (four for pressure and four for state). Independently, the indicator scores are aggregated to generate for each wetland an overall numeric pressure index score and an overall numeric state index score, which can each take on values ranging from 1 to 5, inclusive. As with the individual indicators, a score of 1 is the best possible and a score of 5 is the worst possible. Tilden and Vandergragt (2022) outline the index and subindex aggregation methods.

Data analysis: GBRCA-wide and NRM region scale scoring

For each subindex and index in turn, the scores from all wetlands are analysed to generate subindex and index scores at the GBRCA-wide and NRM region scales using state-of-the-art, model-assisted methods that can account for nonresponse bias and frame error (see below) and assess change over time (trend) in wetland condition (see below). The resulting numeric scores range in value from 1 to 5, inclusive, where 1 is the best possible score and 5 is the worst. Analyses are conducted in R, a language and environment for statistical computing (R Core Team 2022), using a bespoke package (Starcevich 2022).

Non-response bias

The Program established early on that there was nonresponse bias in the wetland assessment data (Australian and Queensland Governments 2016). Reasons for nonresponse are recorded annually and include site inaccessibility (e.g., due to geography); absence of landholder contact information; landholder declining to grant access for sampling; landholder postponement of access for sampling; and no reply from landholder. When this occurs, the 'nonresponding' wetland is replaced from the randomly generated sample (GRTS) list by the next wetland on the list, in the same NRM region as the nonresponding wetland, that can be sampled. This makes the replacement wetland a 'responding' 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, and this represents a potential source of what is known as nonresponse bias.

Logistic regression performed on data gathered to date indicates that NRM region, rather than the intensity of land use surrounding wetlands, is the best predictor, according the corrected Akaike Information Criterion (AICc; Burnham and Anderson 2010), of whether a wetland is nonresponding or responding (with statistical significance, alpha, set at 0.05).

To account for the non-response bias, a state-of-the-art multiple imputation method (Little and Rubin 2019) is used to impute subindex and overall index scores for non-responding wetlands, NRM region by NRM region.

Nonresponding wetlands that are inaccessible due to geography or have no contact information are treated as missing at random (MAR) and those for which landowners decline or postpone participation or do not reply to contact, as missing not at random (NMAR). Wetland condition is assumed to be related to NMAR but not MAR nonresponse, so NMAR and MAR scores are imputed differently. For each index within each NRM region, score means and variances for MAR wetlands are considered similar to those of responding wetlands, under the quasi-randomisation assumption (Oh and Scheuren 1983). So, for each NRM region, forty imputations are drawn for each MAR wetland and index from the truncated normal distribution, within the bounds of the 95% confidence interval for the responding wetland mean (Rodwell et al. 2014). For NMAR cases, scores for each index within each NRM region are assumed to be no lower than the average score observed for responding wetlands. So, for each NRM region, forty imputations are drawn for each NMAR wetland and index from the truncated half-normal distribution (Rodwell et al. 2014), within the bounds of the responding wetland mean up to the maximum score of 5.

The imputed scores for nonresponding wetlands are analysed together with scores from responding wetlands to produce estimates of status and trend in wetland condition that account for nonresponse bias.

Frame error

Frame error results when some wetlands in the list of those approached for assessment do not actually belong to the target subpopulation (e.g. they might have been converted from estuarine to fresh water). Logistic regression performed on data gathered to date indicates that NRM region is the best predictor, according the AICc, of whether or not a wetland is a member of the target subpopulation (with statistical significance, alpha, set at 0.05).

To account for frame error, design weights are applied within NRM regions that sum to the total number of target wetlands in each relevant NRM region. This ensures that the sample of wetlands in an NRM region will represent the target population of wetlands in that 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).

Status: pressure on and the state of wetlands each year

At the *GBRCA-wide scale*, the analysis of wetland condition status in each year since 2016 uses data from responding and nonresponding wetlands *across all six NRM regions combined* in the panels for each respective year as per **Table 1**. For example, the status assessments for 2022 are based on data from panels 1 and 2.

At the *NRM region scale*, the analysis of wetland condition status in each year since 2016 uses data from responding and nonresponding wetlands *within each respective NRM region* in the panels for each respective year as per **Table 1**. Status at the NRM region scale is analysed for 2022 only, as this is the first available year of baseline data for the NRM regions (excluding Mackay Whitsunday and Cape York, for which regional intensification is yet to commence).

Annual design-based estimates of status and 95% confidence intervals are computed for each pressure and state index and subindex using weighted linear regression for design-based estimates (WLRDB; Starcevich et al. 2018a), the 'cont_analysis' function in the 'spsurvey' package (Dumelle et al. 2022) and the neighbourhood variance estimator (Stevens and Olsen 2003, 2004).

The 95% confidence interval is the range of values for which there is 95% confidence that it contains the true value of the score being estimated, based on the Program's sample of wetlands and the methods used to estimate that score. The narrower the range, the more certainty there is in the estimate.

Trend: change over time in the pressure on and state of wetlands

The analysis of change over time (annual trend) in the pressure on and state of wetlands *at the GBRCA-wide scale* is done using data gathered since 2016 from responding and nonresponding wetlands across *all six NRM regions combined*.

Trend is not reported at the NRM region scale, because there are three or fewer years only of regional intensification data available to date, which is insufficient for trend detection (Starcevich et al. 2018b; White 2019).

A trend modelling approach is used to estimate change over time for each index and subindex as the annual improvement, decline or no change in status since 2016, along with 95% confidence intervals. Trend estimates and variances are combined across imputations so that the additional variation from multiple imputation is reflected in the variance of the trend estimate.

The linear mixed effects trend model of Piepho and Ogutu (PO; Piepho and Ogutu 2002), which can include random intercept and slope effects (e.g. for NRM regions and/or wetlands), is used to provide inference and perform diagnostic checks on residuals. PO models are fitted using the 'glmmTMB' package (Brooks et al. 2017), and the ‘lmerTest’ package (Kuznetsova et al. 2017) is used to construct 95% confidence intervals and Wald t-tests for trend testing.

The probability-weighted iterative generalized least squares (PWIGLS) model of Starcevich et al. (2018a), which can incorporate the design weights to account for frame error, is then used to provide inference on annual trend. Using both the PO and PWGLS methods enables the effects of weighting and random effects on trend inference to be evaluated.

Results of PWIGLS models are reported below, with statistical significance of trends set at alpha = 0.05.

Results

GBRCA-wide results

Status: the state of GBRCA wetlands in 2022

Freshwater floodplain wetlands in the GRBCA have a score of 2.46 in 2022 for their *overall state* (**Figure 2**). The 95% confidence interval for this score is 2.41 to 2.52 (**Figure 2**).

Out of the four wetland environmental values, *local hydrology* scores a little lower (i.e. better) than the *overall state* index, *biotic integrity* scores similarly to the *overall state* index, while *local physical integrity* and *connectivity* score higher (i.e. worse) than the *overall state* index (**Figure 2**).

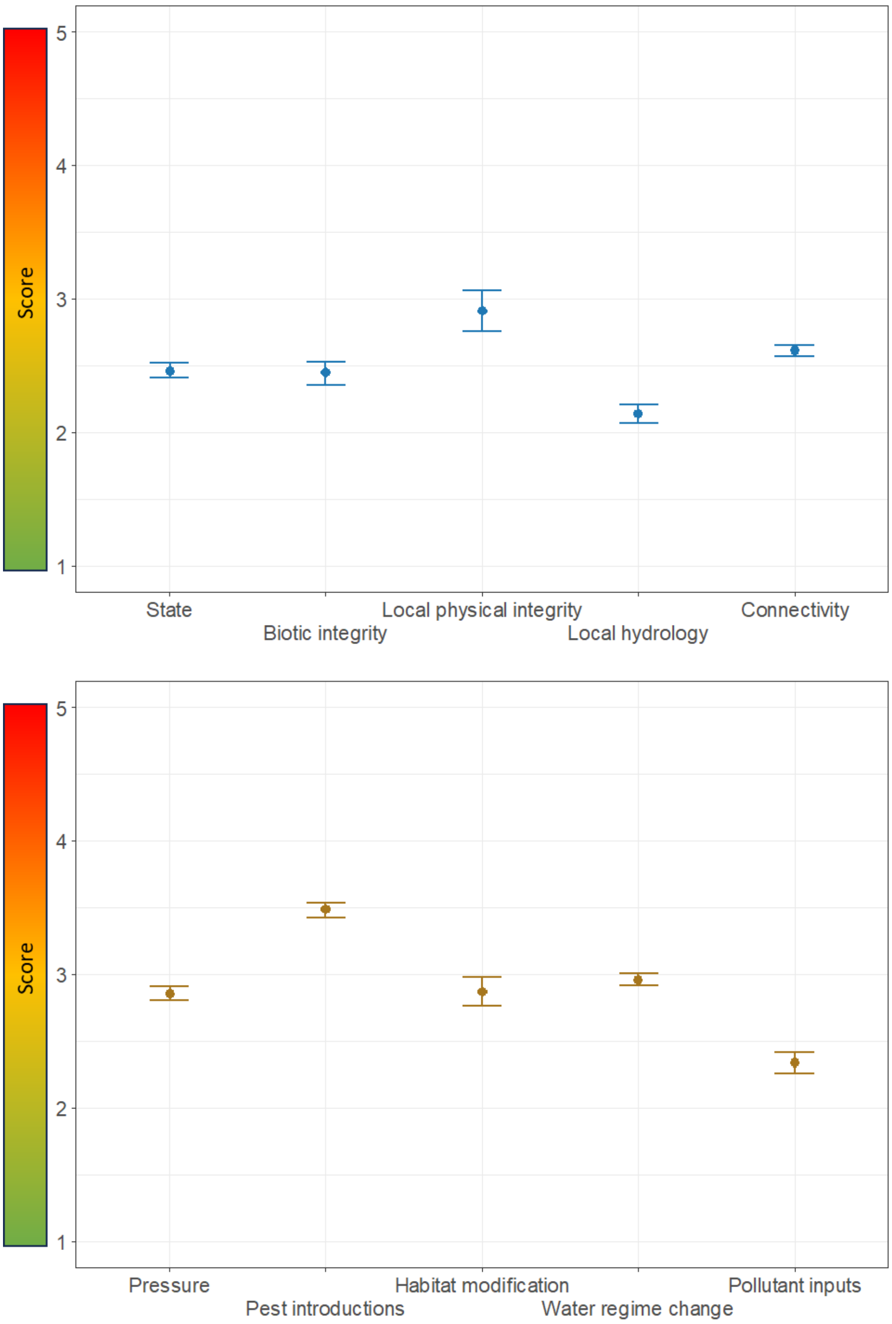


***Figure 2:** The 2022 state (left plots, blue closed circles) and pressure scores (right plots, brown closed circles) for wetland condition indices and subindices, with upper and lower bounds of the 95% confidence intervals shown as 'error bars,' for the Great Barrier Reef catchment area. Note that higher scores are worse, and scores range from 1 (best possible score) to 5 (worst possible score).*

Trend: change over time in the state of GBRCA wetlands

In terms of change over time since 2016, there has been no annual improvement or decline (i.e. trend) in the *overall state* of freshwater floodplain wetlands across the GBRCA overall (**Figure 3**).

There has, however, been an annual trend since 2016 in the *local physical integrity* of GBRCA wetlands (**Figure 3**). The small annual improvement is represented by a score decrease of approximately 0.10 per year, with a 95% confidence interval of 0.04 to 0.16 per year.

Finally, a small annual trend of decline since 2016 was detected in the *biotic integrity* of GBRCA wetlands (represented by a score increase of approximately 0.08 per year; **Figure 3**). The 95% confidence interval for this annual change in score is 0.02 to 0.09.

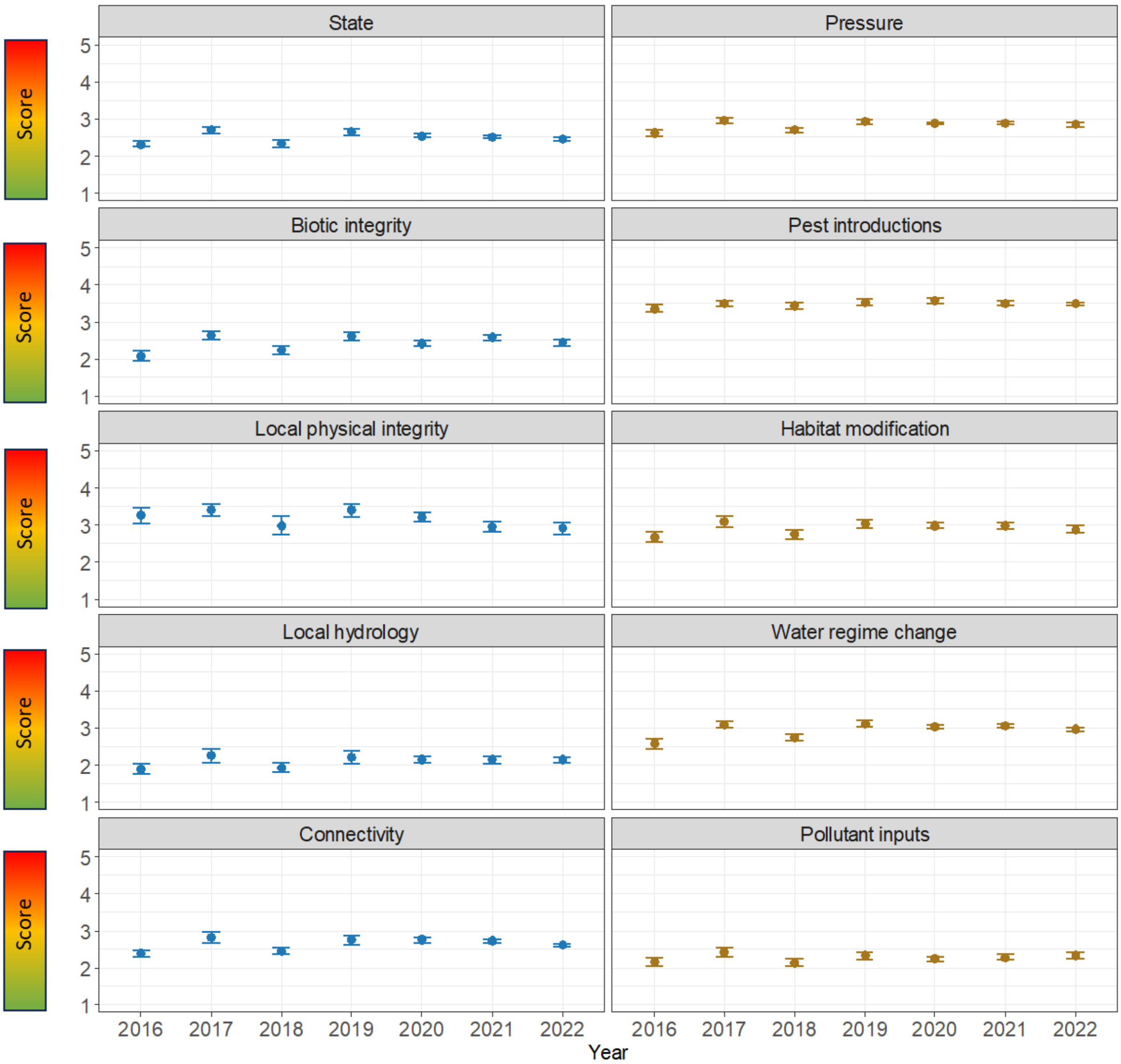


Figure 3: *State (left plots, blue closed circles) and pressure scores (right plots, brown closed circles) by year for wetland condition indices and subindices, with upper and lower bounds of the 95% confidence intervals shown as 'error bars,' for the Great Barrier Reef catchment area.*

Note that no trends were detected using PO models that included random effects. However, when random effects were removed, a decline in the biotic integrity of wetlands was detected. These findings align with results of the PWIGLS models for this state subindex (as reported above; PWIGLS models do not include random effects but do include design weights to account for frame error).

Status: pressure on GBRCA wetlands in 2022

In 2022, freshwater floodplain wetlands at the scale of the GBRCA have an *overall pressure* score of 2.86 (**Figure 2**). The 95% confidence interval for this score is 2.81 to 2.91 (**Figure 2**).

The score for pressure from *pest introductions* is higher (i.e. worse) than that of the *overall pressure* index while the score from *pollutant inputs* is lower (**Figure 2**). Scores from *habitat modification* and *water regime change* are similar to each other in value and to the score for the *overall pressure* index (**Figure 2**).

Findings suggest that land use associated with pest species introductions within 1 km of wetlands, loss of native vegetation within 5 km of wetlands, and changes to landscape hydrological integrity (i.e. natural surface water flow patterns) may be contributing substantively to the pressures on freshwater floodplain wetlands at the GBRCA-wide scale.

Trend: change over time in pressure on GBRCA wetlands

In terms of change over time since 2016, there has been no annual increase or decrease (i.e. trend) in the *overall pressure* on freshwater floodplain wetland condition detected at the GBRCA-wide scale (**Figure 3**).

However, there has been an upward annual trend since 2016 in the pressure score for *water regime change*, indicating an increase in this pressure over time across the GBRCA overall (**Figure 3**). The increase of 0.06 points per year has a 95% confidence interval of 0.02 to 0.09.

Note that no trends were detected using PO models that included random effects. However, when random effects were removed, an increase in pressures associated with water regime change was detected. These findings align with results of the PWIGLS models for this pressure subindex (as reported above; PWIGLS models do not include random effects but do include design weights to account for frame error).

NRM region results: status in 2022

The 2022 scores for the state of and pressure on freshwater floodplain wetlands at the NRM-region scale differ among the four NRM regions for which reporting has commenced (**Figure 4**). In most cases, the 2022 scores for state and pressure indices and subindices for the Burnett Mary NRM region tend to be lower (i.e. better) than the respective 2022 scores for the other three NRM regions for which reporting has commenced (Wet Tropics, Burdekin and Fitzroy). For all four NRM regions, the 2022 pressure index and subindex scores tend to be higher (i.e. worse) than state scores, which is similar to findings for 2022 at the GBRCA-wide scale.

Figure 4: *State (left plots, blue closed circles) and pressure scores (right plots, brown closed circles) by NRM region for wetland condition indices and subindices, with upper and lower bounds of the 95% confidence intervals shown as 'error bars.'*

The Wet Tropics NRM region

The score for the *overall state* of freshwater floodplain wetlands in the Wet Tropics NRM region in 2022 is 3.18, with a 95% confidence interval of 3.13 to 3.23 (**Figure 5**).

The 2022 scores for the state subindices in the Wet Tropics NRM region are all greater than 3.00, except for the score for *local physical integrity* (**Figure 5**). For this NRM region, the 2022 score for *biotic integrity* is the most similar to that of the 2022 score for the *overall state*, while the 2022 score for *connectivity* is the highest (i.e. worst) among state subindex scores (**Figure 5**).

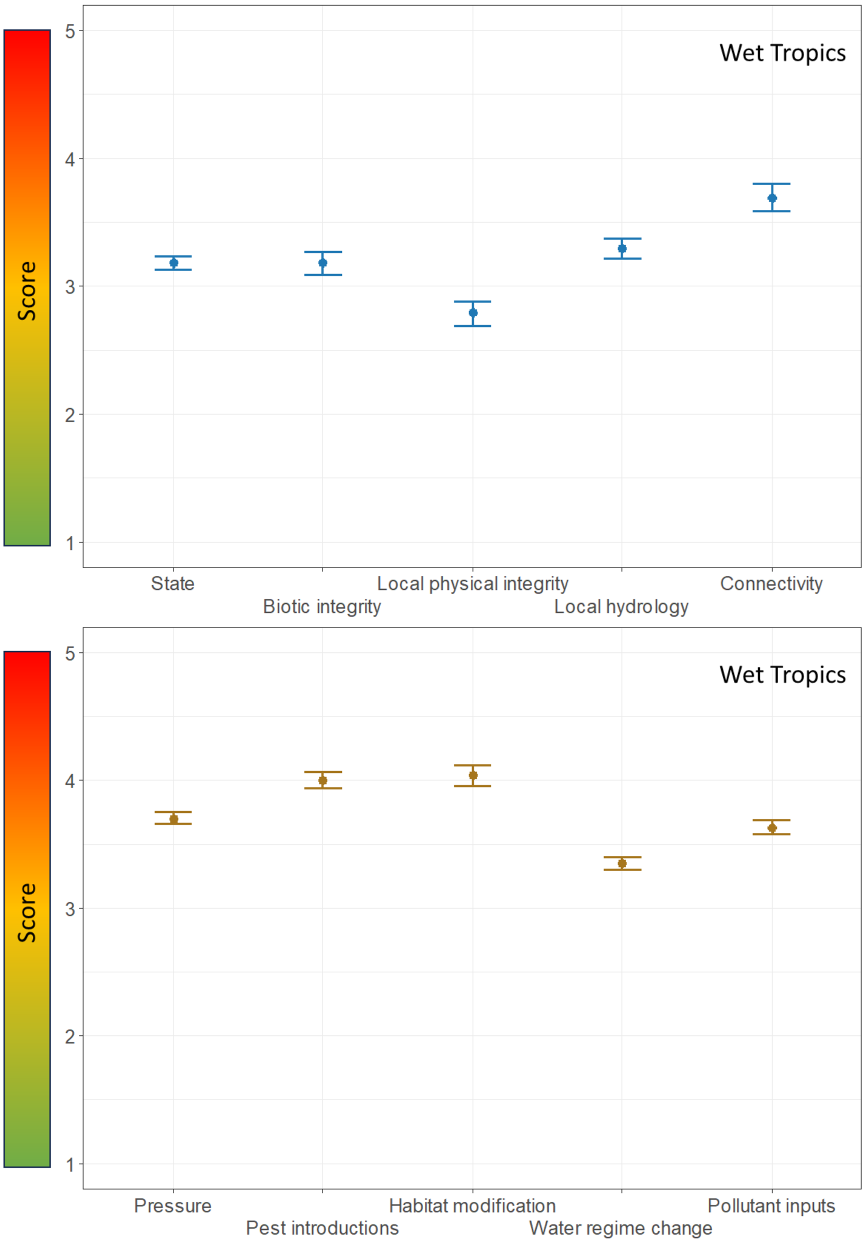


***Figure 5:** The 2022 state (upper plot, blue closed circles) and pressure scores (lower plot, brown closed circles) for wetland condition indices and subindices, with upper and lower bounds of the 95% confidence intervals shown as 'error bars,' for the Wet Tropics NRM region.*

The 2022 scores for all pressure indices and subindices in the Wet Tropics NRM region are greater than 3.00. *Overall pressure* on freshwater floodplain wetlands in 2022 for the Wet Tropics NRM region scores 3.70, with a 95% confidence interval of 3.66 to 3.75 (**Figure 5**).

Out of all the pressure subindex scores for the Wet Tropics NRM region in 2022, scores for *habitat modification* and *pest introductions* are the highest (i.e. worst) and scores for *pollutant inputs* are the lowest (i.e. best), though note that all pressure subindex scores are greater than 3.00 (**Figure 5**).

The Burdekin NRM region

The *overall state* of freshwater floodplain wetlands in catchments of the Burdekin NRM region has a 2022 score of 3.09, with a 95% confidence interval of 3.02 to 3.15 (**Figure 6**).

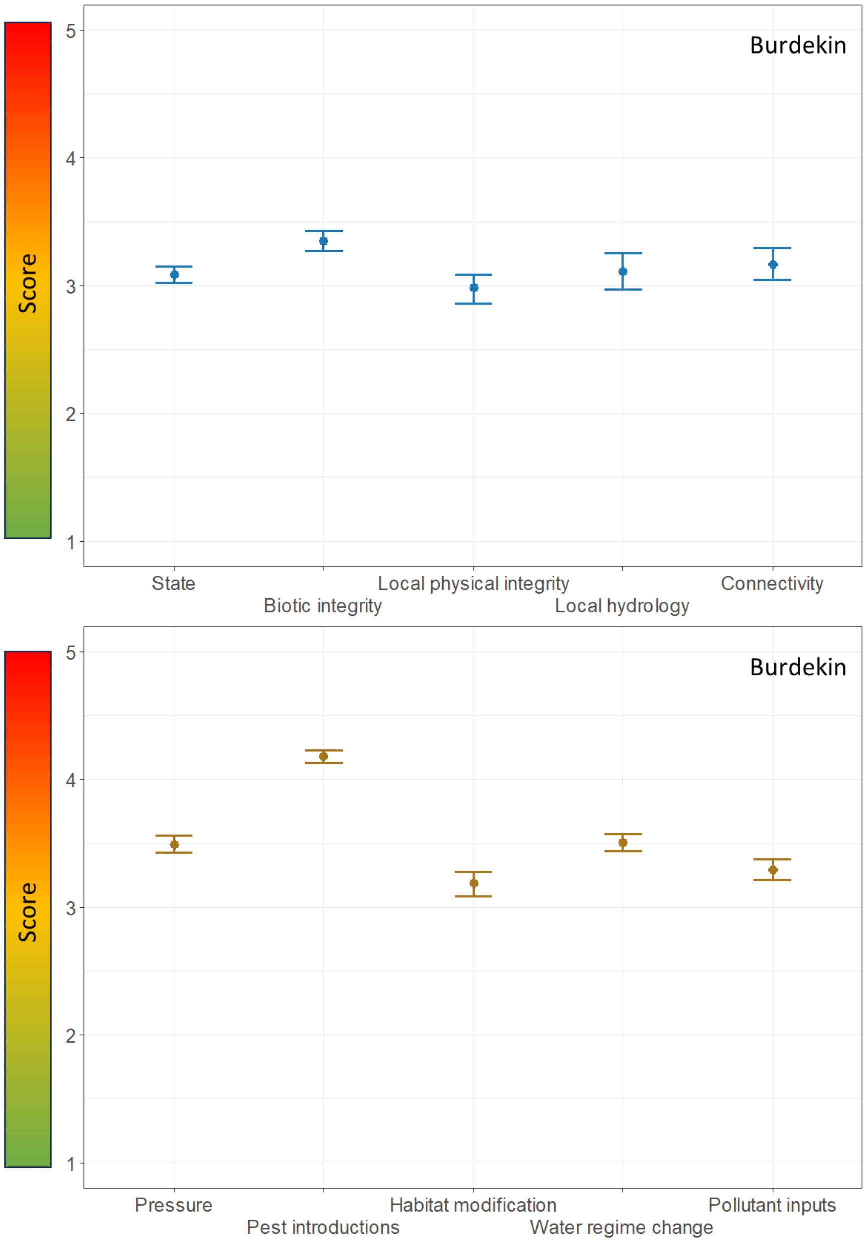


Figure 6: *The 2022 state (upper plot, blue closed circles) and pressure scores (lower plot, brown closed circles) for wetland condition indices and subindices, with upper and lower bounds of the 95% confidence intervals shown as 'error bars,' for the Burdekin NRM region.*

Among the state subindices, the 2022 scores for *biotic integrity*, *local physical integrity*, *local hydrology* and *connectivity* of wetlands within the Burdekin NRM region are reasonably similar to each other, with the score for *biotic integrity* being the highest (i.e. worst; **Figure 6**).

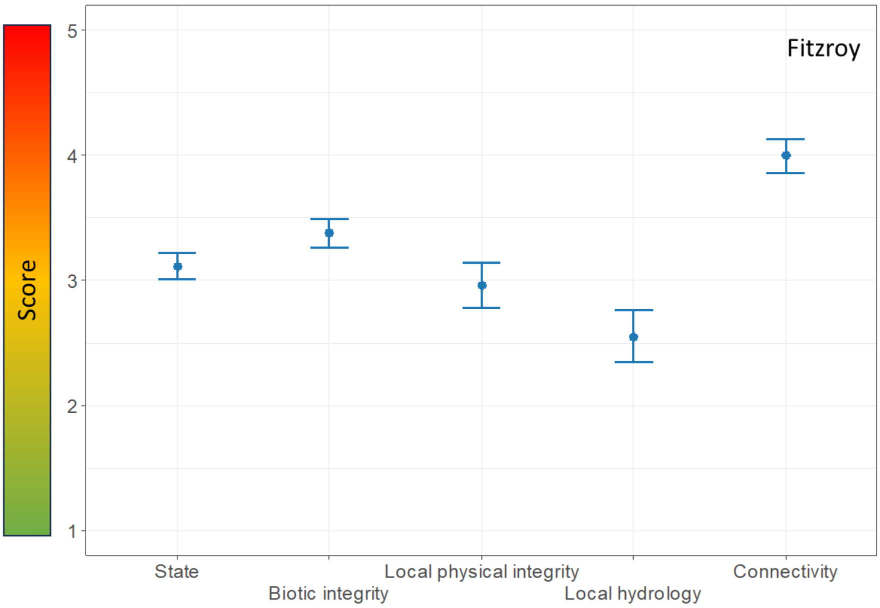
In terms of pressure, the 2022 scores for the pressure indices and subindices in the Burdekin NRM region are all greater than 3.00 (**Figure 6**).

Overall pressure in 2022 within the Burdekin NRM region scores 3.49, with a 95% confidence interval of 3.43 to 3.56 (**Figure 6**).

Pest introductions has the highest 2022 score among the pressure subindices in the Burdekin NRM region, being greater than 4.00 (**Figure 6**).

The Fitzroy NRM region

Freshwater floodplain wetlands in the Fitzroy NRM region have a 2022 *overall state* score of 3.11, with a 95% confidence interval of 3.01 to 3.22 (**Figure 7**).



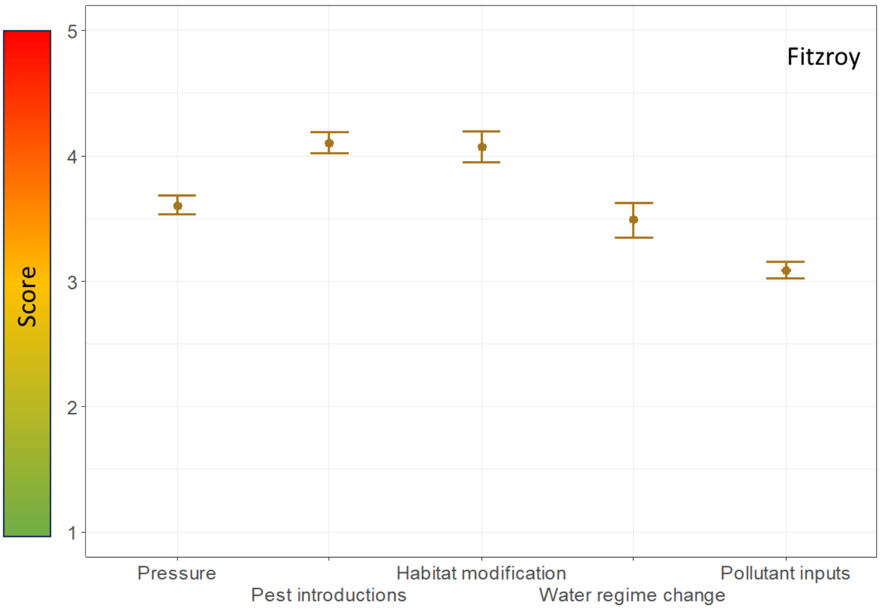


Figure 7: *The 2022 state (upper plot, blue closed circles) and pressure scores (lower plot, brown closed circles) for wetland condition indices and subindices, with upper and lower bounds of the 95% confidence intervals shown as 'error bars,' for the Fitzroy NRM region.*

The lowest (i.e. best) score among the state subindices for the Fitzroy NRM region in 2022 is for *local hydrology*, while the highest (i.e. worst) score is for *connectivity* (**Figure 7**).

As is the case in the Burdekin NRM region, the 2022 scores for all pressure indices and subindices in the Fitzroy NRM region are greater than 3.00 (**Figure 7**).

The 2022 score for *overall pressure* in the Fitzroy NRM region is 3.60, with a 95% confidence interval of 3.53 to 3.68 (**Figure 7**).

Pressure from *pest introductions* and *habitat modification* are the highest (i.e. worst) among the pressure subindices in the Fitzroy NRM region in 2022, followed by pressure from *water regime change* and then by pressure from *pollutant inputs* (**Figure 7**).

The Burnett Mary NRM region

The 2022 score for the *overall state* of freshwater floodplain wetlands in the Burnett Mary NRM region is 2.61, with a 95% confidence interval of 2.54 to 2.68 (**Figure 8**).

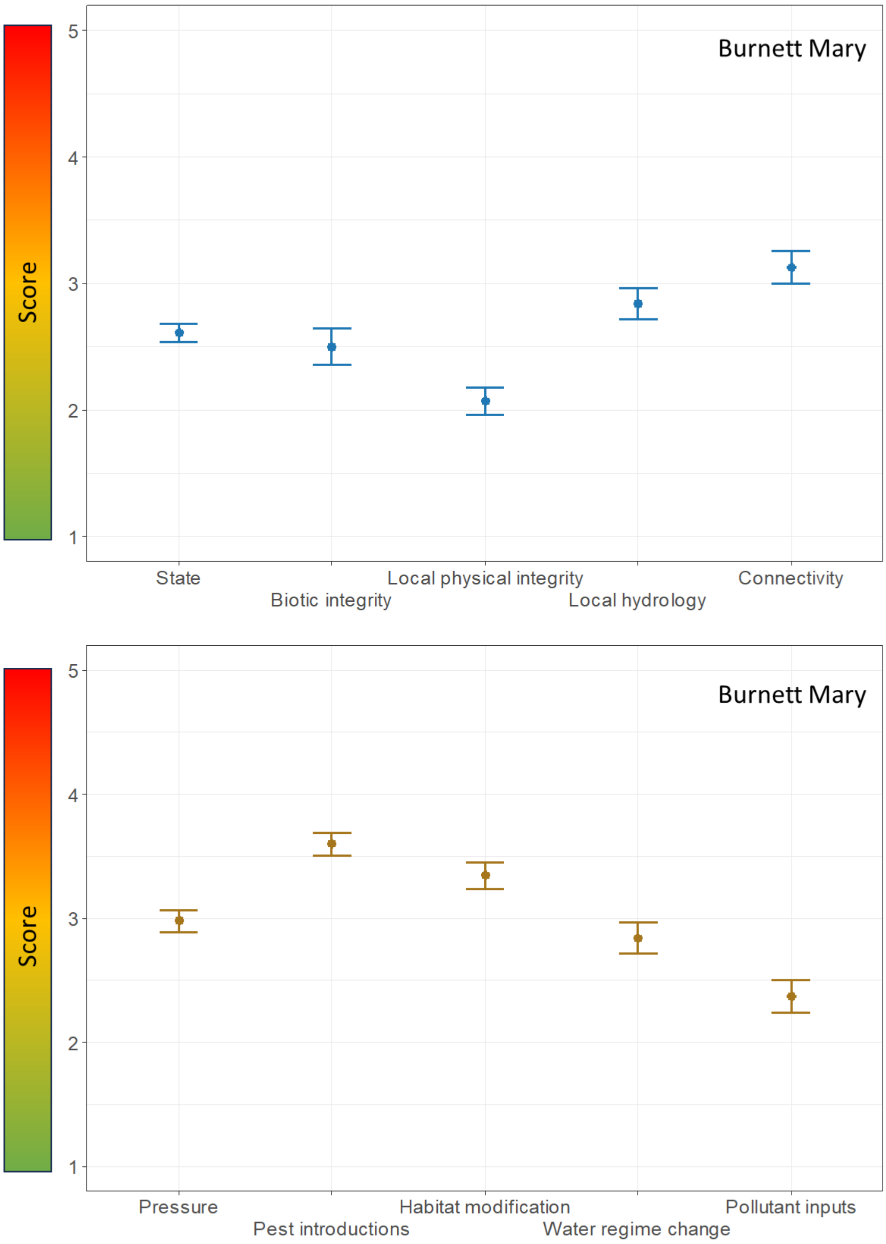


Figure 8: *The 2022 state (upper plot, blue closed circles) and pressure scores (lower plot, brown closed circles) for wetland condition indices and subindices, with upper and lower bounds of the 95% confidence intervals shown as 'error bars,' for the Burnett Mary NRM region.*

The lowest (i.e. best) score among the state subindices for the Burnett Mary NRM region in 2022 is for *local physical integrity* of wetlands (**Figure 8**). The 2022 score for *connectivity* is the highest score among the state subindices for the Burnett Mary NRM region (**Figure 8**).

Overall pressure on freshwater floodplain wetlands in the Burnett Mary NRM region has a score of 2.98, with a 95% confidence interval of 2.89 to 3.06 (**Figure 8**).

In this NRM region, pressure from *pest introductions* is the greatest, followed by pressure from *habitat modification* then *water regime change* (**Figure 8**).

The 2022 score for *pollutant inputs* is the lowest among the pressure subindices within the Burnett Mary NRM region (**Figure 8**), and across the four NRM regions for which reporting has commenced (**Figure 4**). There is a relatively high proportion of wetlands in the Burnett Mary NRM region that are in conservation land use areas (approximately 70% of the surveyed wetlands in 2022).

Discussion

What could be done to help to improve wetland condition?

Findings suggest that at the scale of the GBRCA, management actions focussed on protecting and re-establishing native vegetation in riparian buffer areas should help to improve the biotic integrity of wetlands and contribute to the improved connectivity of wetlands.

Actions to control pest animals and manage livestock access should contribute to improving the physical integrity of freshwater wetlands.

Actions to reduce impacts of drainage modifications and artificial structures in and surrounding wetlands on surface flows should help to improve the local hydrological integrity of wetlands.

Similar actions should be taken within each of the NRM regions.

What could be done to help to reduce pressure on wetlands?

The following actions should collectively contribute to reducing the overall pressure on wetlands in the GBRCA: reducing pressures from pest species in wetlands and surrounding areas; reducing barriers to flow to restore natural water flow patterns; managing water abstraction and livestock access; restoring native vegetation in buffer areas and habitat corridors; and managing nutrient and sediment run-off.

To help reduce the increasing pressure on wetlands associated with water regime change, management actions could specifically seek to reduce pressures from water abstraction and livestock access, loss of vegetation, and land use affecting natural water flow patterns.

In the NRM regions, actions to reduce pressure on wetland condition should be similar to those for the GBRCA.

Coordinated landscape scale actions could be prioritised in relation to the subindex pressure scores in the NRM region of interest, from highest to lowest score. For example, in a region with a high pest introduction score, actions to reduce pressures from pest plants and animals could be implemented as a priority.

Where should these actions be implemented?

The monitoring program is designed to detect improvement in wetland condition in response to management action undertaken at the landscape scale. Therefore, to detect via the monitoring program whether actions aimed at improving wetland condition in the GBRCA are having the desired effect, they should be implemented in the monitored wetland aggregations.

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