

# Assessment of variability in applying the Wetland Condition Index and priorities for review

Envirolink Grant: 2618\_HZLC175

May 2026

Olivia Rata Burge

*Bioeconomy Science Institute Maiangi Taiao*

Karen Denyer

*Papawera Geological Ltd*

Contract Report registration number: 2526-0130

Prepared for: Horizons Regional Council

## Disclaimer

*This report has been prepared by the New Zealand Institute for Bioeconomy Science Limited for Horizons Regional Council. If used by other parties, no warranty or representation is given as to its accuracy and no liability is accepted for loss or damage arising directly or indirectly from reliance on the information in it.*

© The New Zealand Institute for Bioeconomy Science Ltd and Horizons Regional Council 2026

*This information may be copied and distributed to others without limitation, provided the New Zealand Institute for Bioeconomy Science Ltd and Horizons Regional Council are acknowledged. Under no circumstances may a charge be made for this information without the written permission of the New Zealand Institute for Bioeconomy Science Ltd and Horizons Regional Council.*

## Reviewed by:

Neil Fitzgerald  
Researcher  
Bioeconomy Science Institute

## Approved for release by:

Gary Houliston  
Portfolio Leader – Ecosystem Resilience  
Bioeconomy Science Institute

# Contents

- Summary ..... iv
- 1 Introduction ..... 1
- 2 Background ..... 1
- 3 Objectives ..... 2
- 4 Methods ..... 2
  - 4.1 Catalogue ..... 2
  - 4.2 Observer-level variability: field assessment ..... 3
- 5 Results ..... 5
  - 5.1 Catalogue of current wetland monitoring practice ..... 5
  - 5.2 Observer-level variability: field assessment ..... 6
- 6 Discussion ..... 11
  - 6.1 Catalogue of current wetland monitoring practice ..... 11
  - 6.2 Overall condition values ..... 12
  - 6.3 Assessing state vs trend within indicators ..... 12
  - 6.4 Highly variable indicators ..... 13
  - 6.5 Constructed/created wetlands ..... 14
  - 6.6 Limitations ..... 14
- 7 Recommendations ..... 15
- 8 Acknowledgements ..... 15
- 9 References ..... 15

# Summary

## Project and client

- Horizons Regional Council, contracted the Bioeconomy Science Institute, via an Envirolink Grant, to look at how councils are applying the Wetland Condition Index (WCI), and to quantify extent of observer-level variation in scoring the WCI.
- Horizons Regional Council was supported in the Envirolink Grant by Greater Wellington Regional Council, Environment Southland, Northland Regional Council, Bay of Plenty Regional Council, Waikato Regional Council, Gisborne District Council, Taranaki Regional Council, Hawke's Bay Regional Council, Tasman District Council, Marlborough District Council, Environment Canterbury, and Otago Regional Council.
- One goal was to provide information to councils that do not currently undertake wetland condition monitoring, or that are considering revising elements of their monitoring, on how others apply the WCI.
- A second goal was to quantify evidential support for a revision of the WCI by documenting current divergence in practice, and quantifying the variation in observer-level scores for the same wetlands assessed at the same time from the same point. This will benefit councils that have invested in multiple years of monitoring in their current practice, and that must carefully weigh the costs and benefits of changing their practice – or not changing their practice.

## Objectives

- Compile a catalogue of current wetland monitoring practices.
- Provide an assessment of observer-level variation in scoring of the WCI.

## Methods

- The catalogue of current practice was primarily informed by an online survey that was provided to all regional councils and unitary authorities, as well as the Department of Conservation. In addition to this primary data source, the survey was complemented by grey literature and the authors' experience. The full catalogue is written up as a separate document, which accompanies this report. Summary results are described in this report.
- Observer-level variation in the WCI was assessed by taking a group of eight experienced observers to the same eight wetlands over two days and asking them to apply the WCI, and subsequently analysing the variation and range in scores.

## Results

- Thirteen councils and two Department of Conservation representatives responded to the survey. All councils who currently monitor wetlands use a customised version of the WCI. There were varying levels of perceived importance of and confidence in the components and indicators of the WCI. Modifications to the WCI were commonly attributed to a desire to improve efficiency, reduce costs, increase accuracy, and/or include additional components of interest (e.g. native species occupancy).
- Observer-level variation in the field assessment was relatively high, with WCI scores ranging from 13.3 to 20.6 and 13.3 to 21 at the two sites. The most variable indicators related to ecosystem intactness and hydrological integrity.

- Correlation between council confidence in wetland condition components and field variation was low, although indicators in which the surveyed councils were most confident did tend to have lower variability in the field assessment. This suggests that any review should take both the catalogue responses and field survey results into account to capture indicators that were *either* low confidence *or* high variability: either result is notable.
- Key issues in applying the WCI were assessed at the end of the field survey and from the notes in the field survey sheets. It is clear that there are issues regarding the 'baseline' from which a wetland should be assessed, and constructed wetlands were considered hard to score for some components (although there was only one in our field assessment).

## Conclusions

- There is a clear divergence in practice in wetland condition monitoring in New Zealand. The fact that refinements have occurred is not surprising, given that 22 years have passed since publication of the WCI.
- There was observer-level variation in the scoring of the WCI, even among experienced users.
- We conclude that WCI should be revised, and specifically, such a revision should consider methods to address variability, whether the scoring of the WCI needs to be revised, and incorporation of methods for assessment of constructed wetlands.

## Recommendations

- Overall, given the variation in council practice and a clear desire to review the WCI, along with observer-level variability, we recommend revising the WCI.
- This revision could capitalise on technological developments that have occurred since the release of the WCI in 2004, and could include:
  - reviewing and revising the guidance associated with components and indicators
  - reviewing and revising the components and indicators themselves, where appropriate
  - adopting new assessment methods (including remote sensing and GIS), where appropriate
  - reviewing and revising the historical baseline against which wetlands are assessed.
- Quantitative approaches should be preferred where resourcing allows, to reduce observer variability.
- Any revision should include a field-testing element to ensure it is:
  - economical to undertake
  - consistent in its results
  - broadly applicable (both nationally and across wetland types)
  - preferably able to be back-calibrated to capitalise on many years' worth of data gathering by councils, or at least to provide an understanding of how any revised method might differ in results to the current method.
- This will provide confidence to councils who currently undertake monitoring using the current method to adopt the new approach.

## 1 Introduction

Horizons Regional Council, contracted the Bioeconomy Science Institute, via an Envirolink Grant, to look at how councils are applying the Wetland Condition Index (WCI), and to quantify the extent of observer-level variation in scoring the WCI. Horizons Regional Council was supported in the Envirolink Grant by Greater Wellington Regional Council, Environment Southland, Northland Regional Council, Bay of Plenty Regional Council, Waikato Regional Council, Gisborne District Council, Taranaki Regional Council, Hawke's Bay Regional Council, Tasman District Council, Marlborough District Council, Environment Canterbury, and Otago Regional Council.

## 2 Background

The New Zealand Wetland Condition Index (WCI) is a method described in the *Handbook for Monitoring Wetland Condition: Coordinated monitoring of New Zealand wetlands* (the *Handbook*), which was published in 2003 and revised in 2004 (Clarkson et al. 2004). The work was funded by the Ministry for the Environment, with support from the Department of Conservation, Lincoln University, Environment Southland, Environment Canterbury, Wellington Regional Council, Taranaki Regional Council, Environment Bay of Plenty, Environment Waikato, Waikato District Council, and Auckland Regional Council.

The WCI aimed to achieve a nationally consistent assessment of palustrine (inland freshwater) and estuarine wetlands, with lakes and rivers to be dealt with separately.<sup>1</sup> The *Handbook* notes that the indicators used in the WCI were developed using criteria generated at a workshop held in November 2000. As such, it is now over 25 years since the genesis of the WCI. An accompanying index to the WCI is the Wetland Pressure Index (WPI); this was developed at the same time as the WCI and is also described in Clarkson et al. (2004). The WPI is used to assess pressures which may currently, or in the future, affect the WCI. In common parlance, the 'Wetland Condition Index' is occasionally used to refer to both the WCI and WPI, although in this report, we only refer to the WPI explicitly.

- *Condition* (WCI) is assessed using five indicators (e.g. 'Change in hydrological integrity'), and each of the five indicators is made up of at least two components. The mean of the component scores is calculated to obtain one score per indicator (minimum of 0, maximum of 5), and the five indicators are summed to give a total condition score between 0 and 25. Changes are estimated against estimated pre-human baselines.<sup>2</sup> An increase in the WCI represents a putative improvement in wetland condition. The WCI uses a multi-scale approach, whereby quantitative plot data inform the overall assessment, but which also incorporates field reconnaissance and garnering of other data such as historical records.
- *Pressures* (WPI) are assessed using six indicators, which are each scored out of 5. Pressure indicators are summed to give a score out of 30. An increase in WPI represents a potential future deterioration in the wetland via increased pressures. Pressures are monitored in order to assess the likelihood of future changes in condition.

---

<sup>1</sup> International definitions of wetlands include lacustrine and riverine environments, including lakes and rivers.

<sup>2</sup> Per page 12 of the *Handbook*

In the years since the publication of the WCI some councils have undertaken extensive wetland monitoring (for example, Auckland Council is completing its 15<sup>th</sup> year of monitoring in 2026), while others have yet to commence any monitoring of condition. Some revision of the WCI has occurred over time. For example, plot size was originally recommended in the *Handbook* to be 2 × 2 m by default for relatively short vegetation, whereas now larger plot sizes are used by default.<sup>3</sup> Other documents record a revised WCI or alternative monitoring approaches to wetland condition (Denyer et al. 2010; Denyer & Peters 2012; Clarkson et al. 2013; Clarkson & Bartlam 2017; Bellingham et al. 2021; Lee & Johnson 2024), indicating potential divergence in practice, and therefore loss of comparability.

### 3 Objectives

- Compile a catalogue of current wetland monitoring practices.
- Provide an assessment of observer-level variation in scoring the WCI.

### 4 Methods

#### 4.1 Catalogue

A separate document details the full methods and results of the catalogue (Denyer & Peters 2026); this report provides a summary.

An online survey was created as the primary method of compiling current practice with respect to wetland monitoring. The survey was provided to all unitary authorities and regional councils, and to the Department of Conservation. Survey respondents who indicated that their organisation monitors wetlands were directed to a series of questions, which were repeated for each wetland pressure and condition indicator. These questions sought information on:

- the perceived importance of the indicator for baseline assessment
- the perceived importance of the indicator for state of the environment (SOE) monitoring
- the respondent's level of confidence that assessments are likely to be accurate and consistently applied for the indicator
- the relative time investment required to apply the indicator
- how the indicator is applied (field-based visual assessment, field plots or transects, or office-based and/or remotely sensed data)
- reasons for not applying the indicator, if applicable (no perceived value, excessive cost, difficulty of application, or other); if 'other' was selected, a description of the reason (free-text response)
- recommendations for improving the effectiveness and efficiency of data collection for the indicator (free-text response).

---

<sup>3</sup> For example, 5 × 5 m, per Clarkson et al. 2014, and 10 × 10 m, used by Auckland Council and Waikato Regional Council.

## 4.2 Observer-level variability: field assessment

### 4.2.1 Methods

Eight sites were selected within the Waikato region to represent a range of wetland types and conditions, as shown in Table 1. These sites were surveyed over 2 days in February 2026 (12 & 13 February).

**Table 1. Summary of field sites**

Name	Wetland class	Approximate location
Arnold St	Swamp	37°54'45.5"S 175°27'49.9"E
Brymer Park	Swamp	37°46'56.1"S 175°13'37.4"E
Lake Cameron	Fen (surrounding peat lake)	37°51'18.7"S 175°18'09.6"E
Lake Te Koo Utu	Shallow water	37°53'18.5"S 175°28'12.4"E
Rotopiko (East Lake)	Fen (surrounding peat lake)	37°57'03.1"S 175°19'12.6"E
St Kilder (constructed wetland)	Swamp	37°52'28.7"S 175°29'18.7"E
Tamahere Gully	Swamp	37°49'42.8"S 175°21'45.8"E
Twickenham St	Swamp	37°46'44.6"S 175°13'30.6"E

A small number of regional councils were selected on the basis of geographical balance and the presence of an active wetland monitoring programme. These councils were asked to nominate representatives who were experienced in wetland condition monitoring. Selected participants were complemented by the authors of this report, and two Bioeconomy Science Institute ecologists experienced in wetland condition assessments (one of whom also implements wetland condition monitoring for a regional council). In total, nine<sup>4</sup> participants were selected. The collective experience represented wetland condition assessment for councils in the following regions: Otago, Canterbury, Wellington, Waikato, Hawke's Bay, and Auckland, as well as several individuals with experience from sites across New Zealand.

Participants were provided with maps of the prospective sites, with site boundaries and inferred catchments marked. In some cases these boundaries were refined in the field to reflect the area of the site that was being assessed. A local participant identified relevant undesirable species for the group, to avoid a geographical effect on species familiarity causing variability in this score; the same was undertaken for recent fire events that might only be known to local participants. Loss of original wetland extent was calculated on the basis of the Ausseil et al. (2008, 2011) pre-human wetland extent layer, where the layer overlapped the wetland, and was provided to participants. Land cover in the catchment was calculated using the Land Cover Database and provided to participants (MWLR 2025). Datasheets were provided from the 2004 *Handbook*, and hard copies of the *Handbook* were available for reference in the field. Because we were not visiting any bog wetlands we did not attempt to apply, nor subsequently assess, the Von Post (von Post 1924) component<sup>5</sup>, which is applicable only to peat bogs (Clarkson et al. 2004).

<sup>4</sup> One participant had to withdraw part-way through the field trip, leaving eight people's assessments conducted across all eight wetlands. For consistency, we did not include the three assessments made by the ninth participant.

<sup>5</sup> The Von Post method assesses peat degradation.

A key difference from usual application of the WCI was that, aside from the information provided, no further time or information was available to participants to finalise their assessment 'in the office'. A second key difference was that no vegetation plots were measured, in the interests of time. The schedule allowed for approximately 1 hour at each wetland. As a result, we place less emphasis on, but still note, variability arising from vegetation condition metrics, which would usually be informed by vegetation plots and therefore might be less variable than might appear from this exercise.

It was agreed that the scoring would be applied to the methodology as written in 2004 rather than any particular later update. Participants were instructed not to discuss scoring or interpretation of guidance while scoring, and to assess the components on the exact wording of the 2004 WCI index table, setting aside any 'internal' concessions or interpretations they make in their own monitoring practice.<sup>6</sup> This notwithstanding, general discussion about the WCI and WPI, and regional variants, was permitted and encouraged after scoring and assessment were complete, to capitalise on the value of having brought the experts together. These discussions inform the conclusions and recommendations in this report.

#### 4.2.2 Data checks and analysis

Data were entered into an Excel workbook. Where the range of scores for a given component within a site was 4 or greater, scores at both ends of the scored range were checked against participant notes to ensure the correct score was entered. This ambiguity can arise because the relationship between increasing scores and condition reverses between the condition and pressure elements of the WCI (i.e. a high condition score is considered 'good', but a high pressure score is considered 'bad'). Scoring errors were corrected when the assessor was confident from the notes that the score given was the opposite of what was intended. Several participants used non-integer numbers to score components.

We note that the WCI component scores may appear ordinal for some components (e.g. 'B2: Introduced predator impacts on wildlife'), while others appear to be intervals of equal size (e.g. 'B3: Harvesting levels' has two extreme values at 5 [no harvesting] and 0 [all wetland character lost due to harvesting], and then scores from 4 to 1 cover equal intervals of 25% each). Interpretation of summary statistics derived from ordinal data needs to be done with care, as the unit difference is not necessarily the same between each score. Currently the WCI takes the mean of components to achieve an indicator score, and then sums each indicator score.

We assess two forms of variability: standard deviation and range, and present boxplots to show other summary statistics that are robust even to ordinal data. We assess variability at the component and indicator level, as well as the ultimate WCI score. To create a list of components, and indicators ranked by their variability, we calculated the standard deviation of each component at each site (across observers), and then calculated the pooled standard deviation value for each component across sites. The results are presented in tabular form, alongside mean scores summarised in the same way (the mean of scores for the component at that site, and then the mean overall).

---

<sup>6</sup> An example of this is component 'B3: Harvesting levels'. While the *Handbook* does not specify whether this refers to native or non-native species, practitioners may typically score on the basis of native species harvest only.

We note that the WPI is a separately scored index for each wetland, although in common parlance, the Wetland Condition Index is sometimes used to collectively refer to the condition index and the pressure index. While this project was aimed at the Wetland Condition Index, we tested, and report results for, pressures, because it is expected that the pressure index would be reviewed alongside the condition index. We highlight in figures and results where the WPI and its elements are referred to.

Finally, we compared the observer-level variability of components to the confidence expressed by respondents in the same components in the catalogue survey. We used a correlation test using Spearman's rank order correlation test, because the raw scores can be considered ordinal. Significance was no different using Pearson's correlation test (results not shown). Note that field assessors and survey respondents were not necessarily the same people, even where the same organisation was represented. This correlation analysis and visualisation was done to assess whether any components had high confidence in their application, but hitherto observer-level variability, meaning they should also be considered as priorities in any review of the WCI.

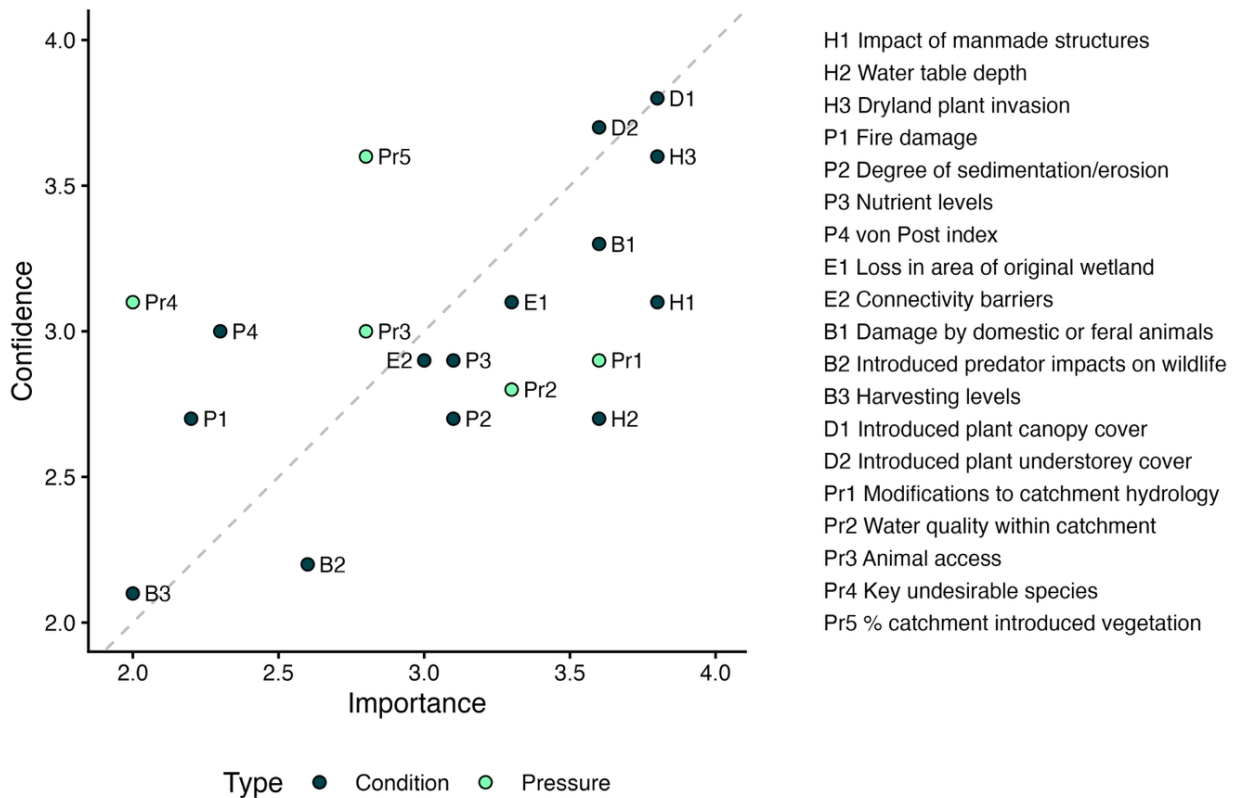
## 5 Results

### 5.1 Catalogue of current wetland monitoring practice

These results are a summarised version of the full catalogue (Denyer & Peters 2026), which accompanies this report. We refer the reader to the full catalogue for further details, observations and recommendations from respondents.

Thirteen regional councils and unitary authorities, and two DOC respondents completed the survey. Ten respondents (all representing regional councils and unitary authorities) answered the full suite of questions regarding pressure and condition indicators. Two councils are not currently monitoring nor planning, and therefore were not presented with those questions. One has yet to start monitoring so was unable to answer the detailed questions. All of the responding regional councils and unitary authorities who currently monitor wetlands use a modified version of the WCI. One respondent from DOC indicated that the WCI is applied in its original form, while another DOC respondent was unsure.

Indicator components were rated according to respondents' views of the component's importance and their confidence in the component. The four indicator components with the highest mean level of confidence all related to vegetation, suggesting that the quantitative data from vegetation plots and visibility of canopy vegetation assist with confidence. The two pressure scores that scored the highest importance values also had the lowest confidence scores (among pressures), making them priorities for consideration in a review. These are shown as 'Pr1: Modifications to catchment hydrology' and 'Pr2: Water quality in the catchment' in Figure 1.



**Figure 1. Mean perceived importance of, and confidence in, components of condition indicators and pressure indicators.**

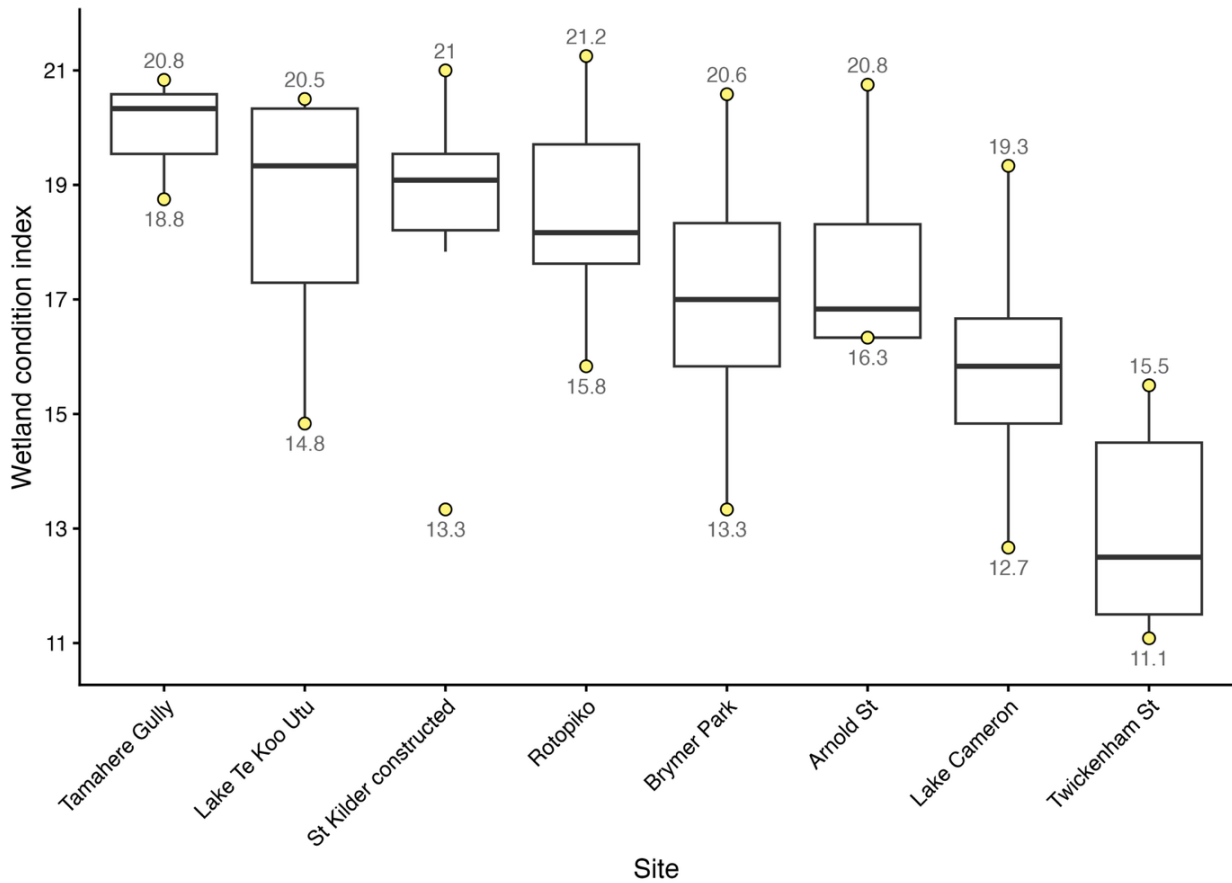
Notes: Abbreviations used in the plot are shown to the right of the figure. The grey dashed line is a 1:1 line to assist with visual interpretation, as importance and confidence were assessed on the same scale. (Source: adapted from data in Denyer & Peters 2026)

Respondents suggested a number of improvements to the WCI, including new indicators describing native species occupancy, and the application of new methods such as the use of wetland delineation scores to indicate change in hydrology and dominance of dryland species. These suggestions are detailed in the catalogue.

## 5.2 Observer-level variability: field assessment

### 5.2.1 Overall WCI

The assessed sites ranged in WCI overall condition metrics from 11.1 to 21.2 (Figure 2). The maximum range within a site was at St Kilder, a constructed wetland, where scores varied from 13.3 to 21.0 (a range of 7.7), followed by Brymer Park, with a range of 7.3. There was one score at St Kilder that was more than 1.5 times the interquartile range and considered an outlier (Figure 2), while at Brymer Park the spread of scores was more even (Figure 2; as evidenced by the whisker of the boxplot for Brymer Park being equivalent to the minimum score).

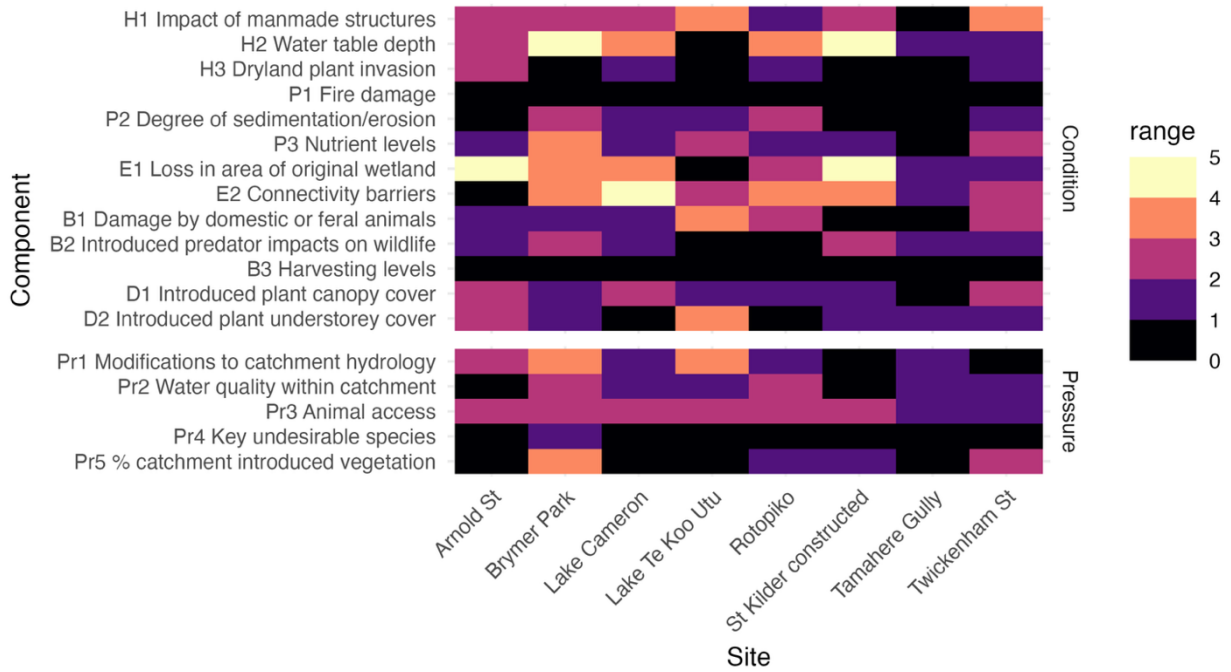


**Figure 2. Overall condition score, by site. The boxplot shows the median (thick horizontal line), the 25<sup>th</sup> and 75<sup>th</sup> percentiles (upper and lower bounds of the rectangle), and the largest and smallest value no further than 1.5 times the interquartile range (vertical lines). The minimum and maximum score for each site are shown as yellow dots, with the value labelled.**

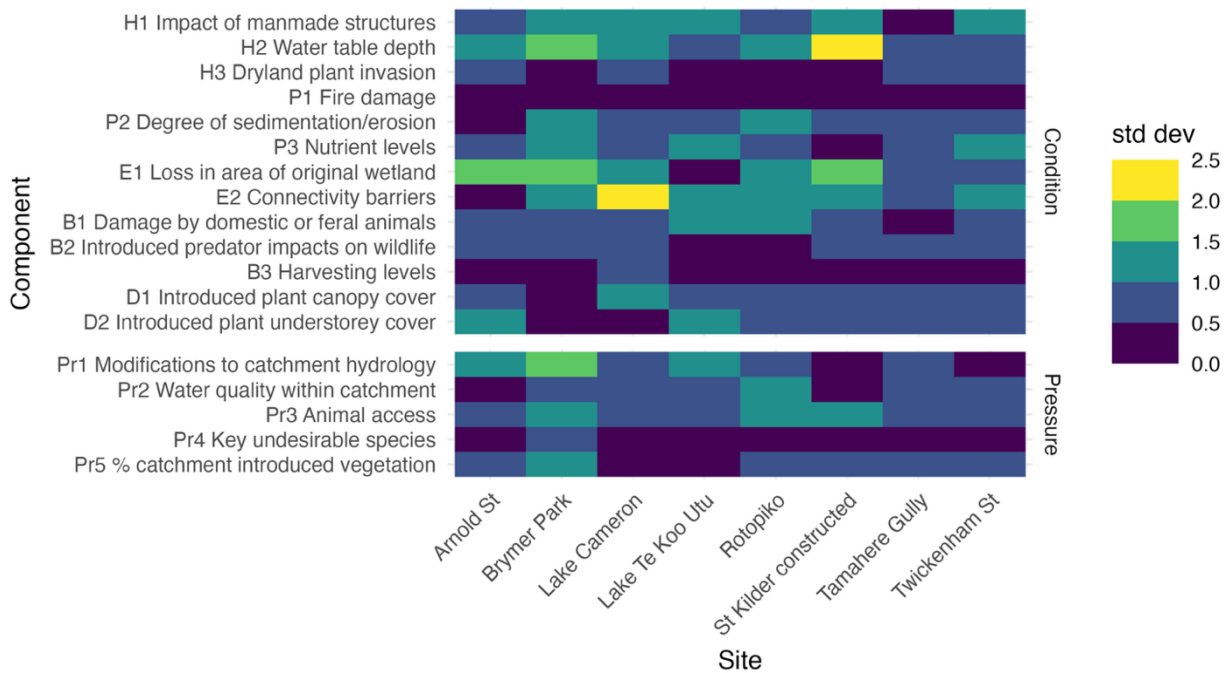
### 5.2.2 Variability in components of indicators, and pressure scores

We assessed the variability of indicator components of the condition index and the components of the pressure index. We assessed both range and standard deviation (Figure 3), and then summarised standard deviation across sites to provide a ranked list of components by variability (Table 2).

### A Range



### B Standard deviation



**Figure 3. A: range (calculated by subtracting the minimum component score for a site from maximum component score), by component and site; B: standard deviation, by component and site.**

Notes: In both cases lighter values indicate more variability. Reading the figures column-wise (top to bottom) provides an overview of the variability by site; reading the figures row-wise (left to right) provides an overview of the variability by component. Similar general trends can be observed in both figures; e.g. smaller range and variability in fire damage, and higher range and variability in water-table depth. Conditions and pressures are separated for separate assessment, but share the same colour scale to facilitate comparison among pressures and condition components.

By site, Tamahere Gully (the highest-scoring site overall) had the lowest overall variability, with a maximum range of 2 for any component and a relatively low standard deviation, while Brymer Park had the highest variation, even for components that otherwise had lower variability (e.g. percentage catchment in introduced vegetation).

By component, Table 2 reports the overall standard deviation for each component across sites, while Figure 3 (above) provides a more detailed breakdown by site. The components of the indicator 'Change in ecosystem intactness' had the highest standard deviation overall (Table 2), which reflects the high variability (both in range and standard deviation) across sites. Next highest in variability were two of the three components of 'Change in hydrological integrity'. The third component of this indicator 'Dryland plant invasion' is less variable, and would therefore reduce overall variability of the indicator (Table 3).

**Table 2. Components of indicators: summary of mean score across sites and standard deviation (SD) for each component across sites. Rows are ordered from highest to lowest standard deviation. There was no fire damage observed at any site, thus producing a standard deviation of zero, as shown in the bottom row of the table (and a mean score of the maximum value 5, as all corrected scores given were 5).**

Indicator	Component	Mean Score	SD
Change in ecosystem intactness	E1 Loss in area of original wetland	2.945	1.364
Change in ecosystem intactness	E2 Connectivity barriers	3.119	1.349
Change in hydrological integrity	H2 Water table depth	3.227	1.316
Pressure	Pr1 Modifications to catchment hydrology	3.382	1.018
Pressure	Pr3 Animal access	3.356	1.009
Change in hydrological integrity	H1 Impact of manmade structures	2.971	0.988
Change in physico-chemical parameters	P3 Nutrient levels	3.128	0.922
Change in browsing, predation and harvesting regimes	B1 Damage by domestic or feral animals	4.308	0.874
Pressure	Pr5 % catchment introduced vegetation	3.559	0.826
Change in dominance of native plants	D1 Introduced plant canopy cover	3.296	0.787
Change in physico-chemical parameters	P2 Degree of sedimentation/erosion	3.981	0.779
Change in dominance of native plants	D2 Introduced plant understorey cover	2.720	0.744
Pressure	Pr2 Water quality within catchment	2.872	0.739
Change in browsing, predation and harvesting regimes	B2 Introduced predator impacts on wildlife	2.658	0.662
Change in hydrological integrity	H3 Dryland plant invasion	3.877	0.545
Pressure	Pr4 Key undesirable species	1.597	0.345
Change in browsing, predation and harvesting regimes	B3 Harvesting levels	4.878	0.318
Change in physico-chemical parameters	P1 Fire damage	5.000	0.000

### 5.2.3 Variability in indicator scores and pressure index

Variability in indicators was assessed by calculating the overall standard deviation for each indicator, which is presented in Table 3. Given the high standard deviation for the components associated with change in ecosystem intactness and hydrological integrity, it is perhaps not surprising that these rank most highly.

**Table 3. Overall mean and standard deviation (SD) associated with each indicator. Rows are ordered by high to low standard deviation.**

Indicator	Mean	SD
Change in ecosystem intactness	3.03	1.090
Change in hydrological integrity	3.36	0.686
Change in dominance of native plants	3.01	0.563
Pressure	2.95	0.531
Change in physico-chemical parameters	4.04	0.422
Change in browsing, predation and harvesting regimes	3.95	0.366

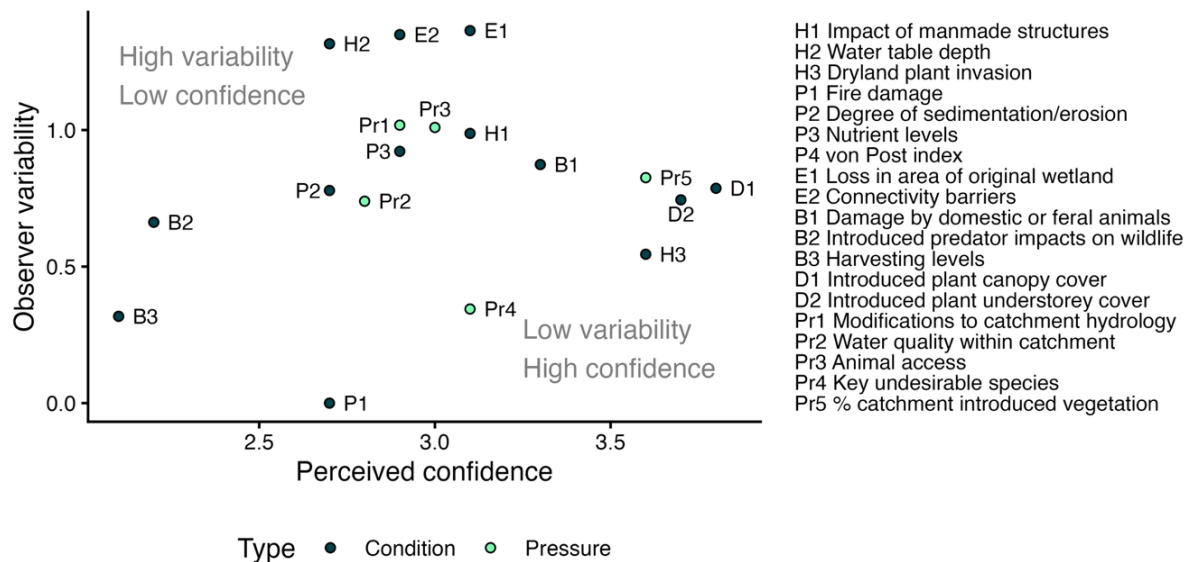
We highlight that pressures are not summarised in the same way as components are to indicators. Pressures are also at a different spatial scale than components and indicators. While pressures have a moderate overall standard deviation, two pressures (Pr1 and Pr3) are in the most variable component-level indicators. Some of the pressure score variability may relate to differences in how 'catchment' was interpreted; further guidance on this could be included as part of a review.

### 5.2.4 Perceived confidence and field variability

In this section we assess the relationship between perceived confidence (from the catalogue of current practice) and the field variability assessment. If indicators in which confidence is highest are those for which the variability is lowest, there is good concordance between these scores. If, however, some scores have high confidence and high variability, this suggests that these components need to be prioritised higher in any WCI revision.

There was no clear overall correlation between observer variability (standard deviation of scores) and perceived confidence, particularly once the two components that had very low actual variability were excluded (these two points are labelled B3 and P1 in Figure 4). Even with the two components included, correlation was estimated to be 0.16 (where 0 is no correlation and 1 is complete correlation), with a *P*-value of 0.53 (non-significant correlation).

Although there was a lack of relationship overall, components in which councils were most confident (D1, D2, H3) did tend to have lower variability once B3 and P1 were excluded. This notwithstanding, there was no clear relationship between confidence and variability, including for components with lower confidence. The lack of relationship between observer variability and confidence in the remaining components suggests that any review should take both the catalogue and field survey results into account, because both may be detecting different forms of variability.



**Figure 4. Observer variability (from field trial) compared to perceived confidence (from catalogue).**

Notes: The figure notes areas of high confidence and low variability (bottom right; metric probably performing well) and areas of low confidence and high variability (top left; metric probably not performing well). If confidence and variability were correlated in this way, points might fall along this line. No clear pattern is observed, with components with moderate confidence having the highest variability scores (e.g. E1 and E2). Components B3 and P1 (bottom left) had very high condition levels in the field (i.e. no fire damage observed), and therefore the low level of variability should be treated with caution, as it was not necessarily tested in situations where it might vary.

## 6 Discussion

### 6.1 Catalogue of current wetland monitoring practice

Current council wetland condition monitoring scores are not comparable at the wetland scale, because every council who undertakes monitoring uses a modified version of the method described in the *Handbook*. Current practice is detailed in the catalogue (Denyer & Peters 2026), and can be summarised as follows:

- all councils have developed their own customisation – to a greater or lesser extent – of the method given in the *Handbook*
- some have incorporated elements from Wetmak (Denyer & Peters 2012)
- some have incorporated a pressure index and faunal values
- multiple councils have dropped the fire damage score (P1), with two councils saying they incorporate it into other metrics
- four councils do not use von Post, although this was primarily because they have not monitored bogs
- not all councils undertake foliage and soil nutrient testing.

That all councils who currently apply wetland condition methods use a modified version of the WCI limits national comparability of wetland condition scores. Current practice is set out in the catalogue itself, but as councils have different modifications of the WCI comparisons at a national scale are unlikely to be robust.

## 6.2 Overall condition values

In addition to the observer variability noted in this report, concerns have been raised by councils that there seems to be a 'floor' for wetlands of apparent very low condition, even where they score 11 or 12 on condition. This means they would still be considered 'moderate' or 'moderate – good' per Clarkson et al. (2015). As noted by Fitzgerald and Burge (2025), the process of averaging components to create an indicator score may cause the WCI to lag behind substantial actual change, because components may respond to change differently or at different rates.

In addition to reviewing the methods by which wetland condition is assessed, we suggest revision of the scoring system as well. We also suggest considering whether, if any single component score reflects an 'extreme' or 'very high' degree of modification to the wetland (condition score of zero), the indicator value should reflect this. This might involve taking the 'worst' value of all components relating to the indicator rather than the average.

An alternative to a revised overall score would be to drop the overall condition score entirely, or at least reduce reliance on it, and compare wetland condition across key indicators. However, this approach would still require an examination of how to aggregate component scores to indicators.

## 6.3 Assessing state vs trend within indicators

The indicators of the WCI are framed as 'change' (e.g. *change* in hydrological integrity, *change* in physico-chemical parameters). However, many of the components could equally be conceptualised as a 'state' assessment; for example, components such as H1, H3, and B1 are assessed according to how much of the current wetland extent is affected by artificial structures, dryland plants, and domestic or feral animals, respectively, based on an assumed 0% of the wetland affected for the historical or unimpacted state. Conversely, H2 assesses water-table depth compared to previous wetland state. Indicators such as H2 are much harder to assess when historical wetland state is not known – and in many cases will be unknowable.

It will also be difficult to assess change *between measures* when both are compared to a historical baseline. For example, a wetland may have had an original extent of 100 ha, but by 2006 80 ha have been lost, leaving 20 ha. At the 2006 measure the wetland would have scored 1 (very high modification), because over 75% of the wetland had been lost compared to its original extent. However, if by 2012 a further 10 ha of wetland had been lost (a loss of 50% over 6 years), the score would remain at 1. As a result the scoring system loses its sensitivity to recent and still-substantial loss, because the score is already saturated by the loss occurring prior to 2006.

A disadvantage of assessing 'state' is that components that are quantified by something other than 'extent of wetland affected' will be difficult to assess. For example, components related to degree of modification overall (e.g. to the water-table) over time will be difficult to assess without additional quantitative work, and, as noted above, ongoing degradation in hydrology may be 'swamped' by the scale of change since historical times and be unable to be detected within the current scoring schema. We suggest specialist hydrologist input to help assess cost-effective and quantitative methods, where appropriate.

## 6.4 Highly variable indicators

In this section we discuss the two most variable indicators, as ranked by the field survey. We acknowledge that if a component was ambiguous or uncertain, participants may have tended towards a middle score, meaning a component may not have been scored 'correctly' but still have low variability. In discussions following the field survey with participants, and assessment of results against our observations, we do not consider this is highly likely, but note the possibility.

### 6.4.1 Change in hydrological integrity

Change in hydrological integrity is noted by the *Handbook* as 'probably the single most important' factor that influences wetland type and wetland processes. It was seen as highly important across all components, yet it was the most variable in our field survey and showed mixed confidence in the catalogue.

Based on assessment of the notes and discussion during the field survey, it is clear that some individuals were assessing the wetland against an inferred historical baseline, while others were using the wetland type as a baseline against which to assess change or degradation. The *Handbook* itself envisages instruments such as staff gauges, permanent dipwells, piezometers, or other instruments for monitoring water-level change, and notes that it is difficult to meaningfully score hydrology from single site visits. Our discussions and observation concluded that most sites do not have such instrumentation, and therefore difficulties in assessing this metric were envisaged by the *Handbook*. However, instrumentation would be costly for multiple wetlands, and would only allow assessment of *recent* change rather than change since a pre-human or pre-disturbance baseline, thus highlighting the question of the appropriate baseline against which to assess change.

Given the confidence in the components that are underlain by quantitative plot data, the possibility of cost-effective hydrological monitoring should be considered as part of a review. If hydrological monitoring is cost-prohibitive, consideration could be given to using methods that indicate hydrological change based on vegetation change, such as the prevalence index (Clarkson 2014). We note that nutrient enrichment suffers from some of the same challenges as hydrological modification: it can be costly to take samples across large wetlands, and detection of nutrient change is difficult because it may be expressed in different ways (Burge et al. 2020). While vegetation foliage and vegetation composition can indicate nutrient change, compositional change, in particular, is a lagging indicator.

### 6.4.2 Change in ecosystem intactness

Change in ecosystem intactness is represented by two components, both of which relate to a historical baseline ('E1: Loss in area of original wetland' and 'E2: Connectivity barriers'). Substantial loss in original area of wetland may saturate and disguise recent extent loss (as discussed above) and may also be difficult to assess, particularly in urban areas where landscapes are highly modified and hydric soils are unable to be mapped due to impervious ground cover. Connectivity barriers may be hard to observe in the field, particularly in large wetlands or wetlands with large perimeters, or where the original extent of the wetland and the wetlands formerly connected to it is unknown.

In the authors' experience, the connectivity assessment criteria should be revised: the scale over which connectivity should be assessed is vague; the type of connectivity is not well defined (e.g. aquatic or terrestrial, plant or animal); and the component does not distinguish loss of downstream connections from upstream connections and their relative importance.<sup>7</sup> E2 (connectivity barriers) is also assessed against a pre-disturbance baseline, so the issue of change saturation applies to this component as well.

It was noted during feedback on this report that some degree of change is expected in wetlands over long time periods (as described in McGlone 2009), and that one possible baseline might be complete native dominance. However, changes in hydrology may be less amenable to such an approach to baselines: homogenisation of most or all wetlands to a native-dominated, but drainage-affected, state would probably be an outcome we would seek to detect with a revised condition index.

To summarise, more consideration should be given to the 'baseline' issue, and to methods of either scoring sites where uncertainty of the baseline state is high, or alternative methods of addressing change in ecosystem intactness. It would be worthwhile to include these in any review of the WCI.

## 6.5 Constructed and created wetlands

Wetlands may be constructed or created for multiple purposes and benefits, including biodiversity. However, the WCI does not currently account for the positive use of structures to create, enhance, or restore wetlands, or for artificial increases in water level. In the field survey we found it difficult to assess some components using the WCI as worded in the *Handbook*, where there was explicit reference to a baseline (e.g. 'H2: Change in water table depth'). This is evidenced by the high variability (standard deviation and range) for the St Kilder constructed wetland for this component, and for the component 'E1: Loss in area of original wetland' (Figure 3). Further work is required to scope whether the WCI should – and could – be modified to allow assessment of constructed wetlands, or whether a parallel system of scoring should be developed for constructed wetlands.

## 6.6 Limitations

Our field assessment was not designed to comprehensively assess whether there was observer-level variability across wetland *classes*, and in fact some wetlands (e.g. seepages) were not surveyed at all. Our recommendations are framed in general terms, and are based on broader experience than just the field assessment, but should be read in light of this limitation. Any field work taken to support a revision of the WCI should incorporate all wetland classes and cover a broad geographical gradient to ensure the index works across wetland classes, and in different regions with different pressures and climates.

---

<sup>7</sup> For example, the loss of all downstream connections would score the same as the loss of half of a wetland's downstream, and half of its upstream, connections. For a wetland reliant on upstream flow, upstream connection loss may have a greater impact than downstream connection loss.

## 7 Recommendations

- Overall, given the variation in council practice and a clear desire to review the WCI, along with observer-level variability, we recommend revising the WCI, and the WPI.
- This revision could capitalise on technological developments that have occurred since the release of the *Handbook* in 2004, and could include:
  - reviewing and revising the guidance associated with components and indicators
  - reviewing and revising the components and indicators themselves, where appropriate
  - adopting new assessment methods (including remote sensing and GIS), where appropriate
  - reviewing and revising the historical baseline against which wetlands are assessed.
- Quantitative approaches should be preferred where resourcing allows, to reduce observer-level variability.
- Any revision should include a field-testing element to ensure it is:
  - economical to undertake
  - consistent in its results
  - broadly applicable (both nationally and across wetland types)
  - preferably able to be back-calibrated to capitalise on many years' worth of data gathering by councils, or at least to provide an understanding of how any revised method might differ in results to the current method.
- Field testing will provide confidence to councils who currently undertake monitoring using the current method to adopt the new approach.

## 8 Acknowledgements

We are deeply indebted to the following participants of the field survey held in February 2026 for their enthusiasm and willing participation, insightful comments, and feedback on the Wetland Condition Index, and their dedication to improving wetland monitoring. In alphabetical order, we thank: Warwick Allen, Gretchen Brownstein, Tiago Mahalingam, Finn Michalak, Kaitlin Morrison, Mark Parker, and Samiksha Patel. We also thank Kaitlin Morrison and Tiago Mahalingam for their local expertise and assistance. Lorraine Cook, Helen White, Darin Sutherland, Georgianne Griffiths, Gretchen Brownstein, Peter Johnson, and Bill Lee are gratefully thanked for their comments on an earlier version of this report. We also warmly thank the representatives of the regional and district councils and the Department of Conservation for taking the time to answer the survey and contribute to the catalogue of current monitoring practice. We thank Ray Prebble for technical editing, and Kate Boardman for formatting assistance.

## 9 References

- Ausseil A-GE, Chadderton WL, Gerbeaux P, Stephens RTT, Leathwick JR 2011. Applying systematic conservation planning principles to palustrine and inland saline wetlands of New Zealand. *Freshwater Biology* 56: 142–161.
- Ausseil A-GE, Gerbeaux P, Chadderton WL, Stephens RTT, Brown D, Leathwick JR 2008. Wetland ecosystems of national importance for biodiversity: Criteria, methods and candidate

- list of nationally important inland wetlands. Landcare Research Contract Report LC0708/158. Wellington, New Zealand, Landcare Research. 171 p.
- Bellingham PJ, Richardson SJ, Burge OR, Wisser SK, Fitzgerald NB, Clarkson BR, Collins K 2021. Standardised methods to report changes in the ecological integrity of sites managed by regional councils. Manaaki Whenua – Landcare Research Contract Report LC3903. Lincoln, New Zealand, Manaaki Whenua - Landcare Research. 54 p.
- Burge OR, Clarkson BR, Bodmin KA, Bartlam S, Robertson HA, Sukias JP, Tanner CC 2020. Plant responses to nutrient addition and predictive ability of vegetation N:P ratio in an austral fen. *Freshwater Biology* 65: 646–656.
- Clarkson BR, Hicks A, Robertson H, Rance BD, Ledgard G 2013. A monitoring approach for Southland's wetlands: Stage 1. Envirolink Advice Grant: 1257-ESRC257. Landcare Research Contract Report LC1722. Hamilton, New Zealand, Landcare Research. 66 p.
- Clarkson B, Overton J, Ausseil A, Robertson H 2015. Towards quantitative limits to maintain the ecological integrity of freshwater wetlands: Interim report. Landcare Research Contract Report LC1933. Hamilton, New Zealand, Landcare Research. 39 p.
- Clarkson BR 2014. A vegetation tool for wetland delineation in New Zealand. Landcare Research Contract Report LC1793. Hamilton, New Zealand, Landcare Research. 62 p.
- Clarkson BR, Bartlam S 2017. Tukituki Catchment. State of the Environment monitoring of Hawke's Bay wetlands. HBRC Report No. RM 17-06. HBRC Publication No. 4928. Hamilton, New Zealand, Manaaki Whenua - Landcare Research. 42 p.
- Clarkson BR, Sorrell BK, Reeves PN, Champion PD, Partridge TR, Clarkson BD 2004. Handbook for monitoring wetland condition. Coordinated monitoring of New Zealand wetlands. A Ministry for the Environment SMF funded project. Wellington, New Zealand, Ministry for the Environment. 73 p.
- Denyer K, Baber M, Clarkson B 2010. Auckland Regional Wetland Biodiversity Monitoring Programme: Field Protocol for Tier I Wetland Condition Monitoring. Internal Report. Auckland, Auckland Regional Council. 94 p.
- Denyer K, Peters M 2012. WETMAK: wetlands monitoring and assessment kit. Hamilton, New Zealand, New Zealand Landcare Trust. 148 p.
- Denyer K, Peters M 2026. Wetland monitoring: Catalogue of current practices in New Zealand. Hamilton, New Zealand, Papawera Geological. 59 p.
- Fitzgerald NB, Burge OR 2025. Changes in Bay of Plenty wetlands: 2014–2024. Bioeconomy Science Institute Contract Report 2526-0027. Hamilton, New Zealand, Bioeconomy Science Institute. 44 p.
- Lee WG, Johnson PN 2024. Monitoring natural wetlands in Otago under the requirements of the National Policy Statement for Freshwater Management (2020). Dunedin, Otago Regional Council. 47 p.
- McGlone MS 2009. Postglacial history of New Zealand wetlands and implications for their conservation. *New Zealand Journal of Ecology* 33: 1–23.
- MWLR 2025. LCDB v6.0 - Land Cover Database version 6.0, Mainland, New Zealand | LRIS Portal.
- von Post L 1924. Ur de sydsrenska skogarnas regionala historia under post-arktisk tid. *Geologiska Föreningen i Stockholm Förhandlingar* 46: 83–128.