Healthy Waterways Strategy 2018-2028
Port Phillip & Westernport, Victoria

# Science Synthesis

## A Technical Report to inform the Healthy Waterways Strategy Mid-term Review

This Technical Report has been developed for Melbourne Water as part of the Healthy Waterways Strategy Mid-term Review through a collective effort with many organisations and individuals. In particular, Melbourne Water thanks:

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# Glossary of terms

| | |
|---|---|
| **BAUF** | business as usual future (for 2068) |
| **CURR** | current, 2018 baseline |
| **CCV** | climate change vulnerable |
| **CCS** | climate change stronghold |
| **eDNA** | environmental DNA |
| **HSM** | habitat suitability model |
| **HWS** | Healthy Waterways Strategy 2018 |
| **KEQ** | Key evaluation question |
| **RCP** | Representative Concentration Pathways: a greenhouse gas concentration (not emissions) trajectory adopted by the Intergovernmental Panel on Climate Change |
| **LTWRA** | Long-term water resources assessment |
| **LUMaR** | Land Use Macroinvertebrate Response index |
| **MDVs** | multiple declining values |
| **MSVs** | multiple stable values |
| **RBI** | riparian bird index |
| **SCPO** | Sub-catchment Performance Objective |
| **Strategy** | refers in this instance as the Healthy Waterways Strategy 2018 |
| **SWPA** | stormwater priority areas in the Healthy Waterways Strategy 2018 |
| **WTD** | refers to a HSM scenario of the 'works to date' that have been undertaken since 2018 |

## Acknowledgement of Traditional Owners

The rivers, wetlands and estuaries of the Port Phillip and Westernport region are part of Country belonging to the Bunurong, Gunaikurnai, Taungurung, Wadawurrung and Wurundjeri Woi-wurrung peoples. These Traditional Owners have lived in and been connected to the land, water, plants and animals of this area for many thousands of years, and we offer our respect to their Elders past and present.

# 1. Introduction

This report is one of several background reports feeding into the Healthy Waterways Strategy (HWS) mid-term review Science Inquiry (Melbourne Water 2023a). It was the last technical paper to be written as it forms a synthesis of the overall science inquiry evaluation and, in doing so, drew upon the findings and information from previous papers.

An evaluation synthesis is the process of integrating and analysing information from various sources to draw meaningful conclusions in the context of program evaluation. It combines data, evidence, and perspectives to address evaluation questions and provide recommendations. The key components of evaluation synthesis include integration, interpretation, and the generation of valuable insights.

The synthesis asked the following questions;

- *What spatial and temporal patterns can be observed across the region for key values?*
- *Are there common threats and conditions that impact the values*? and
- *Which sub-catchments should the implementation inquiry focus on*?

The values synthesis was used to understand common spatial and temporal patterns across the region and between values. The synthesis helped to make sense of the Science Inquiry results through synthesis and interpretation to identify focus area sub-catchments (spatial perspective) and management themes (threats) that are most relevant for the second half of the HWS. The sub-catchments and themes identified in this synthesis will be a focus of the Implementation Inquiry to better understand what is needed to ensure 10-year performance objectives are met by 2028.

It is important to note that the scope of the synthesis relates to environmental values and threats as the availability of social value data and a synthesis methodology was limited at the time of evaluation.

## Approach

After completing the individual key value technical papers, there was a need to synthesise across the values and various lines of evidence to help understand the 'so what does that mean' for the Science Inquiry. As this 'synthesis' step was not clearly outlined in the Mid-term evaluation plan, the approach evolved through a 'learning by doing' approach. The concept of developing 'focus areas' (i.e. sub-catchments) arose to filter the 69 sub-catchments to highlight important areas for consideration for the Implementation Inquiry. A key factor in the synthesis approach was recognising that as many performance objectives were 'off-track', there was a need to identify which performance objectives needed the most attention from a key value perspective for the remainder of the HWS period.

Focus sub-catchments were identified via a multi-step process using key value trajectories, climate change predictions and the baseline status for conditions and values. The key value trajectories were intended to understand where in the region multiple values were stable or declining. Sub-catchments that were relatively stable across values were considered areas to 'protect' from current or future threats. Where multiple values have been declining, it was important to understand likely common causes and flag the performance objectives aimed at addressing the threat. Understanding the implementation of these performance objectives is important to include in the implementation inquiry.

The climate change analysis identified the sub-catchments that were predicted to be vulnerable or resilient to climate change. While this was a limited assessment, as it only evaluated three instream key values, it provided some insights into climate change impacts across the region and is a solid foundation to build from in the future.

The synthesis drew on information from the mid-term review key value papers (Melbourne Water 2023b,c,d,e,f, g, h) and the Threats paper (Melbourne Water 2023i). Additionally, the synthesis used habitat suitability modelling (HSMs) outputs for the instream values (platypus, macroinvertebrates and fish). The approach and outcomes of the updated HSMs, are available in the Re-running HSM's with WTD + 10yr planned works (Chee, et al., 2022) and the Re-running HSM's with climate-impacted projections (Chee, et al., 2022), with further details relating to the synthesis outlined below.

Figure 1 provides an overview of the values synthesis process. Focus sub-catchments were based on one or more of the following criteria:

- Multiple declining values (MDVs) – sub-catchments where there is evidence of multiple values declining
- Multiple stable values (MSVs) – sub-catchments where there is evidence that all assessable values are stable or improving
- Climate vulnerable (CCV) – sub-catchments where values are predicted to be vulnerable to climate changes
- Climate change stronghold (CCS) – sub-catchments where values are predicted to be resilient to climate changes

For each focus sub-catchment, the trajectory of known threats was assessed to help explain reasons for declining values and to highlight areas where future threats may become an issue for currently stable sub-catchments.

The following sections detail the approach for determining each type of focus sub-catchment.

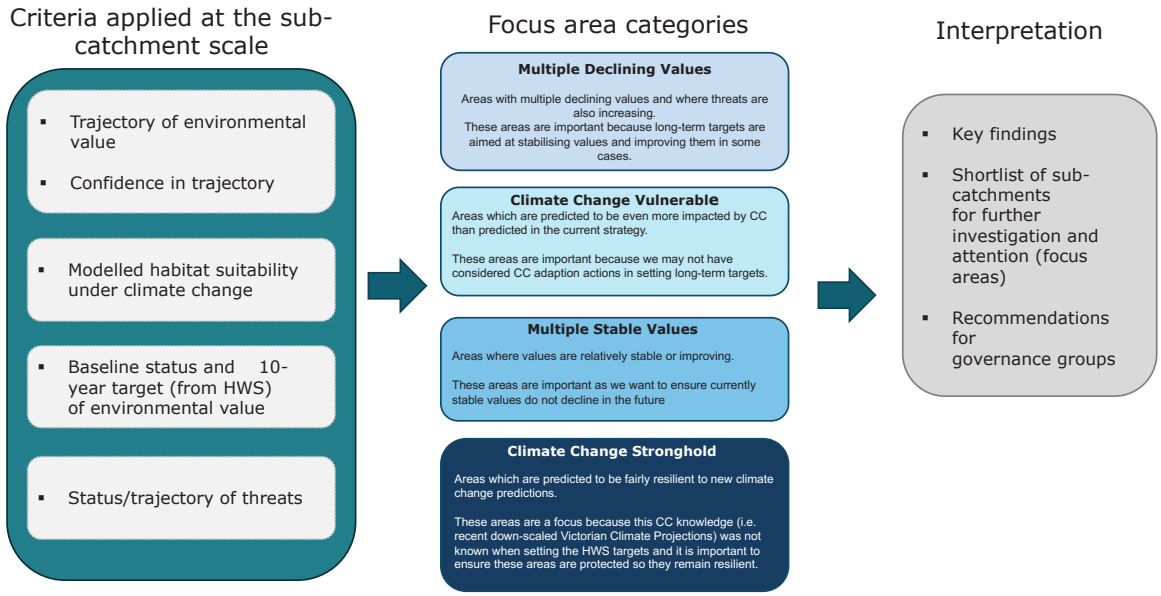



*Figure 1. Overview of the values synthesis process.*

## Multiple declining or stable values

Sub-catchments were categorised according to their value trajectory, i.e. stable or improving, potentially declining, and declining.

The trajectory of individual environmental key values was assessed at the sub-catchment level using multiple lines of evidence to make a judgement on the relative stability of key values. Lines of evidence included monitoring trend data, rubrics used in the background technical papers to assess whether key values were on the target trajectory and HSM 'works to date' outputs.

Table 1 outlines the key values included in the trajectory assessment. While most key values for rivers and wetlands could be assessed, there was inadequate data to assess estuaries. Social values were also excluded from the analysis and the reasoning for this is discussed in the limitations section.

*Table 1. Environmental key values included in the synthesis analysis*

| Asset type | Key value | Trajectory | Climate change | Threat trajectory |
|---|---|---|---|---|
| Rivers | Platypus | Yes | Yes | Yes |
| | Fish | Yes | Yes | Yes |
| | Macroinvertebrates | Yes | Yes | Yes |
| | Vegetation | Yes | *No* | Yes |
| | Birds | Yes | *No* | Yes |
| Wetlands | Birds | Yes | *No* | Yes |
| | Frogs | Yes | *No* | Yes |
| | Fish | Yes | *No* | Yes |
| | Vegetation | *No* | *No* | *No* |
| Estuaries | Birds | *No* | *No* | *No* |
| | Fish | *No* | *No* | *No* |
| | Vegetation | *No* | *No* | *No* |

Table 2 outlines the criteria used to assess the trajectory of each key value. If a key value was not assessed as declining, it was assigned a stable trajectory by default. An 'improving' trajectory was assessed for some values but not others due to time constraints and this and was flagged as an improvement opportunity for future assessments. Some of the criteria used 'standards' or 'rubrics' developed for key value KEQ in the technical reports. Further details on methodology can be found in the respective technical reports as outlined in

The methodology for assessing trajectory from the HSM 'works-to-date' predictions for platypus, fish and macroinvertebrates is outlined in Appendix A.

A confidence rating of high, moderate or low was applied to each of the trajectory assessments, and the criteria for these ratings are also outlined in Table 2.

*Table 2. Criteria used to assess trajectories for each key value.*

| Key Value | Lines of evidence | Criteria |
|---|---|---|
| Platypus (rivers) | Surveillance data (live trapping and eDNA) and HSM works to date predictions<br>KEQ 3a rubrics<br><br>(See Platypus Technical Report (Melbourne Water 2023c) and HSM WTD Report (Chee et al 2022) for methods) | **Declining: Rubric 1** – Off-track i.e HSMs Mod, High or Very High *And* Range of distribution potentially decreasing (i.e no positive eDNA records or other data) **AND/OR** HSM WTD significant declines (i.e a change in HSM prediction of > 0.2.)<br>**Potentially declining: Rubric 2** - 'Not assessable / potentially declining'.<br>**Data gaps** – None - there were no sub-catchments which could not be assessed.<br>**Confidence**<br>High – surveillance data and modelled data within SWPA<br>Moderate – outside stormwater priority areas where modelled data was uncertain<br>Low – Rubric 2 = Not assessable / potentially declining |
| Macroinvertebrates (rivers) | Surveillance data (LUMaR index), and/or HSM works to date predictions<br><br>(See Macroinvertebrate Technical Report (Melbourne Water 2023b) and HSM WTD Report (Chee et al 2022) for methods) | **Declining:** One or more macroinvertebrate surveillance site shows downward trend in the recent trend or the historic trend if recent trends could not be assessed and where there was a moderate to high confidence in the trend). Details are outlined in the Macroinvertebrates Technical Report) **AND/OR** HSM outputs shows 'significant' decline (refer to Appendix A for details).<br>**Stable:** One or more macroinvertebrate surveillance site is stable in the recent trend or the historic trend if recent trends could not be assessed and where there was a moderate to high confidence in the trend). **OR** HSM outputs shows NO 'significant' decline (refer to Appendix A for details). **OR** HSM outputs show SMALL reaches of significant decline.<br>**Data gaps** – None, all sub-catchments were assessed.<br>**Confidence**<br>*High* – when there was moderate to high confidence in trend at the surveillance site and where HSM predictions were used.<br>**Or** HSM results stable but 2 or more sites declining with moderate or high confidence in trend.<br>*Moderate* - no surveillance data and only HSM outputs (inside stormwater priority areas or rural areas) ie reasonable input model data.<br>**Or** surveillance data is different between historic and recent trends and historic trend is used.<br>*Low* – no surveillance data and HSM outputs outside stormwater priority area (SWPA) which have a predominate urban landuse or surveillance site is improving but HSM outputs declining.<br>**Or** if a site is stable but HSM results are declining. |
| Fish (rivers) | HSM works to date for 13 native fish species and 3 key species ie River blackfish, Ornate galaxias and Common galaxias | **Declining:** Top six sub-catchments with 'significant' declines for each selected species (River blackfish, Ornate galaxias and Common galaxias) and stacked native fish (refer to Appendix A). |

| Key Value | Lines of evidence | Criteria |
|---|---|---|
| | (See HSM WTD Report (Chee et al 2022) for methods) | **Data gaps** – sub-catchments outside stormwater priority areas (SWPA) which have a predominate urban landuse.<br>**Confidence**<br>*High* – no areas high due to limitations in data<br>*Moderate* – HSM outputs inside SWPA and declines for multiple species. Or part of sub-catchment is outside SWPA but development is likely.<br>*Low* – HSM outputs outside SWPA (& multiple species) or inside SWPA and only 1 species.<br>*Very low* – HSM outputs outside SWPA and only 1 species. |
| Fish (wetlands) | eDNA (based on presence of threatened species dwarf galaxias | **Declining**: No detection (from eDNA data) of threatened species in wetlands rated as high in 2018.<br>**Data gaps:** There are 68 of 86 wetlands which have no baseline or targets set, with the statement that a metric will be developed. These have been flagged as data gaps.<br>There are 10 wetlands which have baseline scores ranging from very low to high developed during the HWS development process however it is not clear how these were determined. As a result these wetlands have been flagged as data gaps.<br>**Confidence**<br>Low – based on one eDNA sample.<br>Moderate – based on one eDNA sample plus known species re-introductions. |
| Fish (estuaries) | Not enough data to assess | |
| Birds (rivers) | Surveillance data – riparian bird index (RBI)<br><br>KEQ 3a rubric<br>(See Riparian Birds Technical Report (Melbourne Water 2023d) for methods) | **Declining:** 3a Rubric – where the RBI is one or more categories below the sub-catchment target score.<br>**Data gaps:** <40 robust surveys between 2018 and 2023<br>**Confidence**<br>Moderate – where the RBI was 2 categories below the target score<br>Low – where the RBI was 1 category below the target score |
| Birds (wetlands) | Surveillance data – wetland bird index (WBI)<br>KEQ 3a rubric<br>(See Wetlands Technical Report (Melbourne Water 2023f) for methods) | **Declining:** 50% or more of the assessable WLs within a sub-catchment were declining based on 3a rubric for WBI – i.e 2021/22 WBI is one category below the baseline score<br>N/A means there are no targets for wetland birds in the sub-catchment.<br>**Data gaps** – < 50% wetlands in a sub-catchments could be assessed.<br>**Confidence**<br>Moderate – 80% or more wetlands within a sub-catchment were assessable<br>Low – 50-80% or more wetlands within a sub-catchment assessable |
| Birds (estuaries) | Not enough data to assess<br>New surveillance data | |

| Key Value | Lines of evidence | Criteria |
|---|---|---|
| Frogs (wetlands/sub-catchment) | All historic data including frog census data and detailed studies<br><br>(See Wetlands Technical Report (Melbourne Water 2023f) for methods) | **Declining:** Declining trajectory of Observed/Expected metric based on three time blocks (<B001, B001-B010, >B010) – where >100 records per time block.<br>**Potentially declining**: Overall decline in time blocks however there may be < 100 records in at least one of the time blocks or a variable but downward trend in the trajectory (ie very high to moderate to high). Threatened species (i.e Growling grass frog and *Pseudophryne spp*.) were noted within a sub-catchment if they had been historically recorded but not recorded since 2010.<br>**Confidence**<br>*Moderate* – for the declining criteria<br>*Low* – for the potentially declining criteria |
| Vegetation | VV18 and VVB1 data<br><br>(See Vegetation Technical Report (Melbourne Water 2023e) for methods) | **Declining:** cannot be assessed<br>**Potentially declining:** where VV21 rating is 2 scores below the VV18 rating (e.g. condition has potentially declined from a good to a poor condition).<br>**Data gaps:** all other sub-catchments<br>**Confidence**<br>*Low* The overall assessment was considered low confidence |

The criteria for assigning a sub-catchment as Multiple Declining Values (MDVs), Multiple Stable Values (MSVs) or neither are available Table 3. A confidence rating was determined based on the extent of data gaps, i.e. the number of values that could not be assessed.

It is important to note that sub-catchments were placed within the MDV category if there was a declining trend for macroinvertebrates in the main-stem of a river (e.g. Maribyrnong River) even if there was no evidence for other declining values. This is because macroinvertebrates are sensitive to changes in conditions, threats and management interventions, and thus, declines in the main-stem likely reflect a broader deterioration in catchment conditions.

*Table 3. Criterion used to assess whether sub-catchments had multiple stable or multiple declining values.*

| Focus sub-catchments | Description | Criterion | Confidence assessment |
|---|---|---|---|
| Multiple stable values (MSVs) | Key values in the sub-catchment are relatively stable | All key values within a sub-catchment are rated as stable or improving.<br>Or<br>One sub-catchment had only 1 potentially declining value and the rest were stable. | Low - > 6 values could not be assessed. Or one sub-catchment had a potentially declining value.<br>Moderate - 6 values could not be assessed<br>High - < 6 values could not be assessed |
| Multiple declining values (MDVs) | Key values in the sub-catchment are declining | 2 or more values rated as declining or 3 or more values rated as potentially declining.<br><br>Main stem macroinvertebrate site declining. | Low - > 6 values could not be assessed<br>Moderate - 6 values could not be assessed<br>High - < 6 values could not be assessed |

## Climate change assessment

Sub-catchments were classified according to their climate change vulnerability using HSM predictions. Details on how the models were developed with newly updated climate change data can be found in (Chee, Coleman, Burns, Burrows, & Walsh, 2022). While several scenarios were modelled the 'worst case' (HadGEMB_CC_RCP 8.5) predictions using the Victorian Climate Projections 2019 (VCP19) dataset were used for the synthesis.

Climate change strongholds were considered areas where values did not change substantially under the climate change scenario (2070) relative to the 2018 baseline. Climate vulnerable areas were areas where updated climate predictions were substantially worse than climate change predictions made in 2018.

Due to time and data constraints, climate change vulnerability was only assessed for three key values using HSMs for platypus, fish (climate sensitive species: River Blackfish and Ornate Galaxias), and macroinvertebrates. Sub-catchments were included if one or more of these values were categorised as climate change vulnerable (CCV) or a climate change stronghold (CCS). The criteria for assigning these categories is available in Table 4.

In some cases, a sub-catchment was identified as belonging to multiple categories. This is possible because (a) each assessment process used different criteria and (b) the climate change assessment occurred on species individually and at spatial scales smaller than sub-catchments. For instance, River Blackfish may be predicted to remain stable in the upper part of a sub-catchment but decline in lower parts of the same sub-catchment.

*Table 4. Criteria used to determine 'Important Areas' from a climate change perspective for platypus, fish and macroinvertebrates.*

| Important Area | Lines of evidence / criteria |
|---|---|
| CCSs - Climate stronghold | Difference between CURR (2018 baseline) versus HadGEMB_CC_RCP 8.5 (worst-case-scenario of the new climate change projections).<br><br>Qualitative assessment: Stream reaches in the majority of the sub-catchment showed minimal change in predictions, focussing on reaches with High and Very High habitat suitability. |
| CCVs - Climate vulnerable | Difference between BAUF (climate assumptions made in 2018) versus HadGEMB_CC_RCP 8.5 (worst-case-scenario of the new climate change projections).<br><br>Qualitative assessment. Stream reaches in the majority of the sub-catchment showed large declines in suitable habitat. |

## Baseline assessment

A filtering process was applied so that only sub-catchments with moderate or higher sub-catchment baseline environmental value scores (i.e. HWS baseline) for all the river key values at the time of Strategy commencement in 2018 were retained as focus sub-catchments. This was undertaken as it was observed that some sub-catchments were stable because values were very low and unlikely to decline much further. These sub-catchments were filtered out and not taken further in the analysis. We emphasise that sub-catchments with low and very low baseline value or condition scores are still

important as many have performance objectives and long-term targets that aim to improve conditions and values over time.

Like the filtering above, the focus sub-catchments were grouped into those with moderate or greater underlying environmental conditions (Group A) and those with a high proportion of low or very low conditions (Group B). This provides information that may help prioritise efforts based on the findings of the Implementation Inquiry (Melbourne Water *in prep*).

## Threats analysis

Threats were assessed at a high level to help explain drivers of decline and highlight possible future threats in each of the focus sub-catchments. The conceptual models of each key value developed during the development of the HWS (and summarised in the threats technical report (Melbourne Water, 2023i) highlight which threats are likely to impact the different values. Appendix J outlines the priority conditions and threats for each key value. The threats synthesis analysis also drew information from the key values technical reports (Melbourne Water 2023b,c,d,e,f,g,h) and the HSM 'works to date' outputs.

Threats were assessed as stable, increasing or decreasing based on the methodology used in the threats technical report (Melbourne Water, 2023i). These threats were then assessed for each of the focus sub-catchments to understand the extent and severity of different threats in the focus sub-catchments (see Table 5).

Knowledge gaps were identified where there was low confidence in the assessment and helped to highlight where further information is needed to confirm the threat status (e.g., the degree of impact of recreational access in forested sub-catchments is a knowledge gap).

*Table 5. Threat trajectory confidence rating as documented in the Threats Technical Report (Melbourne Water, 2023i). Low confidence threats are bolded.*

| Threat | Confidence | Summary of trajectory across the region | # 'Focus Areas' SCs with increasing threat |
|---|---|---|---|
| Urban flows | High | Stable – increasing | 6 |
| Urban water quality | Moderate | Stable – increasing | 2 |
| Physical modifications | Moderate | Stable – increasing | 3 |
| Wastewater | High | Stable | 0 |
| Platypus Entrapment | Moderate | Stable – increasing | 4 |
| Instream barriers | Moderate | Decreasing – stable | 0 |
| Water availability | Moderate | Stable – increasing | 25 |
| **Agriculture** | **Low** | Stable – increasing | 2 |
| **Recreational access** | **Low** | Stable – increasing | 17 |
| **Pest plants** | **Low** | Stable | 0 |
| Pest animals | High | Stable – increasing | 21 |
| **Vegetation clearing** | **Low** | Stable | 0 |

## Limitations

While the methodology used to determine the focus sub-catchments was logical and fit for purpose, there were a number of limitations around modelling and data gaps that need to be recognised.

The use of models for predicting climate change impacts was limited in the accuracy of the models but also because models only exist for 3 of the 9 key values. As a result, the climate change vulnerable and stronghold areas are limited to an assessment of instream values. However, many of the important climate change areas were in the intact forested headwaters of the region which is where many other values are known to occur.

The assessment of key trajectories was also limited in some sub-catchments due to data gaps in surveillance monitoring of different key values. Table 6 outlines how key values were spread across the different categories and where there were significant data gaps. Table 7 provides additional information on the limitations of assessing each key value.

The assessment of 'improving' was not conducted comprehensively or consistently across the values and this is an area for improvement in the future. The main focus at the outset of the synthesis was on stable or declining with improving being considered in the stable category.

Social values were not included in the final synthesis assessment. While they were part of the testing phase, the trend data and rubrics used in the background paper were not considered robust enough to represent social value trajectories. Some of the reasons for this were; the lack of sub-catchment scale data and the inability to accurately assess trends of the various indicators over time. The other reason is that including them along with the environmental values was complicated when the other factors were dominated towards environmental values. Further thought is needed to determine the best way to include social values in an overall synthesis in future.

While the threat trajectory assessment was useful in synthesising results for each of the focus sub-catchments at a high level and at a regional scale, the data sets were not robust enough to undertake a detailed evaluation. Some of the limitations associated with the threats analysis are outlined below in Table 8. Further information is available in the Threats Technical Report Melbourne Water (2023i).

*Table 6. How values are spread across the different focus sub-catchment categories and where knowledge gaps exist.*

| Sub-catchment categories | Values highlighted through the synthesis | Significant knowledge gaps / limitations |
|---|---|---|
| Multiple stable values - MSVs | Platypus (rivers), macroinvertebrates (rivers), fish (rivers, wetlands), birds (rivers, wetlands), frogs (wetlands, rivers) | Vegetation value (rivers, wetlands and estuaries)<br>Fish (estuaries and wetlands),<br>Birds (estuaries) |
| Climate change stronghold - CCS | Platypus, fish, bugs | Birds, frogs, vegetation, fish (wetlands and estuaries) |
| Climate change vulnerable – CCV | Platypus, fish, bugs | Birds, frogs, vegetation, fish (wetlands and estuaries) |
| Multiple declining values – MDVs | macroinvertebrates, fish (rivers), platypus, veg (rivers), frogs (rivers & wetlands), birds (rivers) | Vegetation value (rivers, wetlands and estuaries)<br>Fish (estuaries and wetlands),<br>Birds (estuaries) |

*Table 7. Summary of limitations of the trajectory analysis for key values.*

| Key Value | Limitations |
|---|---|
| Platypus (rivers) | Lack of recent live trapping surveys and eDNA presence/absence data is a limitation on the confidence in the trend results. |
| Macroinvertebrates (rivers) | Confidence in HSM predictions outside the Stormwater Priority Areas was low due to model input data not including development outside of priority areas or infill development. There are also some concerns with the accuracy of the canopy cover model parameters. |
| Fish (rivers) | Analysis was limited to HSM 'works to date' outputs due to lack of surveillance monitoring data. |
| Fish (wetlands) | Analysis was restricted to very limited data on one threatened species. This is due to a lack of surveillance data. |
| Fish (estuaries) | No assessment could be made due to lack of data. |
| Birds (rivers) | The KEQ3a rubric compares the 2022 time block with the target score not against the 2018 time block and as such a may not represent a decline. E.g some sub-catchments were higher than the baseline but significantly lower than the target. An 'off-track' assessment does not represent a decline in this case. |
| Birds (wetlands) | The KEQ3a rubric compares with the baseline which is different to the rivers assessment. This method is likely to be more accurate than the rivers assessment however time constraints meant these discrepancies in methodology were not resolved.<br>There were substantial data gaps. |
| Birds (estuaries) | No assessment could be made due to lack of data. |
| Frogs | Data was limited for some of the time blocks assessed. It was difficult to factor in data from detailed studies eg threatened species data. |
| Vegetation (rivers) wetlands and estuaries) | There is a high degree of uncertainty with comparison of the VV21 and VV18 data as outlined in the Vegetation technical paper (Melbourne Water 2023e). |
| Vegetation (wetlands and estuaries) | No assessment could be made due to lack of data |

*Table 8. Limitations of the threat trajectory assessment*

| Increasing threat | Limitations |
|---|---|
| Water extraction | The assessment is qualitative in some areas where the Long-term water resources assessment (LTWRA) trends were not available. |
| Deer | While there is good data on the current (2021) threat from deer data and models, the trajectory assessment was qualitative and based on anecdotal information and extrapolated to the other sub-catchments. |
| Recreational access | Confidence in the threat trajectory is low and qualitative i.e. based on park status e.g. state park = increasing threat. |
| Physical modifications | The degree of proposed piping of headwater streams is based on planned drainage scheme infrastructure and has not been verified. |
| Platypus entrapment | Based on an assumption that increasing urbanisation = an increasing entrapment threat. |
| Urban flow | There are gaps in data for many sub-catchments (i.e. 17) eg outside stormwater priority areas. Assumptions were made based on proposed developments. |
| Urban water quality | Some sub-catchments need verification e.g. Phillip Island where the toxicant index trends were unusual. |

# 2. Outcomes

The following section presents results for each stage of the focus sub-catchment assessment process including the trajectories of each key value, the combined value trajectories (ie multiple stable and multiple declining values), the climate vulnerability assessment and the baseline assessment. An assessment of threats for each of the focus sub-catchments then presented along with an overall summary by catchment.

## Trajectory assessment

A summary of the trajectory assessment for each of the key values is outlined below with further details including HSM modelling results provided in Appendix A - H.

### Macroinvertebrates

The trajectory assessment for macroinvertebrates found that the majority of sub-catchments were stable; i.e. 50 of the 69 sub-catchments, and 19 declining (Figure 2). The confidence in the assessment was typically moderate or high, with only 24 low ratings.

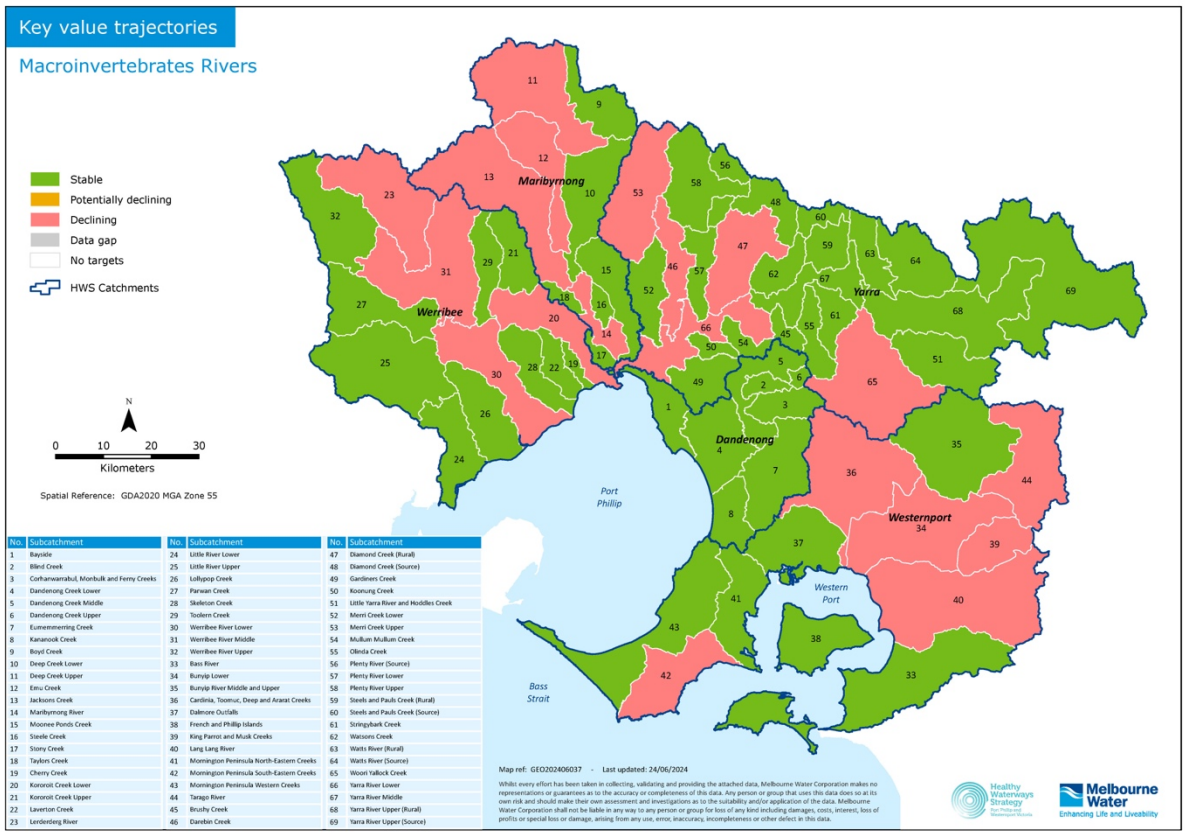
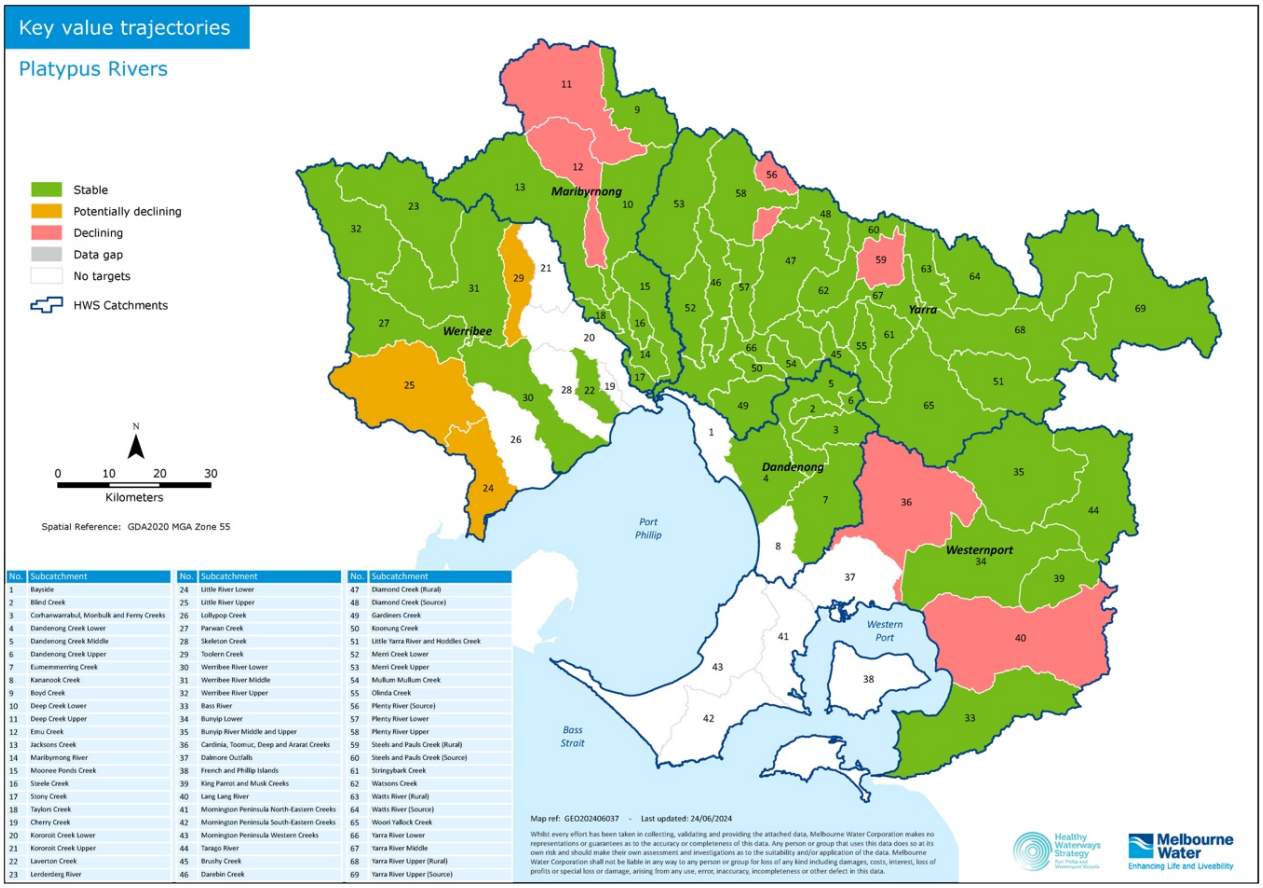



*Figure 2. Long-term trajectory assessment results for macroinvertebrates in Port Phillip and Westernport region*

## Platypus

Overall, 57 of the 69 sub-catchments were assessed. Twelve sub-catchments do not have platypus populations or long-term targets. The majority of assessable sub-catchments were stable (48 out of 57), and nine were declining (Figure 3). The confidence in the assessment was typically moderate or high, with only 5 sub-catchments with low.




| No. | Subcatchment |
|---|---|
| 1 | Bayside |
| 2 | Blind Creek |
| 3 | Corhanwarrabul, Monbulk and Ferny Creeks |
| 4 | Dandenong Creek Lower |
| 5 | Dandenong Creek Middle |
| 6 | Dandenong Creek Upper |
| 7 | Eumemmerring Creek |
| 8 | Kananook Creek |
| 9 | Boyd Creek |
| 10 | Deep Creek Lower |
| 11 | Deep Creek Upper |
| 12 | Emu Creek |
| 13 | Jacksons Creek |
| 14 | Maribyrnong River |
| 15 | Moonee Ponds Creek |
| 16 | Steele Creek |
| 17 | Stony Creek |
| 18 | Taylors Creek |
| 19 | Cherry Creek |
| 20 | Kororoit Creek Lower |
| 21 | Kororoit Creek Upper |
| 22 | Laverton Creek |
| 23 | Lerderderg River |

| No. | Subcatchment |
|---|---|
| 24 | Little River Lower |
| 25 | Little River Upper |
| 26 | Lollypop Creek |
| 27 | Parwan Creek |
| 28 | Skeleton Creek |
| 29 | Toolern Creek |
| 30 | Werribee River Lower |
| 31 | Werribee River Middle |
| 32 | Werribee River Upper |
| 33 | Bass River |
| 34 | Bunyip Lower |
| 35 | Bunyip River Middle and Upper |
| 36 | Cardinia, Toomuc, Deep and Ararat Creeks |
| 37 | Dalmore Outfalls |
| 38 | French and Phillip Islands |
| 39 | King Parrot and Musk Creeks |
| 40 | Lang Lang River |
| 41 | Mornington Peninsula North-Eastern Creeks |
| 42 | Mornington Peninsula South-Eastern Creeks |
| 43 | Mornington Peninsula Western Creeks |
| 44 | Tarago River |
| 45 | Brushy Creek |
| 46 | Darebin Creek |

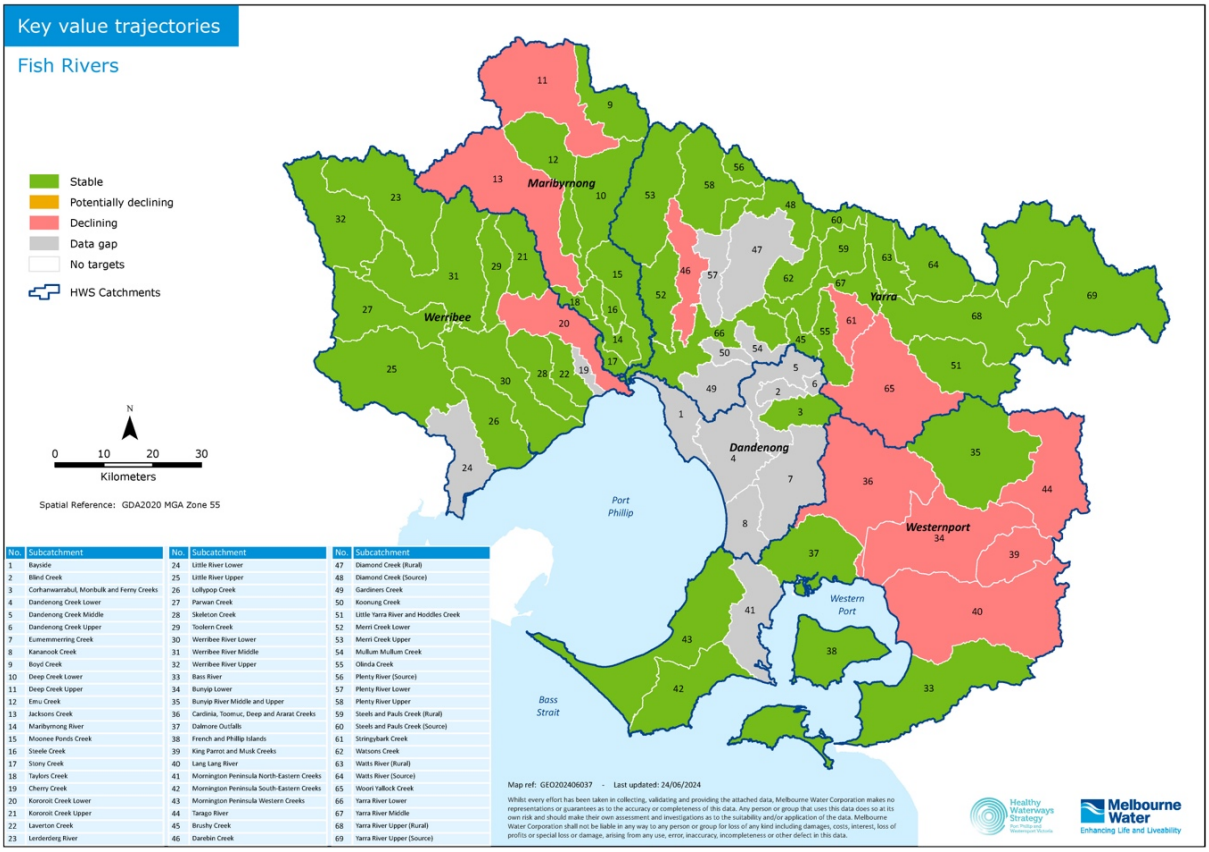
| No. | Subcatchment |
|---|---|
| 47 | Diamond Creek (Rural) |
| 48 | Diamond Creek (Source) |
| 49 | Gardiners Creek |
| 50 | Koonung Creek |
| 51 | Little Yarra River and Hoddles Creek |
| 52 | Merri Creek Lower |
| 53 | Merri Creek Upper |
| 54 | Mullum Mullum Creek |
| 55 | Olinda Creek |
| 56 | Plenty River (Source) |
| 57 | Plenty River Lower |
| 58 | Plenty River Upper |
| 59 | Steels and Pauls Creek (Rural) |
| 60 | Steels and Pauls Creek (Source) |
| 61 | Stringybark Creek |
| 62 | Watsons Creek |
| 63 | Watts River (Rural) |
| 64 | Watts River (Source) |
| 65 | Woori Yallock Creek |
| 66 | Yarra River Lower |
| 67 | Yarra River Middle |
| 68 | Yarra River Upper (Rural) |
| 69 | Yarra River Upper (Source) |



*Figure 3. Long-term trajectory assessment results for platypus in Port Phillip and Westernport region*

## Fish (rivers)

The trajectory assessment for fish was based on HSMs as monitoring data was not adequate for the assessment. The modelled outputs included the stacked probability of 13 native fish species and habitat suitability of 3 individual species, i.e. River blackfish, Ornate galaxias and Common galaxias. Based on these outputs, the majority of sub-catchments (43) were rated as stable with 11 declining (Figure 4). There were 15 sub-catchments where confidence in the HSM models was too low to assign a rating.




| No. | Subcatchment | No. | Subcatchment | No. | Subcatchment |
|---|---|---|---|---|---|
| 1 | Bayside | 24 | Little River Lower | 47 | Diamond Creek (Rural) |
| 2 | Blind Creek | 25 | Little River Upper | 48 | Diamond Creek (Source) |
| 3 | Corhanwarrabul, Monbulk and Ferny Creeks | 26 | Lollypop Creek | 49 | Gardiners Creek |
| 4 | Dandenong Creek Lower | 27 | Parwan Creek | 50 | Koonung Creek |
| 5 | Dandenong Creek Middle | 28 | Skeleton Creek | 51 | Little Yarra River and Hoddles Creek |
| 6 | Dandenong Creek Upper | 29 | Toolern Creek | 52 | Merri Creek Lower |
| 7 | Eumemmerring Creek | 30 | Werribee River Lower | 53 | Merri Creek Upper |
| 8 | Kananook Creek | 31 | Werribee River Middle | 54 | Mullum Mullum Creek |
| 9 | Boyd Creek | 32 | Werribee River Upper | 55 | Olinda Creek |
| 10 | Deep Creek Lower | 33 | Bass River | 56 | Plenty River (Source) |
| 11 | Deep Creek Upper | 34 | Bunyip Lower | 57 | Plenty River Lower |
| 12 | Emu Creek | 35 | Bunyip River Middle and Upper | 58 | Plenty River Upper |
| 13 | Jacksons Creek | 36 | Cardinia, Toomuc, Deep and Ararat Creeks | 59 | Steels and Pauls Creek (Rural) |
| 14 | Maribyrnong River | 37 | Dalmore Outfalls | 60 | Steels and Pauls Creek (Source) |
| 15 | Moonee Ponds Creek | 38 | French and Phillip Islands | 61 | Stringybark Creek |
| 16 | Steele Creek | 39 | King Parrot and Musk Creeks | 62 | Watsons Creek |
| 17 | Stony Creek | 40 | Lang Lang River | 63 | Watts River (Rural) |
| 18 | Taylors Creek | 41 | Mornington Peninsula North-Eastern Creeks | 64 | Watts River (Source) |
| 19 | Cherry Creek | 42 | Mornington Peninsula South-Eastern Creeks | 65 | Woori Yallock Creek |
| 20 | Kororoit Creek Lower | 43 | Mornington Peninsula Western Creeks | 66 | Yarra River Lower |
| 21 | Kororoit Creek Upper | 44 | Tarago River | 67 | Yarra River Middle |
| 22 | Laverton Creek | 45 | Brushy Creek | 68 | Yarra River Upper (Rural) |
| 23 | Lerderderg River | 46 | Darebin Creek | 69 | Yarra River Upper (Source) |

*Figure 4. Long-term trajectory assessment results for fish in rivers in  Port Phillip and Westernport region*

## Fish (wetlands)

Data for wetland fish was very limited when developing the HWS and as a result the HWS only set targets for a select number of wetland fish species i.e. Dwarf galaxias and Yarra pygmy perch. For these listed species, there are targets in eight wetlands (or HWS complexes) across the region with the most in Dandenong Creek catchment and the remaining in Westernport. Due to time and data limitations, the trajectory assessment was only undertaken for Dwarf galaxias, using recently acquired eDNA data and known locations of re-introductions. As shown in Figure 5 and Table 9, all five sub-catchments which contain wetlands with known Dwarf galaxias have been rated as stable.

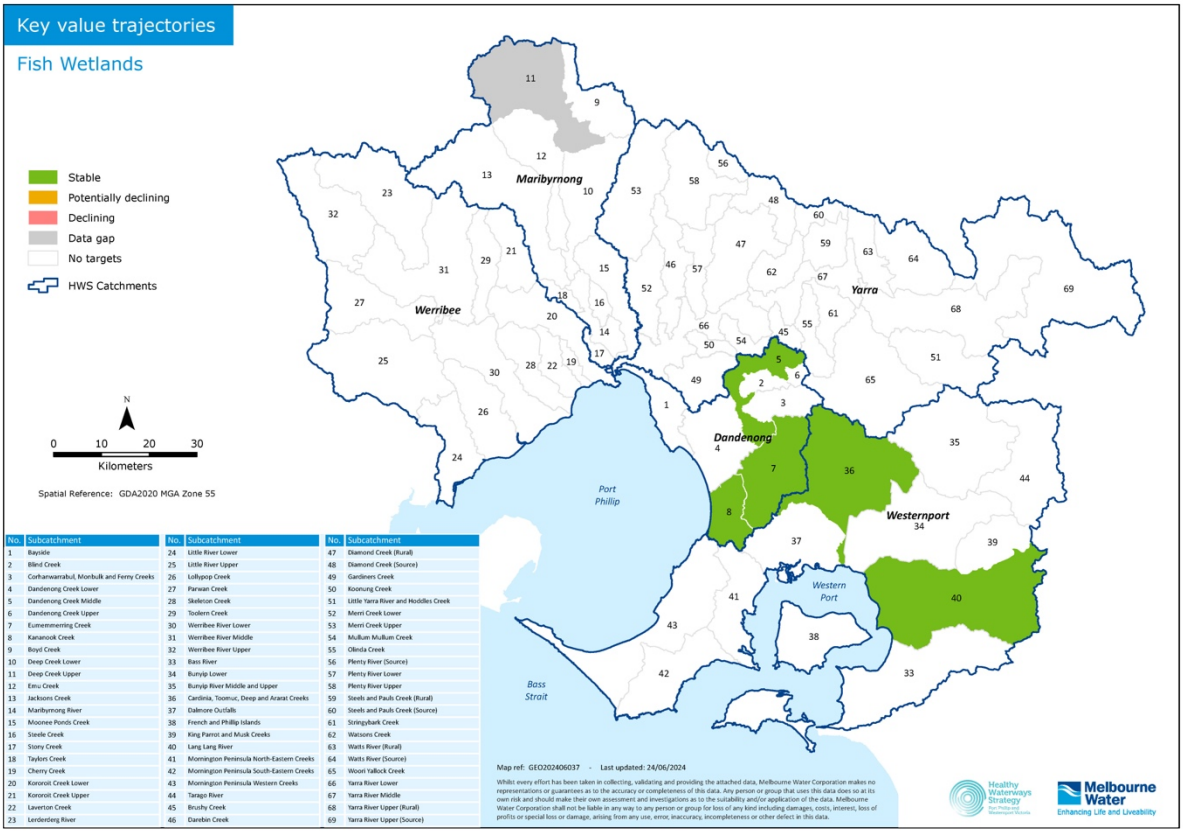



*Figure 5. Long-term trajectory assessment results for fish (specifically dwarf Galaxias) in wetlands in Port Phillip and Westernport region*

*Table 9. Trajectory results for wetland fish (specifically Dwarf galaxias) for each sub-catchment along with the data sources used to determine the status*

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Dandenong | Dandenong Creek Middle (3 wetlands) | Stable | Recent eDNA records and re-introductions in Autumn 2023. | Moderate |
| Dandenong | Eumemmerring Creek (1 wetland) | Stable | Recent eDNA records | Low |
| Dandenong | Kananook Creek (1 wetland) | Stable | Recent eDNA records | Low |
| Westernport | Cardinia, Toomuc, Deep and Ararat (1 wetland) | Stable | Recent eDNA records | Low |
| Westernport | Lang Lang River (1 floodplain wetland) | Stable | Recent eDNA records | Low |

## Frogs

The trajectory analysis for frogs was based on historical data using an observed over expected (O/E) metric. If the O/E metric declined over the 3 the time blocks i.e. < 2001, 2001-2010 and > 2010 the sub-catchment was rated as declining.

Based on this methods just over half (27) of the assessable sub-catchments (49) were rated as stable. There were 16 rated as potentially declining, 6 declining and 20 sub-catchments that could not be assessed due to data limitations (Figure 6).

Given the importance of threatened frog species in the region, available data on Pseudoohryne species and the Growling Grass Frog was assessed separately to highlight potential declines. While this information did not influence the trajectory assessment it is presented as supplementary data (refer to Appendix F).

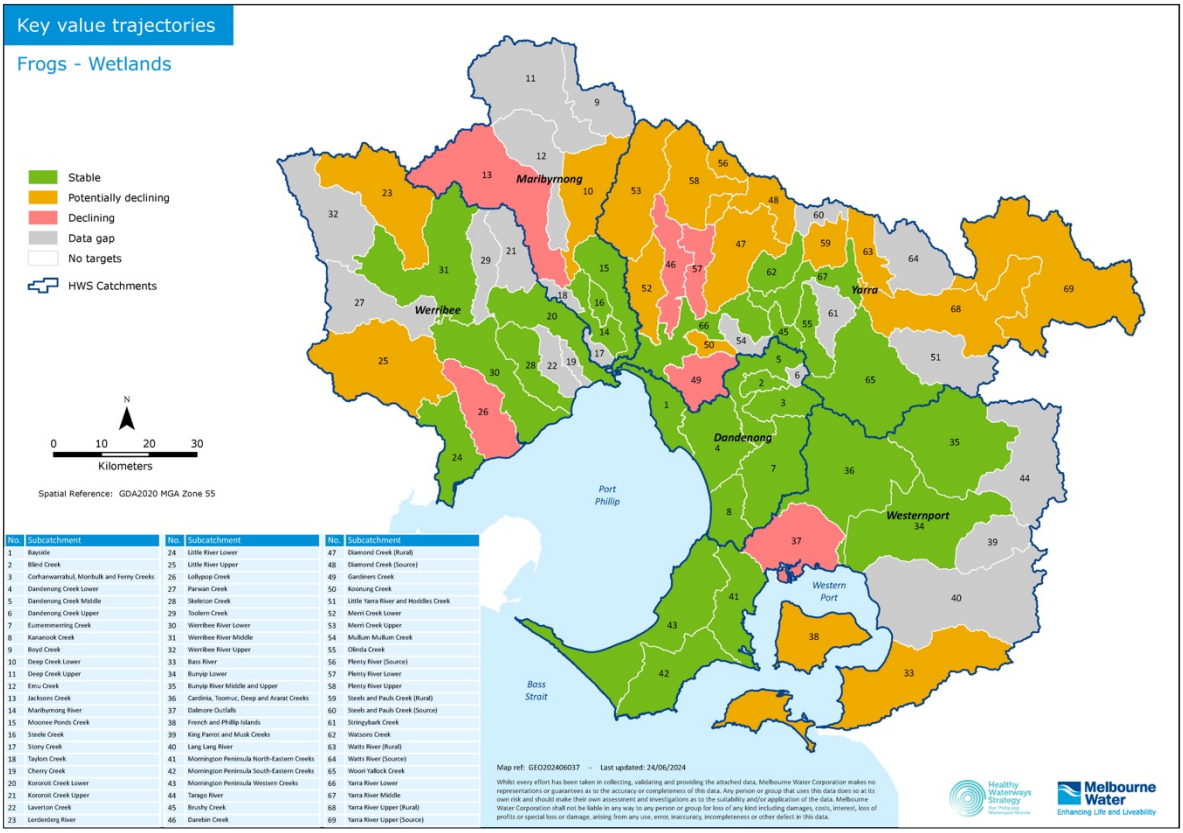



*Figure 6. Long-term trajectory assessment results for frogs in wetlands in Port Phillip and Westernport region*

## Birds (riparian)

Figure 7 below presents the trajectory analysis, which compared the 2023 Riparian Bird Index (RBI) to the target and baseline scores.

The majority of the assessable sub-catchments (45 of 69) were rated as stable (37) with only 8 declining. As discussed in the limitation section, comparison with the target score is a limited way to assess a declining trajectory and improvements to this method are suggested.

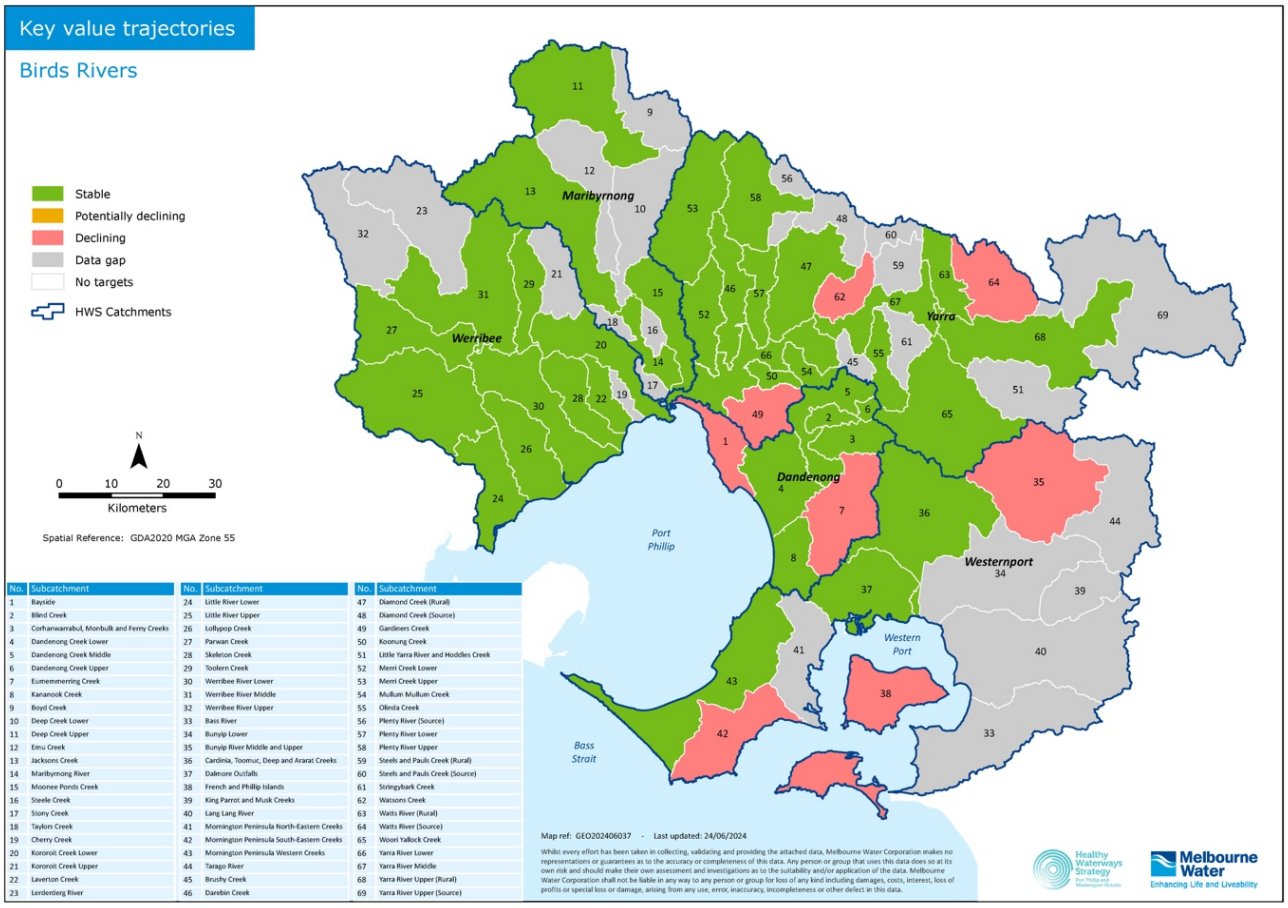
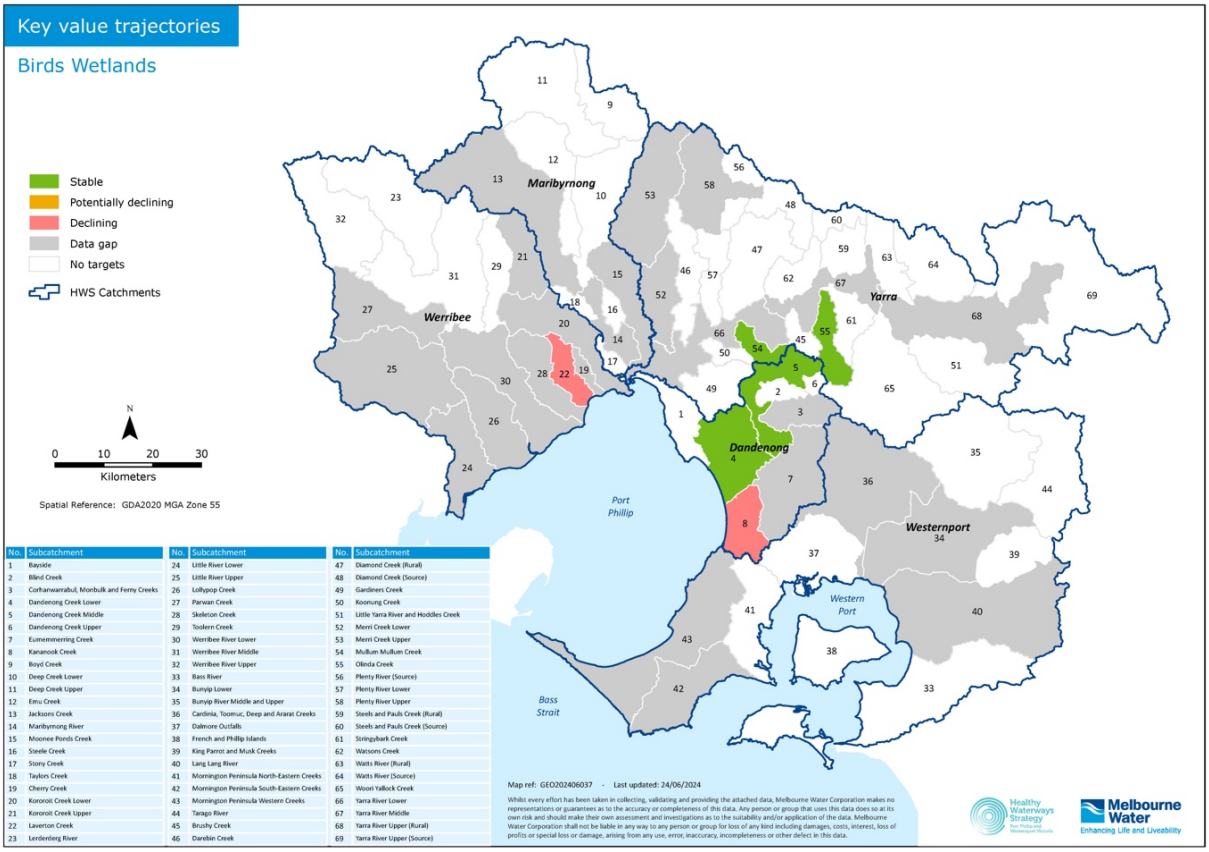



*Figure 7. Long-term trajectory assessment results for riparian birds in Port Phillip and Westernport region*

## Birds (wetlands)

Figure 8 below presents the trajectory analysis which compared the 2021/22 Wetland bird index (WBI) to the baseline scores.

Of the 69 sub-catchments across the region, there were 31 which included targets for wetland birds. Of these, only six sub-catchments could be assessed due to insufficient data for the remaining 25 sub-catchments. Of the assessable sub-catchments, four were rated as stable and two as declining. As discussed in the limitation section, this assessment process is limited and requires a review for any future similar trajectory evaluation.




| No. | Subcatchment | No. | Subcatchment | No. | Subcatchment |
|---|---|---|---|---|---|
| 1 | Bayside | 24 | Little River Lower | 47 | Diamond Creek (Rural) |
| 2 | Blind Creek | 25 | Little River Upper | 48 | Diamond Creek (Source) |
| 3 | Corhanwarrabul, Monbulk and Ferny Creeks | 26 | Lollypop Creek | 49 | Gardiners Creek |
| 4 | Dandenong Creek Lower | 27 | Parwan Creek | 50 | Koonung Creek |
| 5 | Dandenong Creek Middle | 28 | Skeleton Creek | 51 | Little Yarra River and Hoddles Creek |
| 6 | Dandenong Creek Upper | 29 | Toolern Creek | 52 | Merri Creek Lower |
| 7 | Eumemmerring Creek | 30 | Werribee River Lower | 53 | Merri Creek Upper |
| 8 | Kananook Creek | 31 | Werribee River Middle | 54 | Mullum Mullum Creek |
| 9 | Boyd Creek | 32 | Werribee River Upper | 55 | Olinda Creek |
| 10 | Deep Creek Lower | 33 | Bass River | 56 | Plenty River (Source) |
| 11 | Deep Creek Upper | 34 | Bunyip Lower | 57 | Plenty River Lower |
| 12 | Emu Creek | 35 | Bunyip River Middle and Upper | 58 | Plenty River Upper |
| 13 | Jacksons Creek | 36 | Cardinia, Toomuc, Deep and Ararat Creeks | 59 | Steels and Pauls Creek (Rural) |
| 14 | Maribyrnong River | 37 | Dalmore Outfalls | 60 | Steels and Pauls Creek (Source) |
| 15 | Moonee Ponds Creek | 38 | French and Phillip Islands | 61 | Stringybark Creek |
| 16 | Steele Creek | 39 | King Parrot and Musk Creeks | 62 | Watsons Creek |
| 17 | Stony Creek | 40 | Lang Lang River | 63 | Watts River (Rural) |
| 18 | Taylors Creek | 41 | Mornington Peninsula North-Eastern Creeks | 64 | Watts River (Source) |
| 19 | Cherry Creek | 42 | Mornington Peninsula South-Eastern Creeks | 65 | Woori Yallock Creek |
| 20 | Kororoit Creek Lower | 43 | Mornington Peninsula Western Creeks | 66 | Yarra River Lower |
| 21 | Kororoit Creek Upper | 44 | Tarago River | 67 | Yarra River Middle |
| 22 | Laverton Creek | 45 | Brushy Creek | 68 | Yarra River Upper (Rural) |
| 23 | Lerderderg River | 46 | Darebin Creek | 69 | Yarra River Upper (Source) |

*Figure 8. Long-term trajectory assessment results for wetland birds in Port Phillip and Westernport region*

## Vegetation (riparian)

As described in the approach section, the assessment of trajectory for vegetation was very limited due to data constraints. Sub-catchments were rated as 'potentially declining' where there was some evidence of a decrease in vegetation condition (ie VV21 compared with VV18 datasets). Based on this, there are 19 sub-catchments which have potentially declining vegetation condition. The remaining sub-catchments were not assessable due to data constraints.

*Table 10. Trajectory results for riparian vegetation for each sub-catchment and the data sources used to determine the status.*

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Dandenong | Bayside | Gap | | |
| | Blind Creek | Gap | | |
| | Corhanwarrabul, Monbulk and Ferny Creeks | Gap | | |
| | Dandenong Creek Lower | Gap | | |
| | Dandenong Creek Middle | Gap | | |
| | Dandenong Creek Upper | Gap | | |
| | Eumemmerring Creek | Gap | | |
| | Kananook Creek | Gap | | |
| Maribyrnong | Boyd Creek | Gap | | |
| | Deep Creek Lower | Gap | | |
| | Deep Creek Upper | Gap | | |
| | Emu Creek | Gap | | |
| | Jacksons Creek | Gap | | |
| | Maribyrnong River | Gap | | |
| | Moonee Ponds Creek | Gap | | |
| | Steele Creek | Gap | | |
| | Stony Creek | Gap | | |
| | Taylors Creek | Gap | | |
| Werribee | Cherry Creek | Gap | | |
| | Kororoit Creek Lower | Gap | | |
| | Kororoit Creek Upper | Gap | | |
| | Laverton Creek | Gap | | |
| | Lerderderg River | Potentially declining | VV21 and VV18 | Low |
| | Little River Lower | Gap | | |
| | Little River Upper | Gap | | |
| | Lollypop Creek | Gap | | |
| | Parwan Creek | Gap | | |
| | Skeleton Creek | Gap | | |
| | Toolern Creek | Gap | | |
| | Werribee River Lower | Gap | | |
| | Werribee River Middle | Gap | | |
| | Werribee River Upper | Potentially declining | VV21 and VV18 | Low |
| Westernport | Bass River | Gap | | |
| | Bunyip Lower | Gap | | |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| | Bunyip River Middle and Upper | Gap | | |
| | Cardinia, Toomuc, Deep and Ararat | Gap | | |
| | Dalmore Outfalls | Gap | | |
| | French and Phillip Islands | Gap | | |
| | King Parrot and Musk Creeks | Gap | | |
| | Lang Lang River | Gap | | |
| | Mornington Peninsula North-Eastern Creeks | Gap | | |
| | Mornington Peninsula South-Eastern Creeks | Gap | | |
| | Mornington Peninsula Western Creeks | Gap | | |
| | Tarago River | Gap | | |
| Yarra | Brushy Creek | Gap | | |
| | Darebin Creek | Gap | | |
| | Diamond Creek (Rural) | Gap | | |
| | Diamond Creek (Source) | Gap | | |
| | Gardiners Creek | Gap | | |
| | Koonung Creek | Gap | | |
| | Little Yarra River and Hoddles Creek | Gap | | |
| | Merri Creek Lower | Gap | | |
| | Merri Creek Upper | Gap | | |
| | Mullum Mullum Creek | Gap | | |
| | Olinda Creek | Gap | | |
| | Plenty River (Source) | Gap | | |
| | Plenty River Lower | Potentially declining | VV21 and VV18 | Low |
| | Plenty River Upper | Gap | | |
| | Steels and Pauls Creek (Rural) | Gap | | |
| | Steels and Pauls Creek (Source) | Gap | | |
| | Stringybark Creek | Gap | | |
| | Watsons Creek | Gap | | |
| | Watts River (Rural) | Gap | | |
| | Watts River (Source) | Gap | | |
| | Woori Yallock Creek | Potentially declining | VV21 and VV18 | Low |
| | Yarra River Lower | Gap | | |
| | Yarra River Middle | Gap | | |
| | Yarra River Upper (Rural) | Potentially declining | VV21 and VV18 | Low |
| | Yarra River Upper (Source) | Gap | | |

## Multiple Stable and Multiple Declining values

Sub-catchments with multiple stable values were defined as those where all environmental key values were rated as stable or improving or where one value was potentially declining value and the remaining were stable.

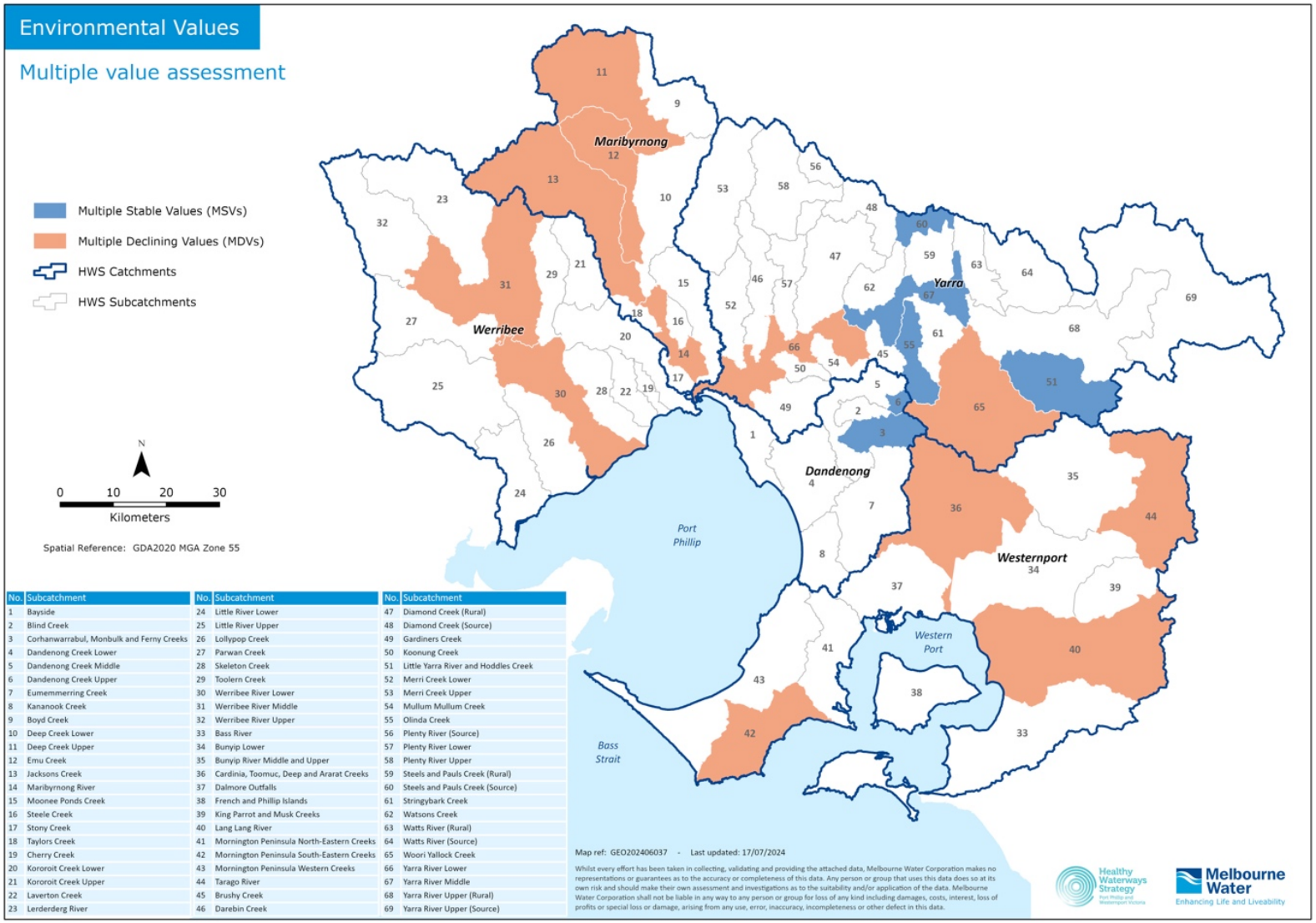
Sub-catchments with multiple declining values were defined as those where 2 or more values were rated as declining or 3 or more values were rated as potentially declining. An exception to this is along the lower main stem reaches of the major systems where macroinvertebrates were the only declining value. The results are presented below in Table 11 along with confidence ratings for each sub-catchment and displayed in Figure 9.

*Table 11. Summary of the key values trajectory assessment. D = Declining, S = Stable, PD = Potentially declining, blank = no targets, G = data gap, MSV = multiple stable values – where N = No there are no stable values in the sub-catchment, Y = there are multiple stable values. * and ** refer to baseline values. Confidence = confidence rating, L = low, M = moderate and H = high.*

| Catchment | Sub-catchment | Frogs (W) | Fish (W) | Birds (W) | Veg (W) | Birds (R) | Macros (R) | Fish (R) | Platypus (R) | Veg (R) | Veg (E) | Fish (E) | Birds (E) | MSVs | MDVs | Confidence |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dandenong | Bayside | S | | | G | D | S | G | | G | G | G | G | N | N | M |
| | Blind Creek | S | | | G | S | S | G | S | G | G | G | G | Y | N | M |
| | Corhanwarrabul, Monbulk & Ferny | S | | G | G | S | S | S | S | G | G | G | G | Y | N | M |
| | Dandenong Creek Lower | S | | S | G | S | S | G | S | G | G | G | G | Y | N | M |
| | Dandenong Creek Middle | S | S | S | G | S | S | G | S | G | G | G | G | Y | N | M |
| | Dandenong Creek Upper | G | | | G | S | S | G | S | G | G | G | G | Y | N | L |
| | Eumemmerring Creek | S | S | G | G | D | S | G | S | G | G | G | G | N | N | L |
| | Kananook Creek | S | S | D | G | S | S | G | | G | G | G | G | N | N | M |
| Maribyrnong | Boyd Creek | G | | | G | G | S | S | S | G | G | G | G | Y | N | L |
| | Deep Creek Lower | PD | | | G | G | S | S | S | G | G | G | G | N | N | M |
| | Deep Creek Upper | G | G | | G | S | D | D | D | G | G | G | G | N | Y | M |
| | Emu Creek | G | | | G | G | D | S | D | G | G | G | G | N | Y | L |
| | Jacksons Creek | D | | G | G | S | D | D | S | G | G | G | G | N | Y | M |
| | Maribyrnong River | S | | G | G | S | D | S | S | G | G | G | G | N | Y** | M |
| | Moonee Ponds Creek | S | | G | G | S | S | S | S | G | G | G | G | Y | N | M |
| | Steele Creek | S | | | G | G | S | S | S | G | G | G | G | Y* | N | M |
| | Stony Creek | G | | | G | G | S | S | S | G | G | G | G | Y* | N | L |
| | Taylors Creek | G | | | G | G | S | S | S | G | G | G | G | Y | N | L |
| Werribee | Cherry Creek | G | | G | G | G | S | G | | G | G | G | G | Y* | N | L |
| | Kororoit Creek Lower | S | | G | G | S | D | D | | G | G | G | G | N | Y* | M |
| | Kororoit Creek Upper | G | | G | G | G | S | S | | G | G | G | G | Y | N | M |
| | Laverton Creek | G | | D | G | S | S | S | S | G | G | G | G | N | N | M |
| | Lerderderg River | PD | | | G | G | D | S | S | PD | G | G | G | N | N | H |

| Catchment | Sub-catchment | Frogs (W) | Fish (W) | Birds (W) | Veg (W) | Birds (R) | Macros (R) | Fish (R) | Platypus (R) | Veg (R) | Veg (E) | Fish (E) | Birds (E) | MSVs | MDVs | Confidence |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Little River Lower | S | | G | G | S | S | G | PD | G | G | G | G | N | N | L |
| | Little River Upper | PD | | G | G | S | S | S | PD | G | G | G | G | N | N | M |
| | Lollypop Creek | D | | G | G | S | S | S | | G | G | G | G | N | N | M |
| | Parwan Creek | G | | G | G | S | S | S | S | G | G | G | G | Y | N | L |
| | Skeleton Creek | S | | G | G | S | S | S | | G | G | G | G | Y | N | M |
| | Toolern Creek | G | | | G | S | S | S | PD | G | G | G | G | N | N | M |
| | Werribee River Lower | S | | G | G | S | D | S | S | G | G | G | G | N | Y** | M |
| | Werribee River Middle | S | | | G | S | D | S | S | G | G | G | G | N | Y** | H |
| | Werribee River Upper | G | | | G | G | S | S | S | PD | G | G | G | N | N | M |
| Westernport | Bass River | PD | | | G | G | S | S | S | G | G | G | G | N | N | M |
| | Bunyip Lower | S | | G | G | G | D | D | S | G | G | G | G | N | Y | L |
| | Bunyip River Middle and Upper | S | | | G | D | S | S | S | G | G | G | G | N | N | H |
| | Cardinia, Toomuc, Deep and Ararat | S | S | G | G | S | D | D | D | G | G | G | G | N | Y | M |
| | Dalmore Outfalls | D | | | G | S | S | S | | G | G | G | G | N | N | H |
| | French and Phillip Islands | PD | | | G | D | S | S | | G | G | G | G | N | N | H |
| | King Parrot and Musk Creeks | G | | | G | G | D | D | S | G | G | G | G | N | Y | L |
| | Lang Lang River | G | S | G | G | G | D | D | D | G | G | G | G | N | Y | L |
| | Mornington Peninsula North-Eastern Creeks | S | | | G | G | S | G | | G | G | G | G | Y | N | L |
| | Mornington Peninsula South-Eastern Creeks | S | | G | G | D | D | S | | G | G | G | G | N | Y | M |
| | Mornington Peninsula Western Creeks | S | | G | G | S | S | S | | G | G | G | G | Y | N | M |
| | Tarago River | G | | | G | G | D | D | S | G | G | G | G | N | Y | L |
| Yarra | Brushy Creek | S | | | G | G | S | S | S | G | G | G | G | Y* | N | M |

| Catchment | Sub-catchment | Frogs (W) | Fish (W) | Birds (W) | Veg (W) | Birds (R) | Macros (R) | Fish (R) | Platypus (R) | Veg (R) | Veg (E) | Fish (E) | Birds (E) | MSVs | MDVs | Confidence |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Darebin Creek | D | | | G | S | D | D | S | G | G | G | G | N | Y | H |
| | Diamond Creek (Rural) | PD | | | G | S | D | G | S | G | G | G | G | N | N | M |
| | Diamond Creek (Source) | PD | | | G | G | S | S | S | G | G | G | G | N | N | M |
| | Gardiners Creek | D | | | G | D | S | G | S | G | G | G | G | N | Y | M |
| | Koonung Creek | PD | | | G | S | S | G | S | G | G | G | G | N | N | M |
| | Little Yarra River and Hoddles Creek | G | | | G | G | S | S | S | G | G | G | G | Y | N | L |
| | Merri Creek Lower | PD | | G | G | S | S | S | S | G | G | G | G | N | N | M |
| | Merri Creek Upper | PD | | G | G | S | D | S | S | G | G | G | G | N | N | M |
| | Mullum Mullum Creek | G | | S | G | S | S | G | S | G | G | G | G | Y | N | L |
| | Olinda Creek | S | | S | G | S | S | S | S | G | G | G | G | Y | N | H |
| | Plenty River (Source) | PD | | | G | G | S | S | D | G | G | G | G | N | N | M |
| | Plenty River Lower | D | | | G | S | S | G | S | PD | G | G | G | N | N | H |
| | Plenty River Upper | PD | | G | G | S | S | S | S | G | G | G | G | N | N | M |
| | Steels and Pauls Creek (Rural) | PD | | | G | G | S | S | D | G | G | G | G | N | N | M |
| | Steels and Pauls Creek (Source) | G | | | G | G | S | S | S | G | G | G | G | Y | N | L |
| | Stringybark Creek | G | | | G | G | S | D | S | G | G | G | G | N | N | L |
| | Watsons Creek | S | | | G | D | S | S | S | G | G | G | G | N | N | H |
| | Watts River (Rural) | PD | | | G | S | S | S | S | G | G | G | G | N | N | H |
| | Watts River (Source) | G | | | G | D | S | S | S | G | G | G | G | N | N | M |
| | Woori Yallock Creek | S | | | G | S | D | D | S | PD | G | G | G | N | Y | H |
| | Yarra River Lower | S | | G | G | S | D | S | S | G | G | G | G | N | Y** | M |
| | Yarra River Middle | S | | G | G | S | S | S | S | G | G | G | G | Y | N | M |
| | Yarra River Upper (Rural) | PD | | G | G | S | S | S | S | PD | G | G | G | N | N | H |
| | Yarra River Upper (Source) | PD | | | G | G | S | S | S | G | G | G | G | N | N | M |




| No. | Subcatchment | No. | Subcatchment | No. | Subcatchment |
|---|---|---|---|---|---|
| 1 | Bayside | 24 | Little River Lower | 47 | Diamond Creek (Rural) |
| 2 | Blind Creek | 25 | Little River Upper | 48 | Diamond Creek (Source) |
| 3 | Corhanwarrabul, Monbulk and Ferny Creeks | 26 | Lollypop Creek | 49 | Gardiners Creek |
| 4 | Dandenong Creek Lower | 27 | Parwan Creek | 50 | Koonung Creek |
| 5 | Dandenong Creek Middle | 28 | Skeleton Creek | 51 | Little Yarra River and Hoddles Creek |
| 6 | Dandenong Creek Upper | 29 | Toolern Creek | 52 | Merri Creek Lower |
| 7 | Eumemmerring Creek | 30 | Werribee River Lower | 53 | Merri Creek Upper |
| 8 | Kananook Creek | 31 | Werribee River Middle | 54 | Mullum Mullum Creek |
| 9 | Boyd Creek | 32 | Werribee River Upper | 55 | Olinda Creek |
| 10 | Deep Creek Lower | 33 | Bass River | 56 | Plenty River (Source) |
| 11 | Deep Creek Upper | 34 | Bunyip Lower | 57 | Plenty River Lower |
| 12 | Emu Creek | 35 | Bunyip River Middle and Upper | 58 | Plenty River Upper |
| 13 | Jacksons Creek | 36 | Cardinia, Toomuc, Deep and Ararat Creeks | 59 | Steels and Pauls Creek (Rural) |
| 14 | Maribyrnong River | 37 | Dalmore Outfalls | 60 | Steels and Pauls Creek (Source) |
| 15 | Moonee Ponds Creek | 38 | French and Phillip Islands | 61 | Stringybark Creek |
| 16 | Steele Creek | 39 | King Parrot and Musk Creeks | 62 | Watsons Creek |
| 17 | Stony Creek | 40 | Lang Lang River | 63 | Watts River (Rural) |
| 18 | Taylors Creek | 41 | Mornington Peninsula North-Eastern Creeks | 64 | Watts River (Source) |
| 19 | Cherry Creek | 42 | Mornington Peninsula South-Eastern Creeks | 65 | Woori Yallock Creek |
| 20 | Kororoit Creek Lower | 43 | Mornington Peninsula Western Creeks | 66 | Yarra River Lower |
| 21 | Kororoit Creek Upper | 44 | Tarago River | 67 | Yarra River Middle |
| 22 | Laverton Creek | 45 | Brushy Creek | 68 | Yarra River Upper (Rural) |
| 23 | Lerderderg River | 46 | Darebin Creek | 69 | Yarra River Upper (Source) |

*Figure 9. Map of multiple declining environmental values and multiple stable environmental values*

There were a number of sub-catchments that were neither stable or declining because they didn't fit either criteria. Ie They typically had 1 declining value or 2 potentially declining values. These should be re-considered in the future (Table 12).

*Table 12. Sub-catchments that were NOT categorised as stable or declining.*

| Catchment | Sub-catchment | Frogs (W) | Fish (W) | Birds (W) | Veg (W) | Birds (R) | Macros (R) | Fish (R) | Platypus (R) | Veg (R) |
|---|---|---|---|---|---|---|---|---|---|---|
| Dandenong | Bayside | S | | | G | D | S | G | | G |
| Dandenong | Eumemmerring Creek | S | S | G | G | D | S | G | S | G |
| Dandenong | Kananook Creek | S | S | D | G | S | S | G | | G |
| Maribyrnong | Deep Creek Lower | PD | | | G | G | S | S | S | G |
| Werribee | Laverton Creek | **G** | | D | G | S | S | S | S | G |
| Werribee | Lerderderg River | PD | | | G | G | D | S | S | PD |
| Werribee | Little River Lower | S | | G | G | S | S | G | PD | G |
| Werribee | Little River Upper | PD | | G | G | S | S | S | PD | G |
| Werribee | Lollypop Creek | D | | G | G | S | S | S | | G |
| Werribee | Toolern Creek | **G** | | | G | S | S | S | PD | G |
| Werribee | Werribee River Upper | **G** | | | G | G | S | S | S | PD |
| Westernport | Bass River | PD | | | G | G | S | S | S | G |
| Westernport | Bunyip River Middle and Upper | S | | | G | D | S | S | S | G |
| Westernport | Dalmore Outfalls | D | | | G | S | S | S | | G |
| Westernport | French and Phillip Islands | PD | | | G | D | S | S | | G |
| Yarra | Diamond Creek (Rural) | PD | | | G | S | D | G | S | G |
| Yarra | Diamond Creek (Source) | PD | | | G | G | S | S | S | G |
| Yarra | Koonung Creek | PD | | | G | S | S | G | S | G |
| Yarra | Merri Creek Lower | PD | | G | G | S | S | S | S | G |
| Yarra | Merri Creek Upper | PD | | G | G | S | D | S | S | G |
| Yarra | Plenty River (Source) | PD | | | G | G | S | S | D | G |
| Yarra | Plenty River Lower | D | | | G | S | S | G | S | PD |
| Yarra | Plenty River Upper | PD | | G | G | S | S | S | S | G |
| Yarra | Steels and Pauls Creek (Rural) | PD | | | G | G | S | S | D | G |
| Yarra | Stringybark Creek | **G** | | | G | G | S | D | S | G |
| Yarra | Watsons Creek | S | | | G | D | S | S | S | G |
| Yarra | Watts River (Rural) | PD | | | G | S | S | S | S | G |
| Yarra | Watts River (Source) | **G** | | | G | D | S | S | S | G |
| Yarra | Yarra River Upper (Rural) | PD | | G | G | S | S | S | S | PD |
| Yarra | Yarra River Upper (Source) | PD | | | G | G | S | S | S | G |

## Climate change assessment

The assessment of climate change drew on the updated predictions as outlined in the (Chee, Coleman, Burns, Burrows, & Walsh, 2022) and a qualitative evaluation of the climate change vulnerable versus stronghold.

The following figures present the results (Figure 10, Figure 11 and Figure 12). In some cases, a sub-catchment was identified as belonging to Climate Change Stronghold (CCS) and Climate Change Vulnerable (CCV). This is possible because the climate change assessment occurred on species individually and at spatial scales smaller than sub-catchments. For instance, River Blackfish may be predicted to remain stable in the upper part of a sub-catchment but decline in lower parts of the same sub-catchment.

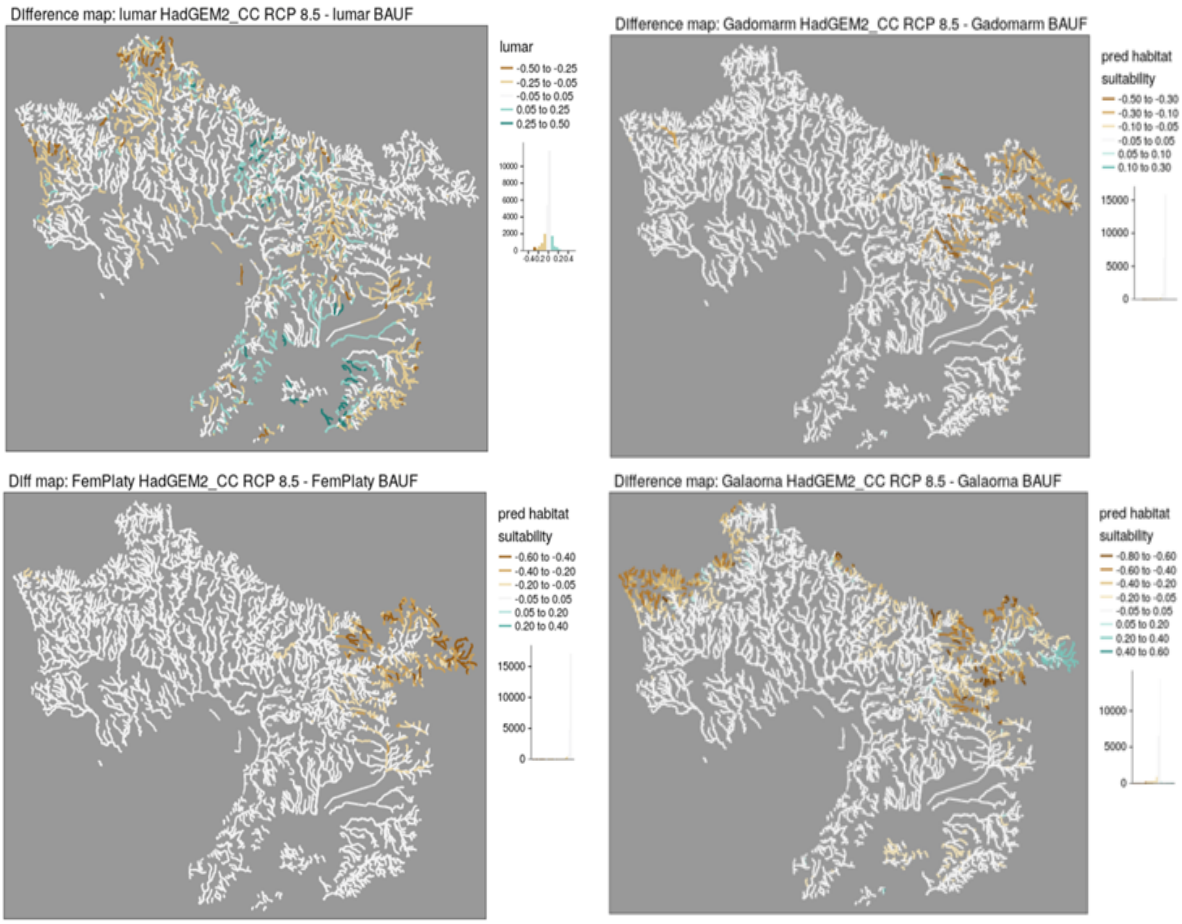



*Figure 10. Climate change predictions used to assess climate change vulnerability. Mapped habitat suitability predictions for Macroinvertebrates, River Blackfish, Ornate Galaxias and Female Platypus across the PPWP region. 'Difference' maps show where predicted habitat suitability under HadGEMB_CC RCP8.5 differs from that of the BAUF scenario used in HWS 2018. On this diverging colour scale darker browns indicate lower predicted habitat suitability relative to BAUF, white indicates little difference and deeper blue-greens indicate higher predicted habitat suitability relative to BAUF.*

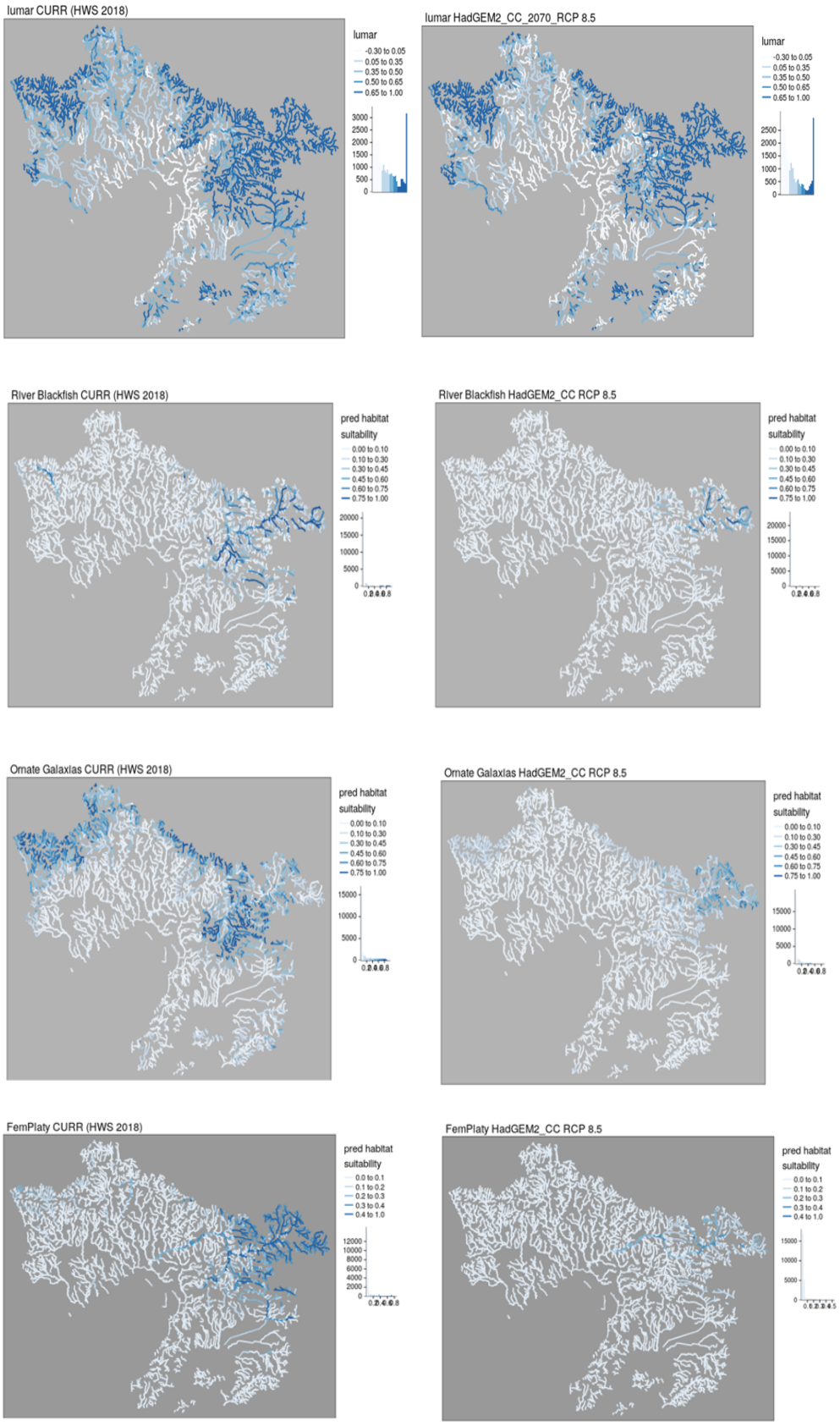



*Figure 11. Climate change predictions used to assess climate strongholds. Mapped habitat suitability predictions for Macroinvertebrates (lumar), River Blackfish, Ornate Galaxias and Female Platypus across the region under the CURR scenario used in HWS B018 (left) and HadGEMB_CC RCP8.5 (right). Deeper blues indicate higher predicted habitat suitability.*

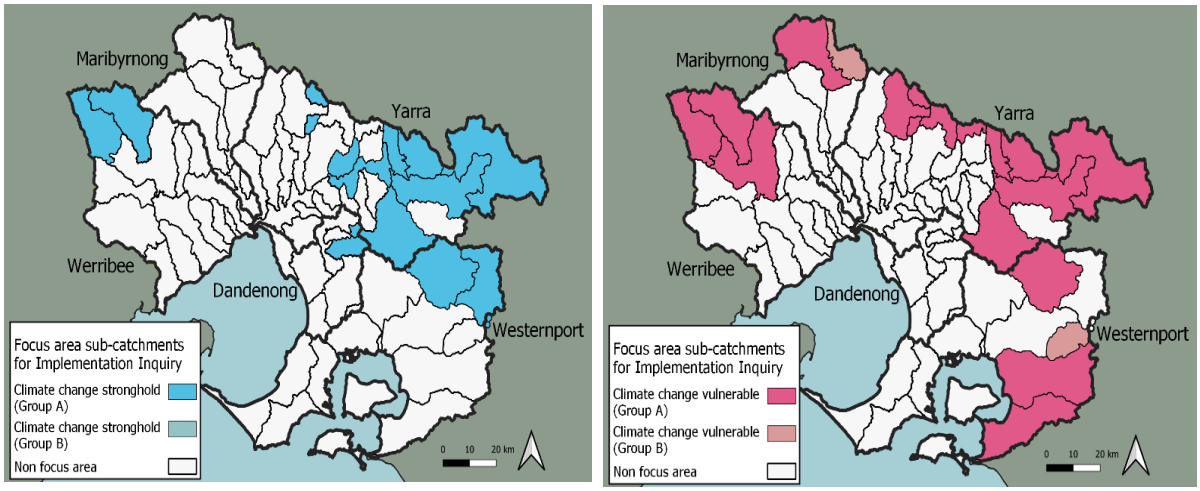



*Figure 12. Sub-catchments identified as being (a) climate change strongholds (CCS; left) and (b) climate change vulnerable (CCV; right) for one or more of four aquatic species: macroinvertebrates, River Blackfish, Ornate Galaxias, and platypus. (Group A) and those with a high proportion of low or very low conditions (Group B).*

## Baseline assessment

Sub-catchments that were removed from the focus sub-catchment list when baseline environmental value scores were all low or very low (see Table 13). It should be noted that Kororoit Creek Lower sub-catchment did have moderate baseline values for riparian birds and frogs. This is likely to have been an error and this sub-catchment could be considered a focus sub-catchment in the future.

*Table 13. Sub-catchments removed from the focus sub-catchment list due to low or very low baseline environmental value scores*

| Catchment | Sub-catchment | MSVs | MDVs | CCV | CCS | birds | fish | frogs | bugs | platypus | vegetation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Maribyrnong | Steele Creek | y | n | n | n | No data | Low | Very low | Very low | Very low | Low |
| | Stony Creek | y | n | n | n | No data | Low | Very low | Very low | Very low | Very low |
| Werribee | Cherry Creek | y | n | n | n | No data | Very low | Very low | Very low | No data | Low |
| | Kororoit Creek Lower | n | y | n | n | Mod | Low | Mod | Low | No data | Low |
| Yarra | Brushy Creek | y | n | n | n | No data | Low | Very low | Very low | Very low | Low |

Similar to the filtering outlined above, the focus sub-catchments were grouped into those with moderate or greater underlying environmental conditions (Group A) and those with a high proportion of low or very low conditions (Group B).

Table 14 presents the Group B sub-catchments including the baseline environmental condition score ratings that were used to determine the groupings and some exceptions where confidence in the

data was low. I.e. where the number of low or very low baseline scores was 3 or less an explanation was provided.

*Table 14. Focus sub-catchment where the proportion of low baseline conditions was high. These sub-catchments were considered **Focus B sub-catchments**. #l/VL = the number of values in a sub-catchment that had low or very low baseline scores.*

| Catchment | Sub-catchment | # L/ VL | Exceptions | connectivity | physical form | stormwater | veg extent | veg Quality | eflows | water Quality |
|---|---|---|---|---|---|---|---|---|---|---|
| Dandenong | Blind Creek | 5 | | Very low | High | Very low | Moderate | Low | Low | Very low |
| | Dandenong Creek Lower | 5 | | Moderate | High | Very low | Very low | Very low | Low | Very low |
| | Dandenong Creek Middle | 5 | | Low | High | Very low | Moderate | Low | Very low | Very low |
| Maribyrnong | Boyd Creek | 2 | Low confidence in the eflows and physical form scores. | Moderate | Moderate | Very high | Very low | Low | Very high | Moderate |
| | Moonee Ponds Creek | 6 | | Low | Moderate | Low | Very low | Low | Low | Low |
| | Taylors Creek | 6 | | Low | High | Very low | Very low | Low | Low | Very low |
| Werribee | Kororoit Creek Upper | 3 | Low confidence in the eflows score. | Low | Moderate | High | Very low | Very low | Very high | Moderate |
| | Parwan Creek | 3 | Low confidence in the high eflows score. | Moderate | Very low | Very high | Very low | Very low | High | Moderate |
| | Skeleton Creek | 4 | | Low | Moderate | Low | Very low | Low | High | Moderate |
| Westernport | Bunyip Lower | 3 | Low confidence in the physical form and eflows score . | High | High | Very high | Low | Low | Very high | Low |
| | King Parrot and Musk Creeks | 3 | There is low confidence in the physical form and eflows score | Moderate | Moderate | Very high | Low | Low | High | Low |
| | Mornington Peninsula North-Eastern Creeks | 4 | | Very high | High | Low | Low | Very low | High | Very low |
| | Mornington Peninsula | 4 | | High | Low | Low | Moderate | Low | High | Very low |

| Catchment | Sub-catchment | # L/ VL | Exceptions | connectivity | physical form | stormwater | veg extent | veg Quality | eflows | water Quality |
|---|---|---|---|---|---|---|---|---|---|---|
| | Western Creeks | | | | | | | | | |
| Yarra | Darebin Creek | 5 | | Low | High | Low | Very low | Low | High | Very low |
| | Gardiners Creek | 5 | | Very low | High | Very low | Mode rate | Low | Low | Very low |
| | Mullum Mullum Creek | 4 | | High | Low | Very low | High | Mode rate | Low | Very low |

## Focus sub-catchments from synthesis

Sub-catchments became focus sub-catchments in the Science inquiry if they were rated as MDVs, MSVs, CCV or CCS and were categorised into Group A or B based on the baseline condition assessment (Table 15). These sub-catchments are intended to be focus areas for the implementation inquiry to consider as part of the HWS mid-term review.

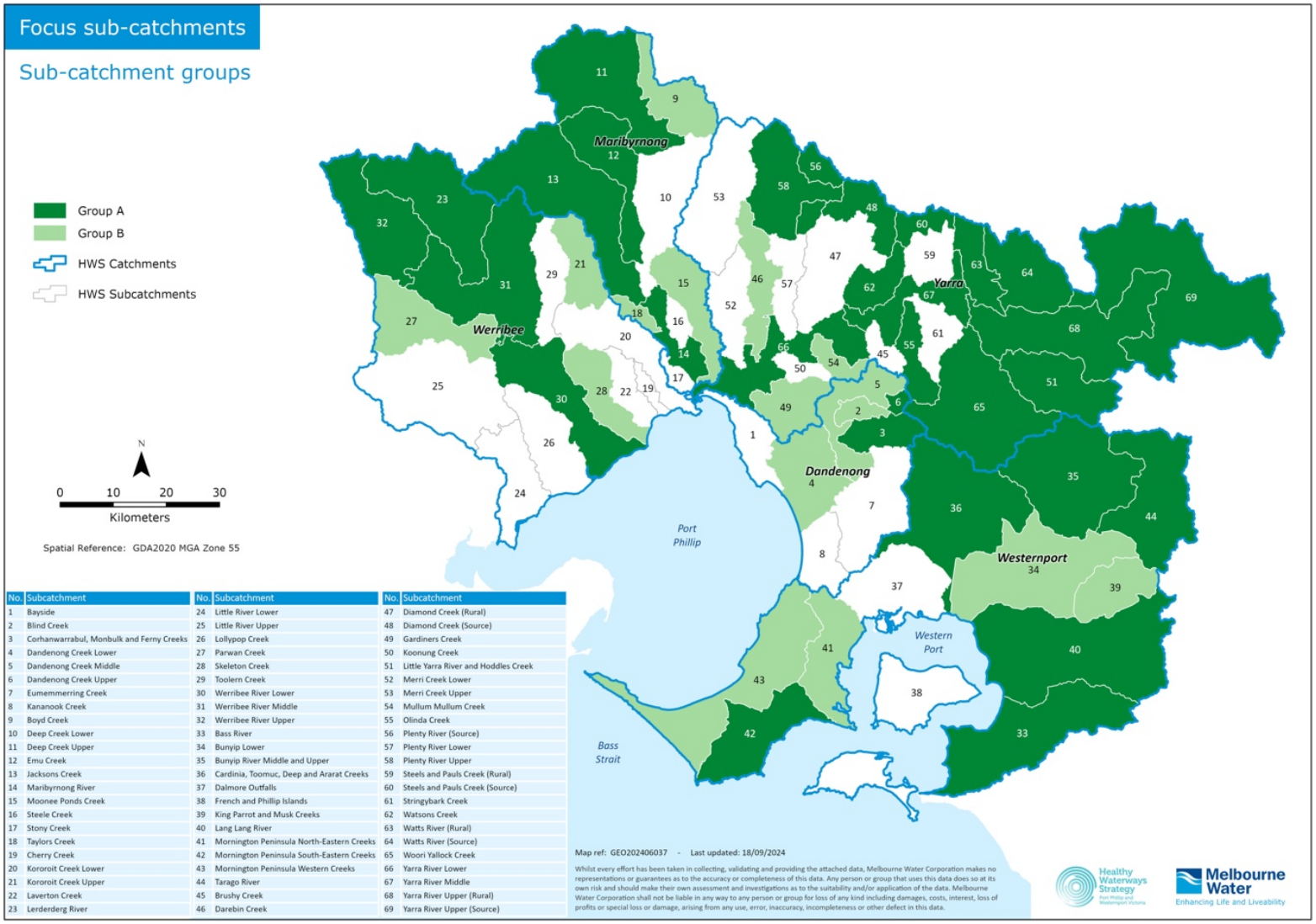
**[NOTE: these focus sub-catchments underwent another assessment process in the Implementation Inquiry based on the likelihood of meeting 10-year targets, and the final focus sub-catchments are presented in the Implementation Inquiry (Melbourne Water, *in prep*)].**

Figure 13 is a map of the focus sub-catchments identified from this synthesis for the region showing those with moderate or greater underlying environmental conditions (Group A) and those with a high proportion of low or very low conditions (Group B).

*Table 15. Focus sub-catchments including the category they were selected for and the grouping. MDVs = multiple declining values, MSVs = multiple stable values, CCV = climate change vulnerable, CCS = climate change stronghold.*

| Catchment | Sub-catchment | MDVs | MSVs | CCV | CCS | Group |
|---|---|---|---|---|---|---|
| Yarra | Diamond Creek (Source) | | | × | | A |
| Yarra | Little Yarra River and Hoddles Creek | | × | | | A |
| Yarra | Olinda Creek | | × | | | A |
| Yarra | Plenty River (Source) | | | × | × | A |
| Yarra | Plenty River Upper | | | × | | A |
| Yarra | Steels and Pauls Creek (Source) | | × | × | | A |
| Yarra | Watsons Creek | | | | × | A |
| Yarra | Watts River (Rural) | | | × | × | A |
| Yarra | Watts River (Source) | | | × | × | A |
| Yarra | Woori Yallock Creek | × | | × | × | A |
| Yarra | Yarra River Lower | × | | | | A |
| Yarra | Yarra River Middle | | × | | × | A |
| Yarra | Yarra River Upper (Rural) | | | × | × | A |
| Yarra | Yarra River Upper (Source) | | | × | × | A |
| Yarra | Darebin Creek | × | | | | B |

| Catchment | Sub-catchment | MDVs | MSVs | CCV | CCS | Group |
|---|---|---|---|---|---|---|
| Yarra | Gardiners Creek | × | | | | B |
| Yarra | Mullum Mullum Creek | | × | | | B |
| Werribee | Lerderderg River | | | × | × | A |
| Werribee | Werribee River Lower | × | | | | A |
| Werribee | Werribee River Middle | × | | × | | A |
| Werribee | Werribee River Upper | | | × | × | A |
| Werribee | Kororoit Creek Upper | | × | | | B |
| Werribee | Parwan Creek | | × | | | B |
| Werribee | Skeleton Creek | | × | | | B |
| Maribyrnong | Deep Creek Upper | × | | × | | A |
| Maribyrnong | Emu Creek | × | | | | A |
| Maribyrnong | Jacksons Creek | × | | | | A |
| Maribyrnong | Maribyrnong River | × | | | | A |
| Maribyrnong | Moonee Ponds Creek | | × | | | B |
| Maribyrnong | Taylors Creek | | × | | | B |
| Maribyrnong | Boyd Creek | | × | × | | B |
| Dandenong | Corhanwarrabul, Monbulk and Ferny Creeks | | × | | × | A |
| Dandenong | Dandenong Creek Upper | | × | | × | A |
| Dandenong | Blind Creek | | × | | | B |
| Dandenong | Dandenong Creek Lower | | × | | | B |
| Dandenong | Dandenong Creek Middle | | × | | | B |
| Westernport | Bunyip River Middle and Upper | | | × | × | A |
| Westernport | Cardinia, Toomuc, Deep and Ararat | × | | | | A |
| Westernport | Lang Lang River | × | | × | | A |
| Westernport | Mornington Peninsula South-Eastern Creeks | × | | | | A |
| Westernport | Tarago River | × | | | × | A |
| Westernport | Bass River | | | × | | A |
| Westernport | Bunyip Lower | × | | | | B |
| Westernport | King Parrot and Musk Creeks | × | | × | | B |
| Westernport | Mornington Peninsula North-Eastern Creeks | | × | | | B |
| Westernport | Mornington Peninsula Western Creeks | | × | | | B |




| No. | Subcatchment | No. | Subcatchment | No. | Subcatchment |
|---|---|---|---|---|---|
| 1 | Bayside | 24 | Little River Lower | 47 | Diamond Creek (Rural) |
| 2 | Blind Creek | 25 | Little River Upper | 48 | Diamond Creek (Source) |
| 3 | Corhanwarrabul, Monbulk and Ferny Creeks | 26 | Lollypop Creek | 49 | Gardiners Creek |
| 4 | Dandenong Creek Lower | 27 | Parwan Creek | 50 | Koonung Creek |
| 5 | Dandenong Creek Middle | 28 | Skeleton Creek | 51 | Little Yarra River and Hoddles Creek |
| 6 | Dandenong Creek Upper | 29 | Toolern Creek | 52 | Merri Creek Lower |
| 7 | Eumemmerring Creek | 30 | Werribee River Lower | 53 | Merri Creek Upper |
| 8 | Kananook Creek | 31 | Werribee River Middle | 54 | Mullum Mullum Creek |
| 9 | Boyd Creek | 32 | Werribee River Upper | 55 | Olinda Creek |
| 10 | Deep Creek Lower | 33 | Bass River | 56 | Plenty River (Source) |
| 11 | Deep Creek Upper | 34 | Bunyip Lower | 57 | Plenty River Lower |
| 12 | Emu Creek | 35 | Bunyip River Middle and Upper | 58 | Plenty River Upper |
| 13 | Jacksons Creek | 36 | Cardinia, Toomuc, Deep and Ararat Creeks | 59 | Steels and Pauls Creek (Rural) |
| 14 | Maribyrnong River | 37 | Dalmore Outfalls | 60 | Steels and Pauls Creek (Source) |
| 15 | Moonee Ponds Creek | 38 | French and Phillip Islands | 61 | Stringybark Creek |
| 16 | Steele Creek | 39 | King Parrot and Musk Creeks | 62 | Watsons Creek |
| 17 | Stony Creek | 40 | Lang Lang River | 63 | Watts River (Rural) |
| 18 | Taylors Creek | 41 | Mornington Peninsula North-Eastern Creeks | 64 | Watts River (Source) |
| 19 | Cherry Creek | 42 | Mornington Peninsula South-Eastern Creeks | 65 | Woori Yallock Creek |
| 20 | Kororoit Creek Lower | 43 | Mornington Peninsula Western Creeks | 66 | Yarra River Lower |
| 21 | Kororoit Creek Upper | 44 | Tarago River | 67 | Yarra River Middle |
| 22 | Laverton Creek | 45 | Brushy Creek | 68 | Yarra River Upper (Rural) |
| 23 | Lerderderg River | 46 | Darebin Creek | 69 | Yarra River Upper (Source) |

*Figure 13. Sub-catchments identified as focus areas for the implementation inquiry as part of the HWS Science Inquiry. Sub-catchments are shown as those with moderate or greater underlying environmental conditions (Group A) and those with a high proportion of low or very low conditions (Group B).*

Taking gaps in available datasets into consideration, most assessable sub-catchment and wetlands have been assessed as stable in the mid-term evaluation (Table 16).

*Table 16. Proportion of sub-catchments or wetlands assessed as stable for each value.*

| Value | *Number of sub-catchments rated as stable/total number sub-catchments assessable (% of 69 sub-catchments)* |
|---|---|
| Macroinvertebrates (rivers) | 50/69 (72%) |
| Platypus (rivers) | 48/57 (84%) |
| Fish (rivers) | 43/54 (62%) |
| Fish (wetlands) | 5/69 (7%) |
| Vegetation (rivers) | Not assessable at sub-catchment scale |
| Birds (rivers) | 37/45 (54%) |
| Birds (wetlands) | 12/25 priority wetlands (72%) |
| Frogs (rivers and wetlands) | 27/49 (55%) |

Forty-six focus areas were identified from the value synthesis (Figure 13). Seventeen focus areas were identified within the Yarra Catchment, seven in the Werribee Catchment, seven in the Maribyrnong Catchment, five in the Dandenong Catchment, and ten in the Westernport Catchment. Further information on the focus area sub-catchments is available in the Summary by sub-catchment section below.

Multiple declining values were evident in sixteen of the 69 sub-catchments (23%) across the region (Figure 14), with declining trajectories for macroinvertebrates and fish values being the most common reason for the MDV rating. Decreased water availability and increased urbanization, including unmitigated stormwater runoff, were the dominant increasing threats in sub-catchments with multiple declining values.

Eighteen sub-catchments were categorised as currently having multiple stable values (Figure 14). Increasing threats in these sub-catchments, however, represent a risk to achieving long-term targets for values that were set at the beginning of the Strategy. Decreased water availability and unmitigated stormwater runoff were the dominant increasing threats in sub-catchments with multiple stable values. Recreational access was rated as increasing in many sub-catchments with multiple stable values; however, there is a low confidence in this threat rating and its links with values other than riparian vegetation. Deer was also rated as an increasing threat in many sub-catchments; however, the only value it is a direct threat for, vegetation, could not be accurately assessed.

Eighteen sub-catchments were categorised as being climate change vulnerable (Figure 15). Despite this, fourteen sub-catchments are thought to act as climate change strongholds for one or more of the assessed aquatic species (Figure 15). Note that there are no Climate change stronghold focus areas in Group B. There are more sub-catchments with declining values than stable values and more sub-catchments that are climate vulnerable than those that are strongholds. The CCV and CCS are also mostly in the upper parts of the catchments.

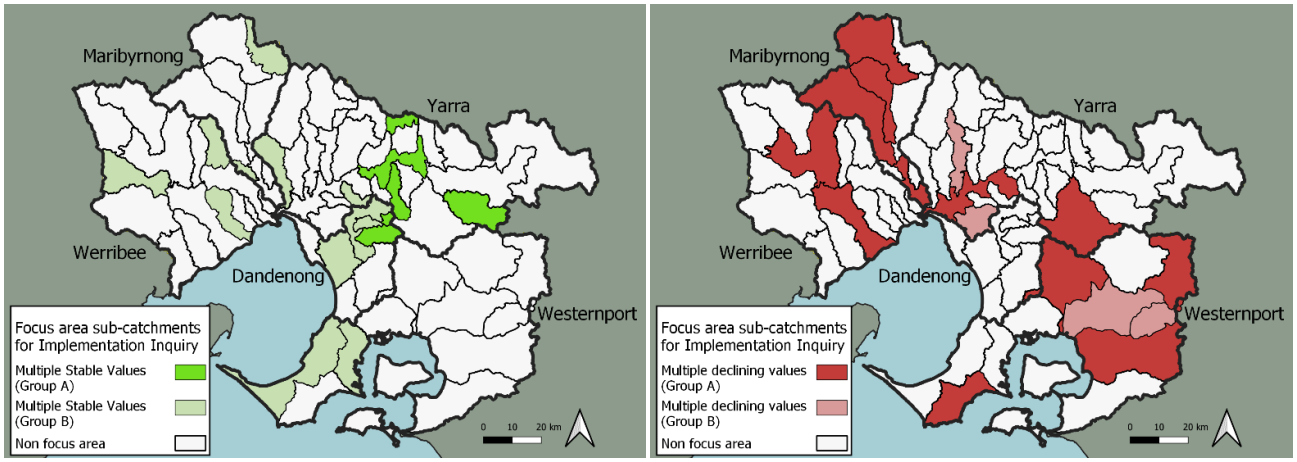



*Figure 14. Sub-catchments identified as having multiple stable (left) and multiple declining (right) values.*

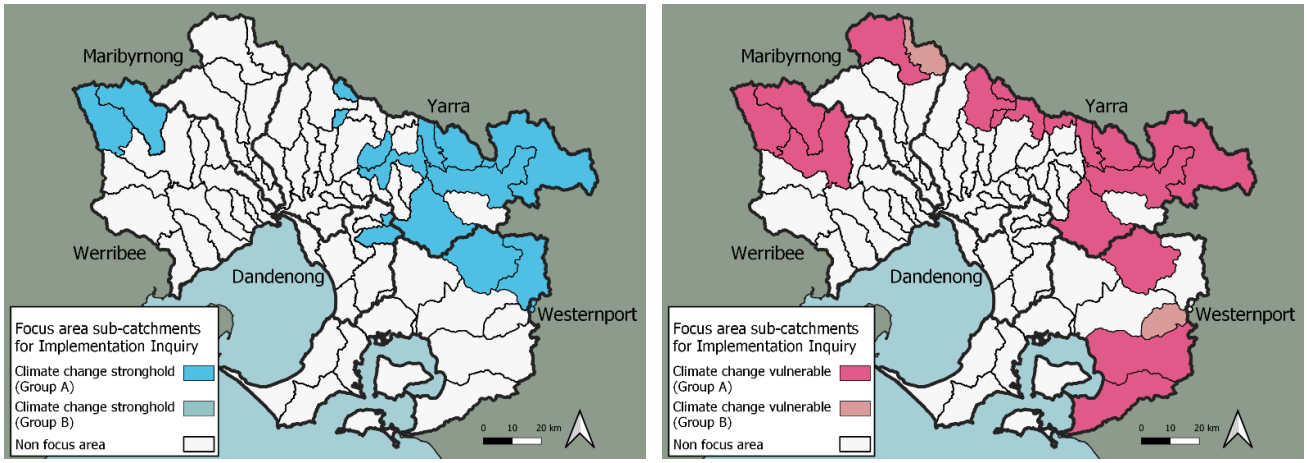



*Figure 15. Sub-catchments identified as being (a) climate change strongholds (CCS; left) and (b) climate change vulnerable (CCV; right) for one or more of four aquatic species: macroinvertebrates, River Blackfish, Ornate Galaxias, and platypus. Classifications were based on differences between "baseline" habitat suitability models and models which include updated precipitation and temperature information from the 2019VCP climate change projections. Sub-catchments are shown as those with moderate or greater underlying environmental conditions (Group A) and those with a high proportion of low or very low conditions (Group B). This provides information that may help prioritise effort based on findings of the implementation inquiry. Note: there are no Climate change stronghold focus areas in Group B.*

## Summary of data gaps

The trajectories of values within each of the 69 HWS sub-catchments is available in Appendix B - H. Synthesis assessment and interpretation at the sub-catchment scale was based on available value trajectory information. However, some sub-catchments had more available information for a wider array of values than others. Figure 16 illustrates the proportion of values (excluding values that have no targets) with available information on value trajectory. The most common values for which we had insufficient information to assess trajectory include riparian birds, wetland birds, frogs, and riparian vegetation.

The largest environmental values data gaps were recorded in the Werribee catchment within the Cherry Creek (83% data gap) and Kororoit Creek Upper (67% data gap) sub-catchments (Figure 16). Mornington Peninsula North-Eastern Creeks sub-catchment also had a large (60%) data gap.

Conversely, there were no environmental data gaps in the Woori Yallock Creek sub-catchment (Figure 16).


*Figure 16. The proportion of environmental value data gaps for values which 10-year targets were set in the HWS.*

## Threats analysis

The purpose of the threats analysis was to understand where threats are increasing in the focus sub-catchments. The results of this analysis helped to identify important region-wide threats along with local-scale information.

Table 17 summarises the extent to which different threat groupings are increasing in the region for all sub-catchments and for the focus sub-catchments. Declining water availability ranks the highest in terms of sub-catchments where the threat is increasing, followed by deer and recreational access.

The confidence, however, in recreational access is low, and further verification of the threat is required.

*Table 17. List of threats identified in the mid-term as being important and a summary of their assessment for the region.*

| Threat group | Threat category | # focus SCs where threat has increased | # SCs where threat has increased | Was the threat trajectory as expected? | Confidence |
|---|---|---|---|---|---|
| Rural related threats | Water availability | 25 | 42 | No – greater than expected. Targets off-track. New evidence of declines. | Moderate |
| | Agriculture | 1 | 3 | Yes | Low |
| Urban related threats | Urban flow (DCI) | 6 | 12 | No – increases due to inability to mitigate | High |
| | Urban WQ (toxicants, industry) | 4 | 11 | No – Priority areas not adequately identified | Moderate |
| | Wastewater (STPs) | 0 | 0 | Yes | Moderate |
| | Septic tanks | Not assessed | Not assessed | Not assessed | Not assessed |
| | Loss of natural wetlands and headwater streams | 9 | 16 | No – not sufficiently included in the HWS | Moderate |
| | Litter (platypus) | 6 | 14 | No - Priority areas not adequately identified | Moderate |
| | Reducing waterway corridor width | Not assessed | Not assessed | Not assessed | Not assessed |
| | Inappropriate light and noise | Not assessed | Not assessed | Not assessed | Not assessed |
| Vegetation and habitat related threats | Weeds | 10 | 18 | No – not meeting targets | Low |
| | Animals (deer) | 22 | 30 | No - not sufficiently included in the HWS | High |
| | Animals (rabbits, overabundant wildlife) | Not assessed | Not assessed | Not assessed | Not assessed |
| | Animals (predators – fish, cats, dogs) | Not assessed | Not assessed | Not assessed | Not assessed |
| | Recreational access | 17 | 21 | Needs further investigation | Low |
| | Vegetation clearing | 0 | 0 | Needs further investigation | Low |
| | Instream barriers | 0 | 0 | Yes | Moderate |
| | LWD removal | Not assessed | Not assessed | Needs further investigation | Not assessed |

The following (Table 18) lists the threats considered to be increasing for each focus sub-catchment.

*Table 18. Summary of threats that are considered increasing in each of the focus sub-catchments. Rec access = threat from recreational access, phys mod = threat to physical form.*

| Catchment | Sub-catchment | MDVs | MSVs | CCV | CCS | Increasing threats |
|---|---|---|---|---|---|---|
| Maribyrnong | Deep Creek upper | Y | | Y | | Water extraction, recreational access, weeds |
| | Jacksons Creek | Y | | | | Urban flow, phys mod, litter, rec access, headwater loss |
| | Emu Creek | Y | | | | Water Extraction, phys mod, recreational access, headwater loss |
| | Deep Creek Lower | | Y | | | Water extraction, weeds |
| | Boyd Creek | | | Y | | Water extraction, weeds |
| | Moonee Ponds Creek | | Y | | | Urban flows |
| Werribee | Lerderderg River | Y | | Y | Y | Water extraction, rec access, weeds |
| | Werribee River Lower | Y | | | | Water extraction, wetland loss |
| | Werribee River Middle | | | Y | | Urban flow, water extraction, litter, rec access |
| | Werribee River Upper | | | Y | Y | Water extraction, rec access, headwater loss |
| | Skeleton Creek | | Y | | | Wetland loss, urban flow, phys mod |
| Yarra | Merri Creek Upper | Y | | | | Urban flow, Urban WQ, water extraction, deer, headwater loss, weeds |
| | Plenty River (source) | Y | | | Y | Water extraction, deer, weeds |
| | Plenty River Upper | | | Y | | Water extraction, rec access, deer, weeds |
| | Plenty River Lower | Y | | | | Urban flow, Urban WQ, litter, weeds |
| | Woori Yallock | Y | | Y | Y | Water extraction, rec access, deer, agriculture |
| | Watsons Ck | | | | Y | Water extraction, rec access, deer |
| | Diamond Ck (source) | | Y | Y | | Water extraction, rec access, deer |
| | Little Yarra River and Hoddles Creek | | Y | | | Water extraction, rec access, deer |
| | Steels and Pauls Creek (Source) | | Y | Y | | rec access, deer |
| | Watts River (Source) | | | Y | Y | Deer |
| | Watts River (Rural) | | Y | | Y | Water extraction, rec access, deer |
| | Yarra River Middle | | | | Y | Water extraction, deer |
| | Yarra River Upper Rural | | | Y | Y | Water extraction, rec access, deer |
| | Yarra River Upper (Source) | | Y | Y | Y | Deer |
| | Gardiners Creek | Y | | | | Urban flow |

| Catchment | Sub-catchment | MDVs | MSVs | CCV | CCS | Increasing threats |
|---|---|---|---|---|---|---|
| | Darebin Creek | Y | | | | Headwater loss, weeds, urban flow, phys mod |
| Dandenong | Dandenong Creek Middle | | Y | | | Weeds |
| | Dandenong Creek Upper | | Y | | Y | Water extraction, rec access, deer |
| | Corhanwarrabul, Monbulk and Ferny | | Y | | Y | Litter, rec access |
| Westernport | Cardinia Creek | Y | | | | Urban WQ, phys mod, litter, water extraction, deer, wetland loss, headwater loss |
| | King Parrot Musk Creeks | Y | | Y | | Urban flow, Urban WQ, phys mod, litter, water extraction, deer, headwater loss |
| | Lang Lang River | Y | | Y | | Water extraction, agriculture, deer, weeds |
| | Tarago River | Y | | | Y | Phys mod, water extraction, rec access, deer, headwater loss |
| | Lower Bunyip | Y | | | | Water extraction, deer |
| | Mornington Peninsula North-Eastern | | Y | | | Water extraction, deer |
| | Mornington Peninsula Western Creeks | | Y | | | Water extraction, deer |
| | Bass River | | | Y | | Water extraction, deer |
| | Bunyip River upper and middle | | | Y | Y | Water extraction, rec access, deer |

## Summary by Catchment

### Yarra

Multiple declining values were recorded for Darebin Creek, Gardiners Creek, Woori Yallock Creek, and the Yarra River Lower sub-catchments (Table 19).

Macroinvertebrates and riverine fish are declining in the Darebin Creek and Woori Yallock Creek sub-catchments, with localised urban impacts thought to be the main cause of decline.

Riparian birds and frogs are declining in the Gardiners Creek sub-catchment; however, the cause of decline could not be identified beyond existing urban impacts.

Macroinvertebrates are declining in Yarra River Lower with catchment urbanization the likely cause; however, further investigation is required.

Five sub-catchments were identified as having multiple stable values (Table 19) with platypus, riverine fish (insufficient data for Mullum Mullum Creek) and macroinvertebrates stable in all.

Values in nine sub-catchments are thought to be climate change vulnerable (Table 19). Ornate Galaxias is climate change vulnerable in seven of these sub-catchments, with River Blackfish and platypus considered climate change vulnerable in three sub-catchments.

Climate change strongholds were identified in eight sub-catchments (Table 19), with most of these sub-catchments situated in the upper parts of the Yarra catchment. In particular, Yarra River Upper (Source) was a stronghold for macroinvertebrates, River Blackfish, Ornate Galaxias and platypus.

*Table 19. Focus Area sub-catchments identified within the Yarra Catchment. *denotes sub-catchments that were included in MDV as it had a declining trend for macroinvertebrates in the main-stem of a river.*

| Sub-catchment | MDVs | MSVs | CCV | CCS | Group |
|---|---|---|---|---|---|
| Diamond Creek (Source) | | | × | | A |
| Little Yarra River and Hoddles Creek | | × | | | A |
| Olinda Creek | | × | | | A |
| Plenty River (Source) | | | × | × | A |
| Plenty River Upper | | | × | | A |
| Steels and Pauls Creek (Source) | | × | × | | A |
| Watsons Creek | | | | × | A |
| Watts River (Rural) | | | × | × | A |
| Watts River (Source) | | | × | × | A |
| Woori Yallock Creek | × | | × | × | A |
| Yarra River Lower | ×* | | | | A |
| Yarra River Middle | | × | | × | A |
| Yarra River Upper (Rural) | | | × | × | A |
| Yarra River Upper (Source) | | | × | × | A |
| Darebin Creek | × | | | | B |
| Gardiners Creek | × | | | | B |
| Mullum Mullum Creek | | × | | | B |

In terms of results for the Yarra catchment by value, this indicates that frogs are declining, which is concerning (Table 20). Conversely, riparian birds, fish and macroinvertebrates are doing better (either stable or improving) in the Yarra catchment compared to the rest of the region.

*Table 20. Summary of results for values for Yarra compared to region. How to read table working left-right: column #1 shows the environmental values (e.g. platypus, fish) monitored over the past 20+ years to understand their long-term trajectory (e.g., is the value declining, stable or improving). Column #2 shows the number of sub-catchments assessed out of the total number of sub-catchments in the Yarra catchment. Column #3 is the results for the Yarra catchment compared to the results for the whole Port Phillip and Westernport region (Column #4).*

| Long-term trajectory of values | sub-catchments assessed / total sub-catchments | % of stable YARRA sub-catchments | % of stable sub-catchments for whole region |
|---|---|---|---|
| Macroinvertebrates | 25/25 | 80% | 72% |
| Platypus | 25/25 | 88% | 84% |
| Fish | 20/25 | 85% | 62% |
| Riparian vegetation | *not assessable at sub-catchment scale* | | |
| Riparian birds | 20/25 | 82% | 54% |
| Frogs | 20/25 | 25% | 40% |

## Werribee

There has been a sustained long-term decline in macroinvertebrates in the Werribee River Middle and Werribee River Lower sub-catchment at monitoring sites along the main-stem of the Werribee River.

Skeleton Creek is thought to have stable values for riparian birds, macroinvertebrates, frogs, riverine fish, and platypus.

Three sub-catchments were considered to be climate change vulnerable for at least one value (Table 21).

Lerderderg River and Werribee River Upper are considered climate change strongholds for macroinvertebrates (Table 21).

*Table 21. Focus Area sub-catchments identified within the Werribee Catchment. *denotes sub-catchments that were included in MDV as it had a declining trend for macroinvertebrates in the main-stem of a river.*

| Sub-catchment | MDVs | MSVs | CCV | CCS | Group |
|---|---|---|---|---|---|
| Lerderderg River | | | × | × | A |
| Werribee River Lower | ×* | | | | A |
| Werribee River Middle | ×* | | × | | A |
| Werribee River Upper | | | × | × | A |
| Kororoit Creek Upper | | × | | | B |
| Parwan Creek | | × | | | B |
| Skeleton Creek | | × | | | B |

Results for the Werribee catchment by value indicate that riparian birds and fish are either stable or improving in the Werribee catchment compared to the rest of the region and that platypus are declining in some sub-catchments (Table 22).

*Table 22. Summary of values results for Werribee catchment compared to region.*

| Long term trajectory of values | sub-catchments assessed / total sub-catchments | % of stable WERRIBEE sub-catchments | % of stable sub-catchments for whole region |
|---|---|---|---|
| Macroinvertebrates | 14/14 | 71% | 72% |
| Platypus | 9/14 | 66% | 84% |
| Fish | 12/14 | 91% | 62% |
| Riparian vegetation | *Not assessable at sub-catchment scale* | | |
| Riparian birds | 10/14 | 100% | 54% |
| Frogs | 8/14 | 62% | 40% |

## Maribyrnong

Macroinvertebrates and riverine fish are declining in Deep Creek Upper and Jacksons Creek sub-catchments, with water availability and urban impacts implicated as the major causes of decline.

The Maribyrnong River main-stem has experienced a sustained decline in macroinvertebrates over time, associated with urbanization in the greater catchment. Macroinvertebrates, as well as platypus, were categorised as declining in the Emu Creek sub-catchment. However, there is currently no eDNA monitoring data from lower parts of Emu Creek, where platypus are known to reside near the confluence with Deep Creek (Platypus: A Technical Report To Inform The Healthy Waterways Strategy Mid-term Evaluation), and this lack of data may underlie the apparent decline of platypus in the Emu Creek sub-catchment.

Three sub-catchments have multiple stable values but these had low scores value and condition scores in 2018 (Table 23). The Deep Creep Upper and Boyd Creek sub-catchments were considered climate change vulnerable (Table 23) due to a predicted decline in macroinvertebrates and Ornate Galaxias. No sub-catchments in the Maribyrnong Catchment were considered climate change strongholds for the values assessed (Table 23).

*Table 23. Focus Area sub-catchments identified within the Maribyrnong Catchment. *denotes sub-catchments that were included in MDV as it had a declining trend for macroinvertebrates in the main-stem of a river.*

| Sub-catchment | MDVs | MSVs | CCV | CCS | Group |
|---|---|---|---|---|---|
| Deep Creek Upper | × | | × | | A |
| Emu Creek | × | | | | A |
| Jacksons Creek | × | | | | A |
| Maribyrnong River | ×* | | | | A |
| Moonee Ponds Creek | | × | | | B |
| Taylors Creek | | × | | | B |
| Boyd Creek | | × | × | | B |

Results for the Maribyrnong catchment by value indicate that macroinvertebrates are declining in just under half the sub-catchments. Fish and riparian birds are stable or improving in the Maribyrnong catchment compared to the region (Table 24).

*Table 24. Summary of values results for Maribyrnong catchment compared to region.*

| Long term trajectory of values | sub-catchments assessed / total sub-catchments | % of stable MARIBYRNONG sub-catchments | % of stable sub-catchments for whole region |
|---|---|---|---|
| Macroinvertebrates | 10/10 | 60% | 72% |
| Platypus | 10/10 | 80% | 84% |
| Fish | 10/10 | 80% | 62% |
| Riparian vegetation | *Not assessable at sub-catchment scale* | | |
| Riparian birds | 4/10 | 100% | 54% |
| Frogs | 5/10 | 60% | 40% |

## Dandenong

Although values such as riparian and wetland birds are declining in some sub-catchments, no sub-catchments in Dandenong were identified as having multiple declining values (Table 25). Importantly, a number of data gaps hindered trajectory assessment of some values. We were unable to assess riparian vegetation in all sub-catchments and we could only assess riverine fish in Corhanwarrabul, Monbulk and Ferny Creeks sub-catchment. Despite data limitations, five sub-catchments were categorised as having multiple stable values. Dandenong Creek Upper and Corhanwarrabul, Monbulk and Ferny Creeks sub-catchments were considered climate strongholds for macroinvertebrates (Table 25).

*Table 25. Focus Area sub-catchments identified within the Dandenong Catchment.*

| Sub-catchment | MDVs | MSVs | CCV | CCS | Group |
|---|---|---|---|---|---|
| Corhanwarrabul, Monbulk and Ferny Creeks | | × | | × | A |
| Dandenong Creek Upper | | × | | × | A |
| Blind Creek | | × | | | B |
| Dandenong Creek Lower | | × | | | B |
| Dandenong Creek Middle | | × | | | B |

Results for the Dandenong catchment by value indicate that platypus is declining, which is concerning. Conversely, frogs are doing better (either stable or improving) in the Dandenong catchment compared to the rest of the region (Table 26).

*Table 26. Summary of values results for Dandenong catchment compared to region.*

| Long-term trajectory of values: | Sub-catchments assessed / total sub-catchments | % of stable DANDENONG sub-catchments | % of stable sub-catchments for whole region |
|---|---|---|---|
| Macroinvertebrates | 8/8 | 100% | 72% |
| Platypus | 6/8 | 0% | 84% |
| Fish | 1/8 | 100% | 62% |
| Riparian vegetation | *not assessable at sub-catchment scale* | | |
| Riparian birds | 8/8 | 75% | 54% |
| Frogs | 7/8 | 86% | 40% |

## Westernport

In all six sub-catchments with multiple declining values (Table 27), both macroinvertebrates and fish have declining trajectories. Platypus are also thought to be declining in two of these five sub-catchments (Cardinia, Toomuc, Deep and Ararat Creeks and Lang Lang River sub-catchments). The cause of declines in these sub-catchments are largely uncertain, but urbanization, as well as water availability, were noted as the likely and most common causes of decline.

Mornington Peninsula North-Eastern Creeks and Mornington Peninsula Western Creeks sub-catchments were categorised as having multiple stable values (Table 27).

Lang Lang River, King Parrot & Musk Creeks and the Bass River sub-catchments were considered climate vulnerable for macroinvertebrates. The Bunyip River Middle and Upper sub-catchment was considered climate vulnerable for River Blackfish and Platypus but also a climate stronghold for macroinvertebrates. The Tarago River sub-catchment was also considered a climate stronghold for macroinvertebrates (Table 27).

*Table 27. Focus Area sub-catchments identified within the Westernport Catchment.*

| Sub-catchment | MDVs | MSVs | CCV | CCS | Group |
|---|---|---|---|---|---|
| Bunyip River Middle and Upper | | | × | × | A |
| Cardinia, Toomuc, Deep and Ararat | × | | | | A |
| Lang Lang River | × | | × | | A |
| Mornington Peninsula South-Eastern Creeks | × | | | | A |
| Tarago River | × | | | × | A |
| Bass River | | | × | | B |
| Bunyip Lower | × | | | | B |
| King Parrot and Musk Creeks | × | | × | | B |
| Mornington Peninsula North-Eastern Creeks | | × | | | B |
| Mornington Peninsula Western Creeks | | × | | | B |

Results for the Westernport catchment by value indicate that macroinvertebrates and fish are declining, which is concerning. Conversely, frogs are doing better (either stable or improving) in the Westernport catchment compared to the rest of the region (Table 28).

*Table 28. Summary of values results for Westernport catchment compared to region.*

| Long term trajectory of values | Sub-catchments assessed / total sub-catchments | % of stable WESTERNPORT sub-catchments | % of stable sub-catchments for whole region |
|---|---|---|---|
| Macroinvertebrates | 12/12 | 50% | 72% |
| Platypus | 7/12 | 71% | 84% |
| Fish | 11/12 | 54% | 62% |
| Riparian vegetation | *Not assessable at sub-catchment scale* | | |
| Riparian birds | 6/12 | 50% | 54% |
| Frogs | 9/12 | 66% | 40% |

# 3. Overall Summary

Forty-six focus area sub-catchments out of 69 sub-catchments were identified across the region:

- Sixteen sub-catchments (twelve in Group A, four in Group B) were categorised as currently having multiple declining values (MDVs),
- Eighteen sub-catchments (six in Group A, twelve in Group B) were categorised as currently having multiple stable values (MSVs),
- Eighteen sub-catchments (seventeen in Group A, one in Group B) were categorised as being climate change vulnerable (CCV),
- Fourteen sub-catchments (all in Group A) were categorised as being climate change strongholds (CCS).

For MDV focus areas, the most likely reason for declines in values were also typically flagged as increasing threats.

Most of the MSV sub-catchments had increasing threats which could lead to future declines if these threats are not mitigated.

The most common threat in MDV and MSV sub-catchments were related to adverse environmental conditions resulting from decreased water availability and increased urbanization including unmitigated stormwater runoff. Recreational access and deer were noted as increasing threats in many of the focus area sub-catchments; however, there is a low confidence in the links these threats have with key values.

New modelling incorporating updated climate projections indicates that climate change is a greater risk than originally predicted in 2018, with potentially significant declines in water availability. Climate strongholds represent areas predicted to be reasonably resilient to new climate change predictions and can provide an important refuge for key values. These are typically located in the forested headwaters. Climate change vulnerable areas represent locations where future declines are predicted for values and climate change adaptation actions are needed. Note that some sub-catchments can be listed a climate change stronghold and vulnerable due to different key environmental values.

## Recommendations for consideration

- Consider the focus sub-catchments during the prioritisation exercise in the implementation inquiry when determining where to focus effort for the next 5 years of HWS implementation.
- Improve data and methodologies where confidence in the evaluation was low.
- Reassess the method used to determine focus sub-catchments for the final HWS review.

# 4. References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# Appendix A HSM 'works to date'

**HSM 'works to date' analysis methods and results**

The method for updating the habitat suitability modes (HSMs) is included Chee et al (2023). This section summarises the analysis of the outputs that were used in the values trajectory.

An assessment of the modelled HSM reach-scale outputs was undertaken to determine 'significant' (determined using a value-specific threshold value) changes in predicted habitat suitability due to management actions since the begging of the Strategy. This assessment compared predicted habitat suitability under the works-to-date (WTD) scenario to that developed at the start of the Strategy (CURR) at the reach-scale for platypus, macroinvertebrates as represented by LUMaR, stacked native fish probability, Common galaxias, Ornate galaxias, and River blackfish. Threshold values of change were determined for each of these predictions. The thresholds and the justification for each is available in Table 29. The reach-scale outcome (stable, improvement, decline) for each value was used alongside other criteria (range reduction or expansion, site-specific trends in values) to assess whether a key value within a sub-catchment was stable/improving, potentially declining, or declining.

WTD management actions centred on the ability to reduce directly connected imperviousness and riparian revegetation. It is important to note that the WTD scenarios are assessments of total change in directly connected imperviousness – reductions in directly connected imperviousness via management actions in some areas may therefore be masked by development that increased directly connected imperviousness.

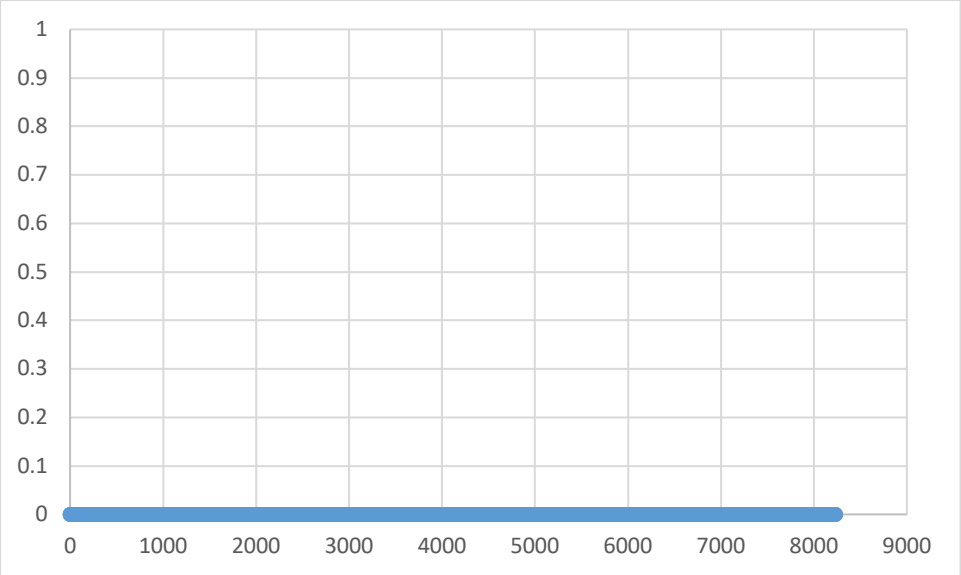
*Table 29. The threshold applied and the justification for its use.*

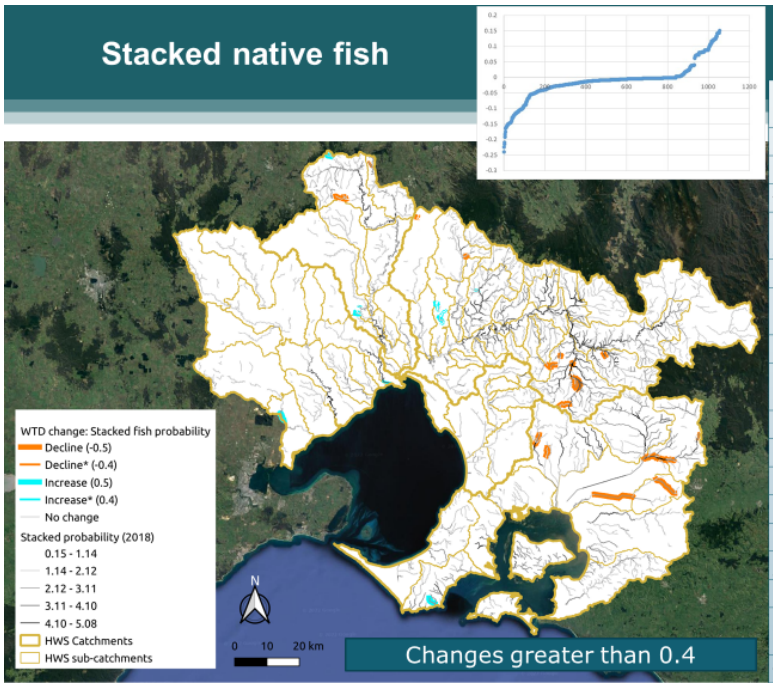
| Environmental value (habitat suitability prediction) | Threshold applied (+/-) | Threshold justification |
|---|---|---|
| Platypus (AllPlatyHWS) | 0.2 | A value of 0.2 was thought to represent a meaningful change in platypus habitat suitability. Note: a threshold of 0.1 was also trialled and produced <5% difference in reach-length change compared to a threshold of 0.2. |
| Macroinvertebrates (LUMaR) | 0.15 | Expert opinion (Dr Chris Walsh) indicated that a change in LUMaR of 0.15 represents a discernible shift in this macroinvertebrate index. |
| Fish (stacked native fish) | 0.4 | ~95% of reaches recorded a change less than this threshold of predicted habitat suitability. See |
| Fish (Common galaxias) | 0.06 | ~95% of reaches recorded a change less than this threshold of predicted habitat suitability. |
| Fish (Ornate galaxias) | 0.05 | ~95% of reaches recorded a change less than this threshold of predicted habitat suitability. |
| Fish (River blackfish) | 0.02 | ~95% of reaches recorded a change less than this threshold of predicted habitat suitability. |

The frequency plots used to determine appropriate threshold of change for each fish HSM investigated is available below.

**Stacked native fish**

The threshold for decline for staked probability was +/- 0.4. Changes to habitat suitability less than that were not considered in the evaluation. The frequency plot below excluded differences < 0.001 as it was easier to determine the appropriate threshold for declines.

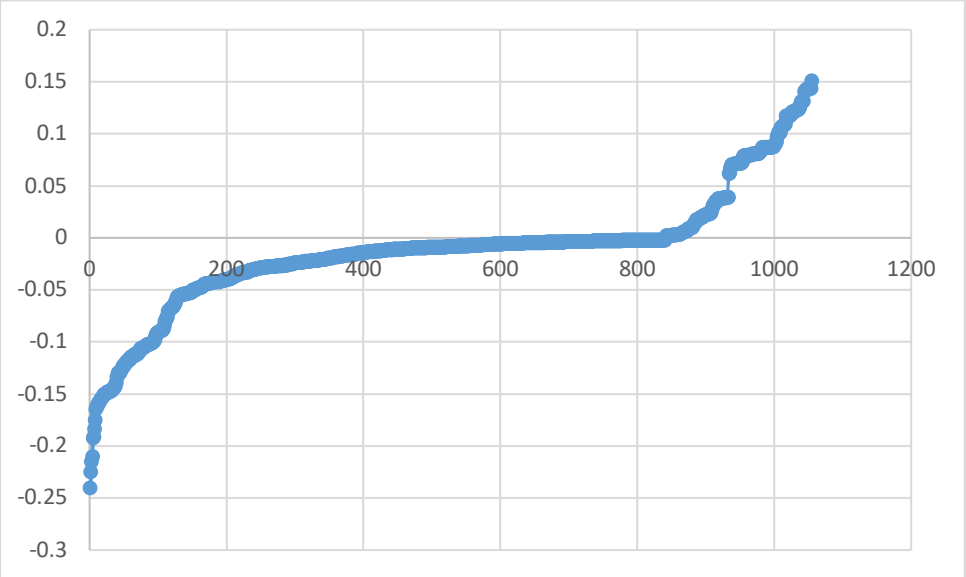


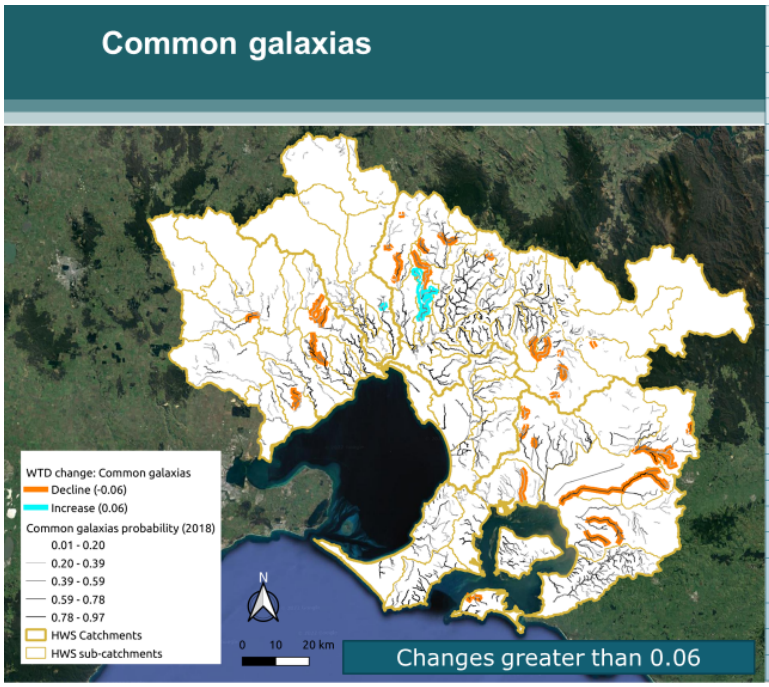




| Sub-catchment | Declined (kms) | improved >0.4 |
|---|---|---|
| Bunyip Lower | 23.25 | |
| Woori Yallock Creek | 20.07 | |
| Tarago River | 6.94 | |
| Cardinia, Toomuc, Deep and Ararat Creeks | 6.68 | |
| Deep Creek Upper | 6.44 | 1.47 |
| King Parrot and Musk Creeks | 5.21 | |
| Lang Lang River | 3.49 | |
| Little Yarra River and Hoddles Creek | 0.91 | |
| Plenty River Upper | 0.29 | |
| Merri Creek Upper | | |
| Cherry Creek | | 3.13 |
| Darebin Creek | | 10.44 |
| Diamond Creek (Rural) | | 2.24 |
| Jacksons Creek | | 2.46 |
| Little River Lower | | 3.61 |
| Mornington Peninsula South-Eastern Creeks | | 3.72 |
| **TOTAL** | **73.29** | **27.06** |

**Common galaxias**

The threshold for decline for Common galaxias was +/- 0.06. Changes to habitat suitability less than that were not considered in the evaluation. The frequency plot below excluded differences < 0.001 as it was easier to determine the appropriate threshold for declines.

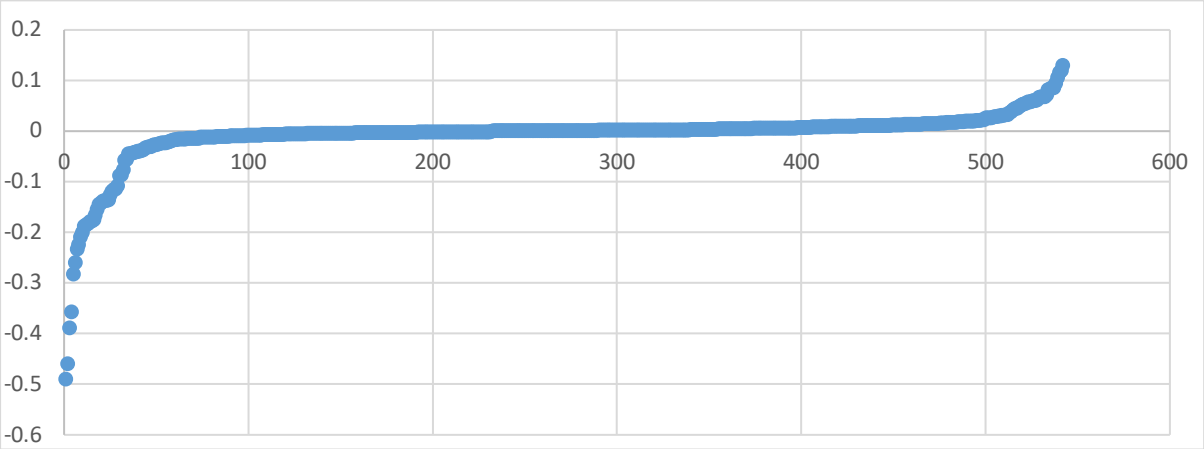


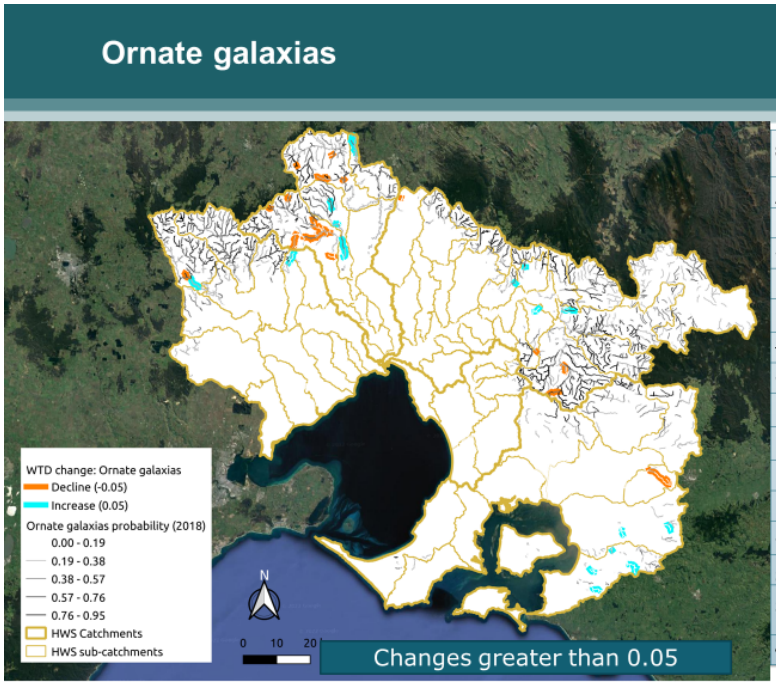




| Sub-catchments | declined (kms) | Improved (kms) |
|---|---|---|
| Bunyip Lower | 58.86 | |
| Lang Lang River | 33.22 | |
| Woori Yallock Creek | 20.78 | |
| Tarago River | 20.50 | |
| Kororoit Creek Lower | 18.96 | |
| Darebin Creek | 18.07 | 35.66 |
| Merri Creek Upper | 13.79 | |
| Skeleton Creek | 12.95 | |
| Cardinia, Toomuc, Deep and Ararat | 10.66 | |
| Dalmore Outfalls | 10.23 | |
| Lollypop Creek | 7.69 | |
| Plenty River Upper | 5.30 | |
| King Parrot and Musk Creeks | 5.21 | |
| Parwan Creek | 4.47 | |
| French and Phillip Islands | 2.76 | |
| Stringybark Creek | 2.52 | |
| Jacksons Creek | 1.86 | |
| Diamond Creek (Rural) | 1.07 | |
| Little Yarra River and Hoddles | 0.91 | |
| Mornington Peninsula North-Eastern Creeks | | |
| Moonee Ponds Creek | | 1.28 |
| Merri Creek Lower | | 0.62 |
| **TOTAL** | **249.81** | **37.55** |

**Ornate galaxias**

The threshold for decline for Ornate galaxias was +/- 0.05. Changes to habitat suitability less than that were not considered in the evaluation. The frequency plot below excluded differences < 0.001 as it was easier to determine the appropriate threshold for declines.

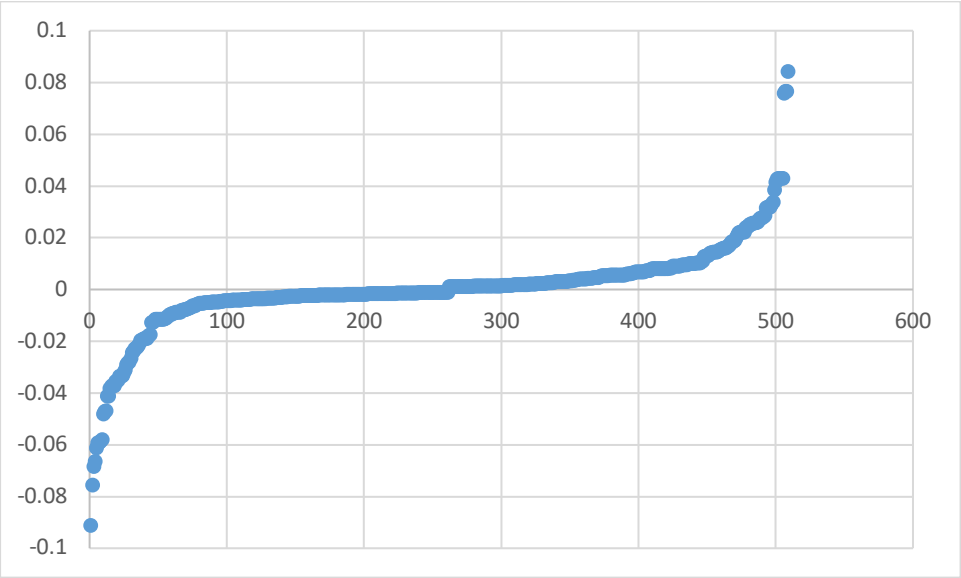


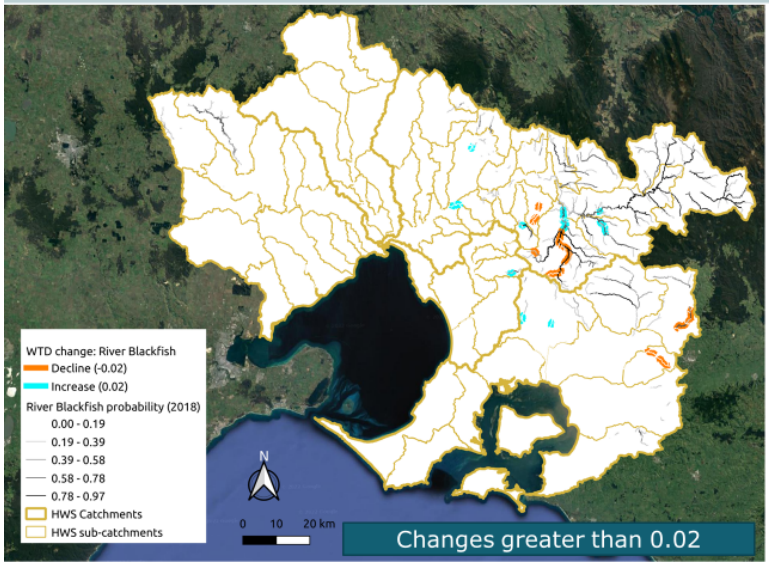

| Sub-catchment | Declined (kms) | Improved (kms) |
|---|---|---|
| Jacksons Creek | 32.65 | 4.28 |
| Deep Creek Upper | 6.63 | 10.25 |
| Woori Yallock Creek | 5.75 | |
| King Parrot and Musk Creeks | 5.21 | |
| Lang Lang River | 3.49 | 5.31 |
| Tarago River | 1.96 | |
| Werribee River Upper | 1.78 | 5.16 |
| Merri Creek Upper | 0.005 | |
| Bass River | | 10.41 |
| Emu Creek | | 8.41 |
| Deep Creek Lower | | 4.15 |
| Watts River (Rural) | | 3.32 |
| Stringybark Creek | | 1.89 |
| Steels and Pauls Creek (Rural) | | 0.61 |
| **TOTAL** | **57.48** | **53.78** |

**Blackfish**

The threshold for decline for blackfish was +/- 0.02. Changes to habitat suitability less than that were not considered in the evaluation. The frequency plot below excluded differences < 0.001 as it was easier to determine the appropriate threshold for declines.




## River blackfish




| Sub-catchment | Declined (kms) | Improved (kms) |
|---|---|---|
| King Parrot and Musk Creeks | 2.38 | |
| Stringybark Creek | 2.89 | |
| Lang Lang River | 3.49 | |
| Tarago River | 16.14 | |
| Woori Yallock Creek | 21.47 | 14.21 |
| Cardinia, Toomuc, Deep and Ararat Creeks | | 2.67 |
| Corhanwarrabul, Monbulk and Ferny Creeks | | 1.12 |
| Diamond Creek (Rural) | | 3.02 |
| Little Yarra River and Hoddles Creek | | 2.55 |
| Olinda Creek | | 0.43 |
| Yarra River Lower | | 0.56 |
| Yarra River Upper (Rural) | | 0.38 |
| **TOTAL** | **46.37** | **24.93** |

The following Table 30 summarises the maps and figures above for the various model outputs for fish and presents the top 6 sub-catchments as defined in the methodology.

*Table 30 Summary of sub-catchments identified having declining fish habitat as a result of 'works to date'. The top 6 sub-catchments were included as 'declining' in the trajectory assessment.*

| Ornate | | | Common | | | Blackfish | | | Stacked | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sub-catchment | decline kms | | Sub-catchments | decline kms | | Sub-catchment | decline kms | | Sub-catchment | Decline kms |
| Jacksons Creek | 32.65 | | Bunyip Lower | 58.86 | | King Parrot and Musk | 2.38 | | Bunyip Lower | 23.25 |
| Deep Creek Upper | 6.63 | | Lang Lang River | 33.22 | | *Stringybark Creek* | 2.89 | | Woori Yallock Creek | 20.07 |
| Woori Yallock Creek | 5.75 | | Woori Yallock Creek | 20.78 | | Lang Lang River | 3.49 | | Tarago River | 6.94 |
| King Parrot and Musk ( | 5.21 | | Tarago River | 20.50 | | Tarago River | 16.14 | | Cardinia, Toomuc, Deep and Ar | 6.68 |
| Lang Lang River | 3.49 | | Kororoit Creek Lower | 18.96 | | Woori Yallock Creek | 21.47 | | Deep Creek Upper | 6.44 |
| Tarago River | 1.96 | | Darebin Creek | 18.07 | | | | | King Parrot and Musk Creeks | 5.21 |
| Werribee River Upper | 1.78 | | Merri Creek Upper | 13.79 | | | | | Lang Lang River | 3.49 |
| Merri Creek Upper | 0.005 | | Skeleton Creek | 12.95 | | | | | Little Yarra River and Hoddles C | 0.91 |
| | | | Cardinia, Toomuc, Deep and | 10.66 | | | | | Plenty River Upper | 0.29 |
| | | | Dalmore Outfalls | 10.23 | | | | | | |
| | | | Lollypop Creek | 7.69 | | | | | | |
| | | | Plenty River Upper | 5.30 | | | | | | |
| | | | King Parrot and Musk Creeks | 5.21 | | | | | | |
| | | | Parwan Creek | 4.47 | | | | | | |
| | | | French and Phillip Islands | 2.76 | | | | | | |
| | | | *Stringybark Creek* | 2.52 | | | | | | |
| | | | Jacksons Creek | 1.86 | | | | | | |
| | | | Diamond Creek (Rural) | 1.07 | | | | | | |
| | | | Little Yarra River and Hoddle | 0.91 | | | | | | |

# Appendix B Macroinvertebrate trajectory results

Figure 17 presents macroinvertebrate results from the HSMs WTD and monitoring site data with further details for sites and model outputs in the background technical reports i.e. (Macroinvertebrates: A Technical Report to Inform the Healthy Waterways Strategy Mid-term Evaluation and Chee, Walsh, et al. 2022). This information formed the basis of the trajectory assessment for macroinvertebrates as outlined in the approach section. The results summarised for each sub-catchment in Table 31 which includes a summary of the evidence used to assess the trajectory and the overall confidence rating in the assessment.

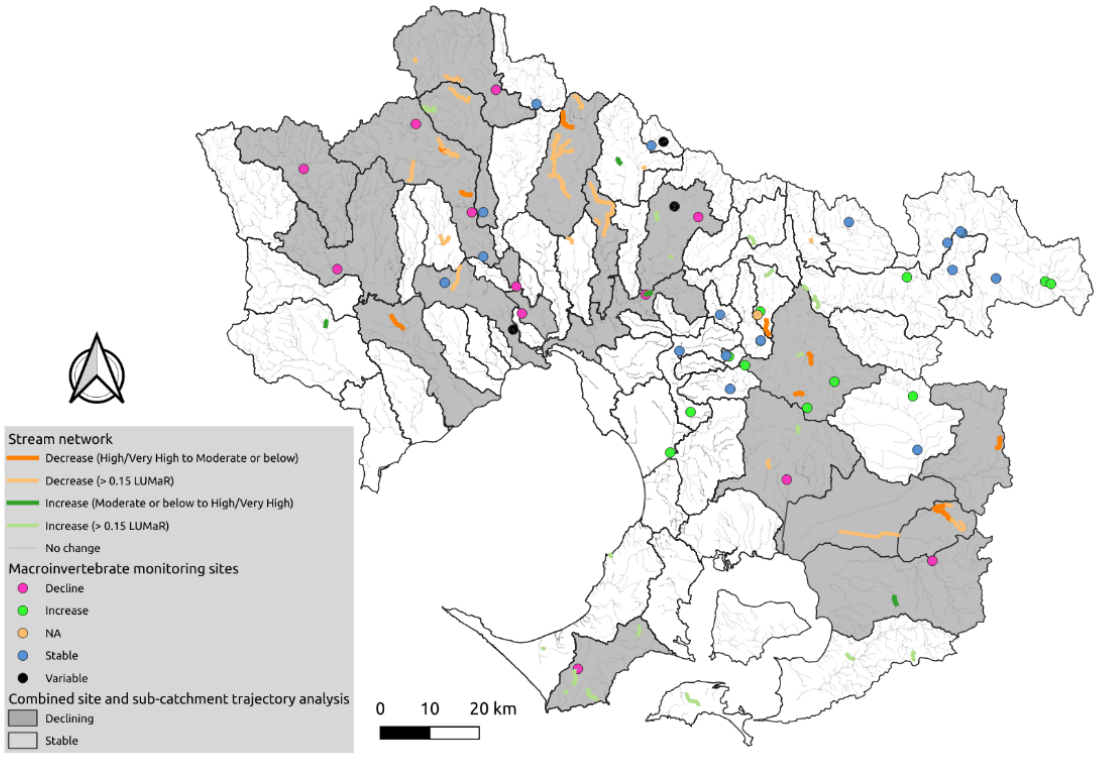



*Figure 17. Summary of the macroinvertebrate data used to assess the trajectory of each sub-catchment.*

*Table 31. Trajectory results for macroinvertebrates for each sub-catchment, with the data sources used to determine the status.*

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Dandenong | Bayside | Stable | HSMs no change | Low |
| Dandenong | Blind Creek | Stable | HSMs no change | Low |
| Dandenong | Corhanwarrabul, Monbulk and Ferny Creeks | Stable | HSM no change & Site data (FER-647-5) | High |
| Dandenong | Dandenong Creek Lower | Stable | HSM no change & Site data stable (DNG-31881-3) | High |
| Dandenong | Dandenong Creek Middle | Stable / increasing | HSM no change & Site data stable (DNG-23690-8, DNG-7957-4) | High |
| Dandenong | Dandenong Creek Upper | Stable / increasing | HSM no change & Site data stable (DBS-363-4, DBS-810-7, DNG-173-5) | High |
| Dandenong | Eumemmerring Creek | Stable | HSMs no change | Low |
| Dandenong | Kananook Creek | Stable | HSMs no change | Low |
| Maribyrnong | Boyd Creek | Stable | HSM no change & site data stable (BOY-13537-6) | High |
| Maribyrnong | Deep Creek Lower | Stable | HSMs no change | Mod |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Maribyrnong | Deep Creek Upper | Declining | HSM reach scale declines and Site data declining (DPW-28678-1) | High |
| Maribyrnong | Emu Creek | Declining | HSM reach scale declines<br>Site data stable (EMU-16701-8) | Low |
| Maribyrnong | Jacksons Creek | Declining | HSM reach scale declines and site data (JKN-34269-0 decline and JKN-40043-9 stable) | Mod |
| Maribyrnong | Maribyrnong River | Declining | HSM stable<br>B sites declining ie (MRB-130320-1 & MRB-134012-8) | High |
| Maribyrnong | Moonee Ponds Creek | Stable | HSM outputs (outside SWPA) no site data | Low |
| Maribyrnong | Steele Creek | Stable | HSM outputs (outside SWPA) no site data | Low |
| Maribyrnong | Stony Creek | Stable | HSM outputs (outside SWPA) no site data | Low |
| Maribyrnong | Taylors Creek | Stable | HSM outputs (outside SWPA) no site data | Low |
| Werribee | Cherry Creek | Stable | HSM outputs (outside SWPA) no site data | Low |
| Werribee | Kororoit Creek Lower | Declining | HSM reach scale declines<br>Site data stable (KRT-13267-6) or variable (KRT-26894-4) | Low |
| Werribee | Kororoit Creek Upper | Stable | Small HSM reach scale declines. No site data | Low |
| Werribee | Laverton Creek | Stable | HSM outputs (outside SWPA) no site data | Low |
| Werribee | Lerderderg River | Declining | HSM outputs stable but Historical declining trend (LER-15145-4) used. | Low |
| Werribee | Little River Lower | Stable | HSM outputs no declines (outside SWPA – but rural) no site data | Mod |
| Werribee | Little River Upper | Stable | HSM outputs no declines (outside SWPA – but rural) no site data | Mod |
| Werribee | Lollypop Creek | Stable | HSM outputs no declines (inside SWPA) no site data | Mod |
| Werribee | Parwan Creek | Stable | HSM outputs no declines (outside SWPA – but rural) no site data | Mod |
| Werribee | Skeleton Creek | Stable | HSM outputs no declines (inside SWPA) no site data | Mod |
| Werribee | Toolern Creek | Stable | HSM outputs no declines (inside SWPA) no site data | Mod |
| Werribee | Werribee River Lower | Declining | HSM reach scale declines (inside SWPA) no site data | Mod |
| Werribee | Werribee River Middle | Declining | HSM outputs no declines (inside SWPA) but site data is declining for historic and recent trends (WER-35204-8) – however confidence in trends is low | Low |
| Werribee | Werribee River Upper | Stable | HSM outputs no declines (inside SWPA) no site data | Mod |
| Westernport | Bass River | Stable | HSM outputs no declines (outside SWPA – but rural) no site data | Mod |
| Westernport | Bunyip Lower | Declining | HSM outputs declines (outside SWPA – but rural) no site data | Mod |
| Westernport | Bunyip River Middle and Upper | Stable | HSM outputs no declines (outside SWPA – but rural)<br>B sites BNY-24764-5 (stable)<br>BNY-2904-2 (increasing) | High |
| Westernport | Cardinia, Toomuc, Deep and Ararat | Declining | HSM outputs declines (inside SWPA) & site declining TOO-4334-B (was low confidence trend) | Mod |
| Westernport | Dalmore Outfalls | Stable | HSM outputs no declines (outside SWPA – but rural)<br>No site data | Mod |
| Westernport | French and Phillip Islands | Stable | HSM outputs (inside SWPA) minor improvements<br>No site data | Mod |
| Westernport | King Parrot and Musk Creeks | Declining | HSM outputs declines (inside SWPA) – several reaches<br>No site data | Mod |
| Westernport | Lang Lang River | Declining | HSM outputs small reach improving but site declining LNG-16294-3 | Mod |
| Westernport | Mornington Peninsula North-Eastern Creeks | Stable | HSM outputs no declines (outside SWPA – but mostly rural) no site data | Mod |
| Westernport | Mornington Peninsula South-Eastern Creeks | Declining | HSM outputs small reach improving but site declining MAI-1320-2 | Mod |
| Westernport | Mornington Peninsula Western Creeks | Stable | HSM outputs no declines (outside SWPA) no site data | Low |
| Westernport | Tarago River | Declining | HSM outputs shows small declines (outside SWPA) no site data | Low |
| Yarra | Brushy Creek | Stable | HSM outputs no declines (inside SWPA) & site stable BRS-1472-0 | High |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Yarra | Darebin Creek | Declining | HSM outputs declines (inside SWPA) – several reaches<br>No site data | Mod |
| Yarra | Diamond Creek (Rural) | Declining | HSM outputs small reaches improving but site declining (DIY-5232-7) and 1 site variable | Low |
| Yarra | Diamond Creek (Source) | Stable | HSM outputs no declines (outside SWPA – but rural) no site data | Mod |
| Yarra | Gardiners Creek | Stable | HSM outputs no declines (outside SWPA) no site data | Low |
| Yarra | Koonung Creek | Stable | HSM outputs no declines (outside SWPA) no site data | Low |
| Yarra | Little Yarra River and Hoddles Creek | Stable | HSM outputs no declines (inside SWPA) no site data | Mod |
| Yarra | Merri Creek Lower | Stable | HSM outputs no declines (outside SWPA) no site data | Low |
| Yarra | Merri Creek Upper | Declining | HSM outputs declines (inside SWPA) – several reaches<br>No site data | Mod |
| Yarra | Mullum Mullum Creek | Stable | HSM outputs no declines (outside SWPA) no site data | Low |
| Yarra | Olinda Creek | Stable | HSM outputs no declines (inside SWPA) no site data | Mod |
| Yarra | Plenty River (Source) | Stable | HSM outputs no declines (outside SWPA – but rural) Site data stable (PLE-2190-0) | Mod |
| Yarra | Plenty River Lower | Stable | HSM outputs no declines (outside SWPA) no site data | Low |
| Yarra | Plenty River Upper | Stable | HSM outputs no declines (inside SWPA) no site data | Mod |
| Yarra | Steels and Pauls Creek (Rural) | Stable | HSM outputs no declines (inside SWPA) no site data | Mod |
| Yarra | Steels and Pauls Creek (Source) | Stable | HSM outputs no declines (inside SWPA) no site data | Mod |
| Yarra | Stringybark Creek | Stable/improving | HSM outputs small reaches improving and site data increasing (LSN-150-4) | High |
| Yarra | Watsons Creek | Stable | HSM outputs no declines (outside SWPA but rural) no site data | Mod |
| Yarra | Watts River (Rural) | Stable | HSM outputs no declines (inside SWPA) no site data | Mod |
| Yarra | Watts River (Source) | Stable | HSM outputs no declines (outside SWPA but rural) and site data stable (WTT-5906-1) | High |
| Yarra | Woori Yallock Creek | Declining | HSM outputs shows several reaches declining but B sites improving (SAS-191-2 and SHE-1665-6) | Low |
| Yarra | Yarra River Lower | Declining | HSM outputs no declines but site data declining YAR-275352-4 | Mod |
| Yarra | Yarra River Middle | Stable | HSM outputs no declines and no site data | Mod |
| Yarra | Yarra River Upper (Rural) | Stable | HSM outputs no declines and site data stable (CMT-828-5 and MCM-5970-4) | High |
| Yarra | Yarra River Upper (Source) | Stable | HSM outputs no declines and several sites stable or improving | High |

# Appendix C – Platypus trajectory results

Figure 18 presents platypus results from modelling and monitoring data. Further details for sites and model outputs can be found in the background technical reports i.e. (Platypus: A Technical Report To Inform The Healthy Waterways Strategy Mid-term Evaluation and Chee at el 2022). This information formed the basis of the trajectory assessment for platypus as outlined in the methods section and summarised for each sub-catchment in Table 32.

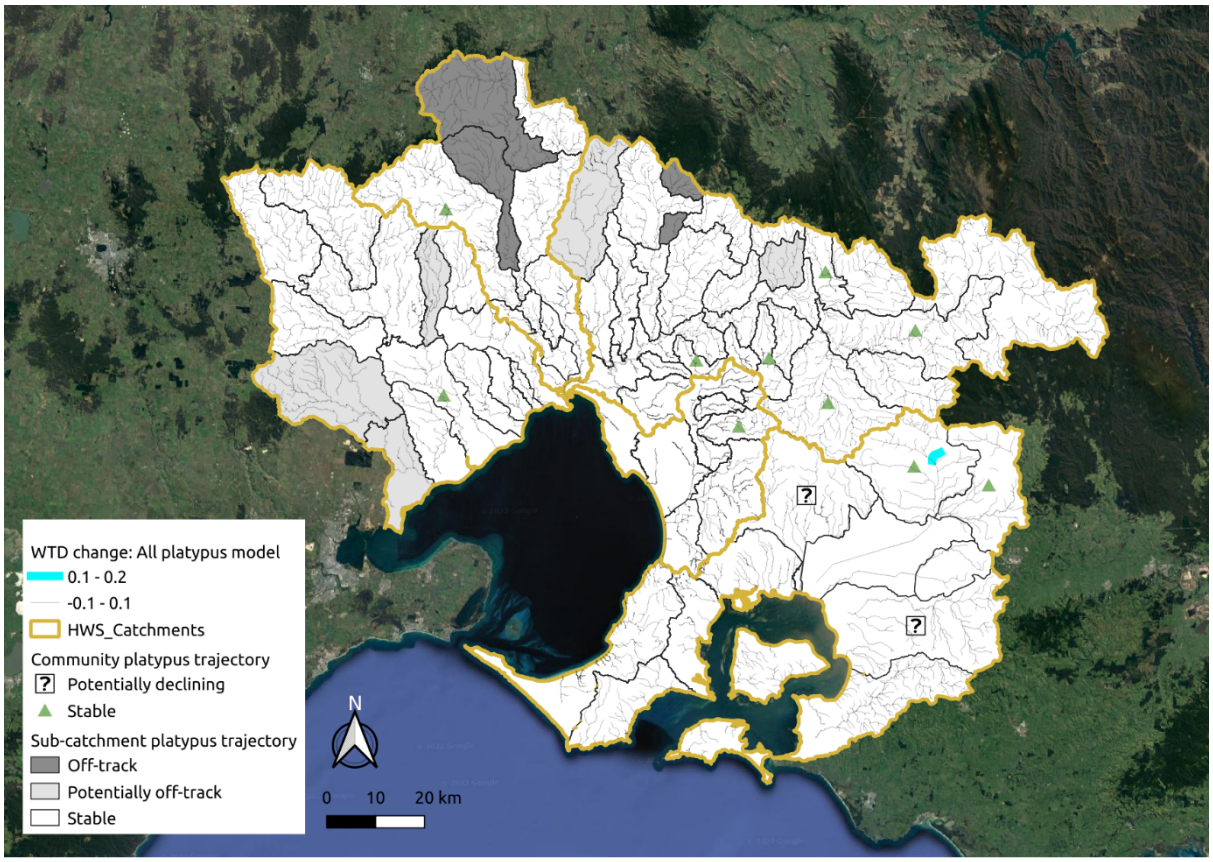



*Figure 18. Summary of the platypus data used to assess the trajectory of each sub-catchment.*

*Table 32. Trajectory results for platypus for each sub-catchment along with the data sources used to determine the status.*

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Dandenong | Bayside | n/a | Populations do not exist | n/a |
| Dandenong | Blind Creek | Stable | Rubric 1 and 2 | Mod |
| Dandenong | Corhanwarrabul, Monbulk and Ferny Creeks | Stable | Rubric 1 and 2 + HSM wtd | High |
| Dandenong | Dandenong Creek Lower | Stable | Rubric 1 and 2 | Mod |
| Dandenong | Dandenong Creek Middle | Stable | Rubric 1 and 2 | Mod |
| Dandenong | Dandenong Creek Upper | Stable | Rubric 1 and 2 | Mod |
| Dandenong | Eumemmerring Creek | Stable | Rubric 1 and 2 | Mod |
| Dandenong | Kananook Creek | n/a | Populations do not exist | n/a |
| Maribyrnong | Boyd Creek | Stable | Rubric 1 and 2 | Mod |
| Maribyrnong | Deep Creek Lower | Stable | Rubric 1 and 2 | Mod |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Maribyrnong | Deep Creek Upper | Declining | Rubric 1 = off-track + HSM wtd | High |
| Maribyrnong | Emu Creek | Declining | Rubric 1 = off-track + HSM wtd | High |
| Maribyrnong | Jacksons Creek | Stable | Rubric 1 and 2 + HSM wtd | High |
| Maribyrnong | Maribyrnong River | Stable | Rubric 1 and 2 | Mod |
| Maribyrnong | Moonee Ponds Creek | Stable | Rubric 1 and 2 | Mod |
| Maribyrnong | Steele Creek | Stable | Rubric 1 and 2 | Mod |
| Maribyrnong | Stony Creek | Stable | Rubric 1 and 2 | Mod |
| Maribyrnong | Taylors Creek | Stable | Rubric 1 and 2 | Mod |
| Werribee | Cherry Creek | n/a | Populations do not exist | n/a |
| Werribee | Kororoit Creek Lower | n/a | Populations do not exist | n/a |
| Werribee | Kororoit Creek Upper | n/a | Populations do not exist | n/a |
| Werribee | Laverton Creek | Stable | Rubric 1 and 2 | Mod |
| Werribee | Lerderderg River | Stable | Rubric 1 and 2 | Mod |
| Werribee | Little River Lower | Potentially Declining | Rubric 1 = potentially off-track | Low |
| Werribee | Little River Upper | Potentially Declining | Rubric 1 = potentially off-track | Low |
| Werribee | Lollypop Creek | n/a | Populations do not exist | n/a |
| Werribee | Parwan Creek | Stable | Rubric 1 and 2 | Mod |
| Werribee | Skeleton Creek | n/a | Populations do not exist | n/a |
| Werribee | Toolern Creek | Potentially Declining | Rubric 1 = potentially off-track + HSM wtd | Low |
| Werribee | Werribee River Lower | Stable | Rubric 1 and 2 + HSM wtd | High |
| Werribee | Werribee River Middle | Stable | Rubric 1 and 2 + HSM wtd | High |
| Werribee | Werribee River Upper | Stable | Rubric 1 and 2 + HSM wtd | High |
| Westernport | Bass River | Stable | Rubric 1 and 2 | Mod |
| Westernport | Bunyip Lower | Stable | Rubric 1 and 2 | Mod |
| Westernport | Bunyip River Middle and Upper | Stable | Rubric 1 and 2 + HSM wtd | High |
| Westernport | Cardinia, Toomuc, Deep and Ararat | Declining | Rubric 2 = potentially declining + HSM wtd | High |
| Westernport | Dalmore Outfalls | n/a | Populations do not exist | n/a |
| Westernport | French and Phillip Islands | n/a | Populations do not exist | n/a |
| Westernport | King Parrot and Musk Creeks | Stable | Rubric 1 and 2 + HSM wtd | High |
| Westernport | Lang Lang River | Declining | Rubric 2 = potentially declining + HSM wtd | High |
| Westernport | Mornington Peninsula North-Eastern Creeks | n/a | Populations do not exist | n/a |
| Westernport | Mornington Peninsula South-Eastern Creeks | n/a | Populations do not exist + HSM wtd | n/a |
| Westernport | Mornington Peninsula Western Creeks | n/a | Populations do not exist + HSM wtd | n/a |
| Westernport | Tarago River | Stable | Rubric 1 and 2 + HSM wtd | High |
| Yarra | Brushy Creek | Stable | Rubric 1 and 2 + HSM wtd | High |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Yarra | Darebin Creek | Stable | Rubric 1 and 2 + HSM wtd | High |
| Yarra | Diamond Creek (Rural) | Stable | Rubric 1 and 2 | Mod |
| Yarra | Diamond Creek (Source) | Stable | Rubric 1 and 2 | Mod |
| Yarra | Gardiners Creek | Stable | Rubric 1 and 2 | Mod |
| Yarra | Koonung Creek | Stable | Rubric 1 and 2 | Mod |
| Yarra | Little Yarra River and Hoddles Creek | Stable | Rubric 1 and 2 + HSM wtd | High |
| Yarra | Merri Creek Lower | Stable | Rubric 1 and 2 | Mod |
| Yarra | Merri Creek Upper | Potentially declining | Rubric 1 = potentially off-track + HSM wtd | Low |
| Yarra | Mullum Mullum Creek | Stable | Rubric 1 and 2 | Mod |
| Yarra | Olinda Creek | Stable | Rubric 1 and 2 + HSM wtd | High |
| Yarra | Plenty River (Source) | Declining | Rubric 1 = off-track | Mod |
| Yarra | Plenty River Lower | Stable | Rubric 1 and 2 | Mod |
| Yarra | Plenty River Upper | Stable | Rubric 1 and 2 + HSM wtd | High |
| Yarra | Steels and Pauls Creek (Rural) | Potentially declining | Rubric 1 = potentially off-track | Low |
| Yarra | Steels and Pauls Creek (Source) | Stable | Rubric 1 and 2 | Mod |
| Yarra | Stringybark Creek | Stable | Rubric 1 and 2 + HSM wtd | High |
| Yarra | Watsons Creek | Stable | Rubric 1 and 2 | Mod |
| Yarra | Watts River (Rural) | Stable | Rubric 1 and 2 + HSM wtd | High |
| Yarra | Watts River (Source) | Stable | Rubric 1 and 2 | Mod |
| Yarra | Woori Yallock Creek | Stable | Rubric 1 and 2 + HSM wtd | High |
| Yarra | Yarra River Lower | Stable | Rubric 1 and 2 | Mod |
| Yarra | Yarra River Middle | Stable | Rubric 1 and 2 + HSM wtd | High |
| Yarra | Yarra River Upper (Rural) | Stable | Rubric 1 and 2 + HSM wtd | High |
| Yarra | Yarra River Upper (Source) | Stable | Rubric 1 and 2 | Mod |

# Appendix D – Fish (rivers) trajectory results

Trajectory assessment for riverine fish is presented in Table 33.

*Table 33. Trajectory results for fish for each sub-catchment along with the data sources used to determine the status.*

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Dandenong | Bayside | Gap | | |
| Dandenong | Blind Creek | Gap | | |
| Dandenong | Corhanwarrabul, Monbulk and Ferny Creeks | Stable | No significant declines observed from the HSM WTD modelling | Low |
| Dandenong | Dandenong Creek Lower | Gap | | |
| Dandenong | Dandenong Creek Middle | Gap | | |
| Dandenong | Dandenong Creek Upper | Gap | | |
| Dandenong | Eumemmerring Creek | Gap | | |
| Dandenong | Kananook Creek | Gap | | |
| Maribyrnong | Boyd Creek | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Maribyrnong | Deep Creek Lower | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Maribyrnong | Deep Creek Upper | Declining | Around 6 kms of predicted decline in habitat for Ornate and stacked fish spp. | Low |
| Maribyrnong | Emu Creek | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Maribyrnong | Jacksons Creek | Declining | Around 32 kms of predicted decline in habitat for Ornate | Low |
| Maribyrnong | Maribyrnong River | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Maribyrnong | Moonee Ponds Creek | Stable | No significant declines observed from the HSM WTD modelling | Low |
| Maribyrnong | Steele Creek | Stable | No significant declines observed from the HSM WTD modelling | Low |
| Maribyrnong | Stony Creek | Stable | No significant declines observed from the HSM WTD modelling | Low |
| Maribyrnong | Taylors Creek | Stable | No significant declines observed from the HSM WTD modelling | Low |
| Werribee | Cherry Creek | Gap | | |
| Werribee | Kororoit Creek Lower | Declining | Significant decline in habitat for Common galaxias (18 kms) | Low |
| Werribee | Kororoit Creek Upper | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Werribee | Laverton Creek | Stable | No significant declines observed from the HSM WTD modelling | Very low |
| Werribee | Lerderderg River | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Werribee | Little River Lower | Gap | | |
| Werribee | Little River Upper | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Werribee | Lollypop Creek | Stable | No significant declines observed from the HSM WTD modelling | Mod |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Werribee | Parwan Creek | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Werribee | Skeleton Creek | Stable | No significant declines observed from the HSM WTD modelling | Low |
| Werribee | Toolern Creek | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Werribee | Werribee River Lower | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Werribee | Werribee River Middle | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Werribee | Werribee River Upper | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Westernport | Bass River | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Westernport | Bunyip Lower | Declining | Significant decline in habitat for Common galaxias (58 kms) stacked native fish (23 kms) | Mod |
| Westernport | Bunyip River Middle and Upper | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Westernport | Cardinia, Toomuc, Deep and Ararat | Declining | Significant decline in habitat for stacked native fish (6 kms) | low |
| Westernport | Dalmore Outfalls | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Westernport | French and Phillip Islands | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Westernport | King Parrot and Musk Creeks | Declining | Significant decline in habitat for Ornate galaxias (5 kms) and Blackfish (2 kms) and stacked native fish (5 kms) | Mod |
| Westernport | Lang Lang River | Declining | Significant decline in habitat for Ornate galaxias (3 kms) and Common galaxias (33 kms) | Mod |
| Westernport | Mornington Peninsula North-Eastern Creeks | Gap | | |
| Westernport | Mornington Peninsula South-Eastern Creeks | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Westernport | Mornington Peninsula Western Creeks | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Westernport | Tarago River | Declining | Significant decline in habitat (3-20 kms) for all key species and stacked native fish | Mod |
| Yarra | Brushy Creek | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Yarra | Darebin Creek | Declining | Around 18 kms of significant decline in habitat for Common galaxias | Low |
| Yarra | Diamond Creek (Rural) | Gap | | |
| Yarra | Diamond Creek (Source) | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Yarra | Gardiners Creek | Gap | | |
| Yarra | Koonung Creek | Gap | | |
| Yarra | Little Yarra River and Hoddles Creek | Stable | No significant declines observed from the HSM WTD modelling | Mod |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Yarra | Merri Creek Lower | Stable | No significant declines observed from the HSM WTD modelling | Low |
| Yarra | Merri Creek Upper | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Yarra | Mullum Mullum Creek | Gap | | |
| Yarra | Olinda Creek | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Yarra | Plenty River (Source) | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Yarra | Plenty River Lower | Gap | | |
| Yarra | Plenty River Upper | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Yarra | Steels and Pauls Creek (Rural) | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Yarra | Steels and Pauls Creek (Source) | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Yarra | Stringybark Creek | Declining | Around 3km significant decline in habitat for Blackfish | Low |
| Yarra | Watsons Creek | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Yarra | Watts River (Rural) | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Yarra | Watts River (Source) | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Yarra | Woori Yallock Creek | Declining | Around B0kms decline in habitat for all 3 key species and the stacked native fish | Mod |
| Yarra | Yarra River Lower | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Yarra | Yarra River Middle | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Yarra | Yarra River Upper (Rural) | Stable | No significant declines observed from the HSM WTD modelling | Mod |
| Yarra | Yarra River Upper (Source) | Stable | No significant declines observed from the HSM WTD modelling | Mod |

# Appendix E – Fish (wetlands)

Trajectory assessment for wetland fish is presented in Table 34.

*Table 34 Trajectory status for wetland fish for HWS priority wetlands across the 69 sub-catchments*

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Dandenong | Bayside | Gap | | |
| Dandenong | Blind Creek | Gap | | |
| Dandenong | Corhanwarrabul, Monbulk and Ferny Creeks | Gap | | |
| Dandenong | Dandenong Creek Lower | Gap | | |
| Dandenong | Dandenong Creek Middle | Stable | Recent eDNA records and re-introductions in Autumn 2023. | Mod |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Dandenong | Dandenong Creek Upper | | | |
| Dandenong | Eumemmerring Creek | Stable | Recent eDNA records | Low |
| Dandenong | Kananook Creek | Stable | Recent eDNA records | Low |
| Maribyrnong | Boyd Creek | Gap | | |
| Maribyrnong | Deep Creek Lower | Gap | | |
| Maribyrnong | Deep Creek Upper | Gap | | |
| Maribyrnong | Emu Creek | Gap | | |
| Maribyrnong | Jacksons Creek | Gap | | |
| Maribyrnong | Maribyrnong River | Gap | | |
| Maribyrnong | Moonee Ponds Creek | Gap | | |
| Maribyrnong | Steele Creek | Gap | | |
| Maribyrnong | Stony Creek | Gap | | |
| Maribyrnong | Taylors Creek | Gap | | |
| Werribee | Cherry Creek | Gap | | |
| Werribee | Kororoit Creek Lower | Gap | | |
| Werribee | Kororoit Creek Upper | Gap | | |
| Werribee | Laverton Creek | Gap | | |
| Werribee | Lerderderg River | Gap | | |
| Werribee | Little River Lower | Gap | | |
| Werribee | Little River Upper | Gap | | |
| Werribee | Lollypop Creek | Gap | | |
| Werribee | Parwan Creek | Gap | | |
| Werribee | Skeleton Creek | Gap | | |
| Werribee | Toolern Creek | Gap | | |
| Werribee | Werribee River Lower | Gap | | |
| Werribee | Werribee River Middle | Gap | | |
| Werribee | Werribee River Upper | Gap | | |
| Westernport | Bass River | Gap | | |
| Westernport | Bunyip Lower | Gap | | |
| Westernport | Bunyip River Middle and Upper | Gap | | |
| Westernport | Cardinia, Toomuc, Deep and Ararat | Gap | | |
| Westernport | Dalmore Outfalls | Gap | | |
| Westernport | French and Phillip Islands | Gap | | |
| Westernport | King Parrot and Musk Creeks | Gap | | |
| Westernport | Lang Lang River | Stable | Recent eDNA records | Low |
| Westernport | Mornington Peninsula North-Eastern Creeks | Gap | | |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Westernport | Mornington Peninsula South-Eastern Creeks | Gap | | |
| Westernport | Mornington Peninsula Western Creeks | Gap | | |
| Westernport | Tarago River | Gap | | |
| Yarra | Brushy Creek | Gap | | |
| Yarra | Darebin Creek | Gap | | |
| Yarra | Diamond Creek (Rural) | Gap | | |
| Yarra | Diamond Creek (Source) | Gap | | |
| Yarra | Gardiners Creek | Gap | | |
| Yarra | Koonung Creek | Gap | | |
| Yarra | Little Yarra River and Hoddles Creek | Gap | | |
| Yarra | Merri Creek Lower | Gap | | |
| Yarra | Merri Creek Upper | Gap | | |
| Yarra | Mullum Mullum Creek | Gap | | |
| Yarra | Olinda Creek | Gap | | |
| Yarra | Plenty River (Source) | Gap | | |
| Yarra | Plenty River Lower | Gap | | |
| Yarra | Plenty River Upper | Gap | | |
| Yarra | Steels and Pauls Creek (Rural) | Gap | | |
| Yarra | Steels and Pauls Creek (Source) | Gap | | |
| Yarra | Stringybark Creek | Gap | | |
| Yarra | Watsons Creek | Gap | | |
| Yarra | Watts River (Rural) | Gap | | |
| Yarra | Watts River (Source) | Gap | | |
| Yarra | Woori Yallock Creek | Gap | | |
| Yarra | Yarra River Lower | Gap | | |
| Yarra | Yarra River Middle | Gap | | |
| Yarra | Yarra River Upper (Rural) | Gap | | |
| Yarra | Yarra River Upper (Source) | Gap | | |

# Appendix F – Frogs

The following Figure 19 and Figure 20 presents the threatened species analysis for the two threatened frog species. While this data did not inform the sub-catchment trajectory, it was presented alongside for information.

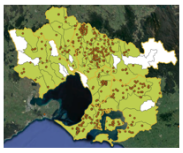
## *Pseudophryne* spp. records – declining

Sub-catchments where *Pseudophryne* spp. has historically been recorded but have not been recorded since 2010

Recently found / Historically found (total# of sub-catchments)

| Catchment | # of sub-catchments | Sub-catchment |
|---|---|---|
| Yarra | 18 / 22 (25) | Gardiners Creek, Little Yarra River and Hoddles Creek, Koonung Creek, Steels and Pauls Creek (Rural), Steels and Pauls Creek (Source), Olinda Creek, Watts River (Source), Merri Creek Lower, Yarra River Middle, Woori Yallock Creek, Darebin Creek, Plenty River Lower, Plenty River (Source), Diamond Creek (Source), Watts River (Rural), Diamond Creek (Rural), Plenty River Upper, Merri Creek Upper |
| Maribyrnong | 7 / 8 (10) | Taylors Creek, Maribyrnong River, Emu Creek, Deep Creek Lower, Deep Creek Upper, Jacksons Creek, Boyd Creek |
| Werribee | 6 / 9 (14) | Lollypop Creek, Little River Lower, Werribee River Lower, Toolern Creek, Lerderderg River, Little River Upper |
| Dandenong | 3 / 4 (8) | Blind Creek, Dandenong Creek Upper, Dandenong Creek Lower |
| Westernport | 4 / 11 (12) | Tarago River, Lang Lang River, Bunyip Lower, and Cardinia, Toomuc, Deep and Ararat Creek |

All records



Post 2010

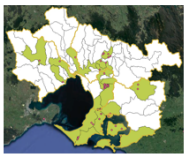


*Figure 19. Sub-catchments where Pseudophryne spp have not been recorded since 2010 but were recorded historically*

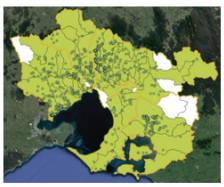
## *Litoria raniformis* (Growling Grass Frog) records – declining

Sub-catchments where GGF has historically been recorded but have not been recorded since 2010

Recently found / Historically found (total# of sub-catchments)

| Catchment | # of sub-catchments | Sub-catchment |
|---|---|---|
| Yarra | 18 / 23 (25) | Yarra River Upper (Rural), Gardiners Creek,Koonung Creek, Steels and Pauls Creek (Source), Diamond Creek (Source), Mullum Mullum Creek, Olinda Creek, Plenty River (Source), Steels and Pauls Creek (Rural), Stringybark Creek, Watsons Creek, Watts River (Rural), Yarra River Middle, Yarra River Upper (Source), Woori Yallock Creek, Diamond Creek (Rural), Plenty River Lower, Yarra River Lower |
| Maribyrnong | 2 / 9 (10) | Deep Creek Upper, Boyd Creek |
| Werribee | 3 / 13 (14) | Kororoit Creek Upper, Cherry Creek, Laverton Creek |
| Dandenong | 5 / 6 (8) | Blind Creek, Dandenong Creek Middle, Dandenong Creek Lower, Kananook Creek, Eumemmerring Creek |
| Westernport | 6 / 10 (12) | Lang Lang River, Bass River, Dalmore Outfalls, King Parrot and Musk Creek, French and Phillip Islands |

All records



Post 2010

*Figure 20. Sub-catchments where Growling Grass Frogs have not been recorded since 2010 but were recorded historically*

Trajectory assessment for frogs is presented in Table 35.

*Table 35. Trajectory results for frogs for each sub-catchment along with the data sources used to determine the status. One * represents one threatened species not found since 2010 while two ** represents 2 threatened species not found since 2010.*

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Dandenong | Bayside | stable | O/E (<2001, 2001-2010, >2010) | Mod |
| Dandenong | Blind Creek | stable ** | O/E (<2001, 2001-2010, >2010) | Mod |
| Dandenong | Corhanwarrabul, Monbulk and Ferny Creeks | stable | O/E (<2001, 2001-2010, >2010) | Mod |
| Dandenong | Dandenong Creek Lower | stable ** | O/E (<2001, 2001-2010, >2010) | Mod |
| Dandenong | Dandenong Creek Middle | stable * | O/E (<2001, 2001-2010, >2010) | Mod |
| Dandenong | Dandenong Creek Upper | gap * | O/E (<2001, 2001-2010, >2010) | |
| Dandenong | Eumemmerring Creek | stable * | O/E (<2001, 2001-2010, >2010) | Mod |
| Dandenong | Kananook Creek | stable * | O/E (<2001, 2001-2010, >2010) | Mod |
| Maribyrnong | Boyd Creek | gap ** | < 100 records per time block available. | |
| Maribyrnong | Deep Creek Lower | potentially declining * | O/E (<2001, 2001-2010, >2010) | Low |
| Maribyrnong | Deep Creek Upper | gap ** | Refer to methods table | |
| Maribyrnong | Emu Creek | gap ** | Refer to methods table | |
| Maribyrnong | Jacksons Creek | declining * | O/E (<2001, 2001-2010, >2010) | Mod |
| Maribyrnong | Maribyrnong River | stable * | O/E (<2001, 2001-2010, >2010) | Mod |
| Maribyrnong | Moonee Ponds Creek | stable | O/E (<2001, 2001-2010, >2010) | Mod |
| Maribyrnong | Steele Creek | stable | O/E (<2001, 2001-2010, >2010) | Mod |
| Maribyrnong | Stony Creek | gap | Refer to methods table | |
| Maribyrnong | Taylors Creek | gap * | Refer to methods table | |
| Werribee | Cherry Creek | gap * | Refer to methods table | |
| Werribee | Kororoit Creek Lower | stable | O/E (<2001, 2001-2010, >2010) | Mod |
| Werribee | Kororoit Creek Upper | gap * | Refer to methods table | |
| Werribee | Laverton Creek | gap * | Refer to methods table | |
| Werribee | Lerderderg River | potentially declining * | O/E (<B001, B001-B010, >B010) | Low |
| Werribee | Little River Lower | stable * | O/E (<2001, 2001-2010, >2010) | Mod |
| Werribee | Little River Upper | potentially declining * | O/E (<2001, 2001-2010, >2010) | Low |
| Werribee | Lollypop Creek | declining * | O/E (<2001, 2001-2010, >2010) | Mod |
| Werribee | Parwan Creek | gap | Refer to methods table | |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Werribee | Skeleton Creek | stable | O/E (<2001, 2001-2010, >2010) | Mod |
| Werribee | Toolern Creek | gap * | Refer to methods table | |
| Werribee | Werribee River Lower | stable | O/E (<2001, 2001-2010, >2010) | Mod |
| Werribee | Werribee River Middle | stable | O/E (<2001, 2001-2010, >2010) | Mod |
| Werribee | Werribee River Upper | gap | Refer to methods table | |
| Westernport | Bass River | potentially declining * | O/E (<2001, 2001-2010, >2010) | Low |
| Westernport | Bunyip Lower | stable * | O/E (<2001, 2001-2010, >2010) | Mod |
| Westernport | Bunyip River Middle and Upper | stable | O/E (<2001, 2001-2010, >2010) | Mod |
| Westernport | Cardinia, Toomuc, Deep and Ararat | stable * | O/E (<2001, 2001-2010, >2010) | Mod |
| Westernport | Dalmore Outfalls | declining * | O/E (<2001, 2001-2010, >2010) | Mod |
| Westernport | French and Phillip Islands | potentially declining * | O/E (<2001, 2001-2010, >2010) | Low |
| Westernport | King Parrot and Musk Creeks | gap * | O/E (<2001, 2001-2010, >2010) | |
| Westernport | Lang Lang River | gap ** | Refer to methods table | |
| Westernport | Mornington Peninsula North-Eastern Creeks | stable | O/E (<2001, 2001-2010, >2010) | Mod |
| Westernport | Mornington Peninsula South-Eastern Creeks | stable | O/E (<2001, 2001-2010, >2010) | Mod |
| Westernport | Mornington Peninsula Western Creeks | stable | O/E (<2001, 2001-2010, >2010) | Mod |
| Westernport | Tarago River | gap * | Refer to methods table | |
| Yarra | Brushy Creek | stable | O/E (<2001, 2001-2010, >2010) | Mod |
| Yarra | Darebin Creek | declining * | O/E (<2001, 2001-2010, >2010) | Mod |
| Yarra | Diamond Creek (Rural) | potentially declining ** | O/E (<2001, 2001-2010, >2010) | Low |
| Yarra | Diamond Creek (Source) | potentially declining ** | O/E (<2001, 2001-2010, >2010) | Low |
| Yarra | Gardiners Creek | declining ** | O/E (<2001, 2001-2010, >2010) | Mod |
| Yarra | Koonung Creek | potentially declining ** | O/E (<2001, 2001-2010, >2010) | Low |
| Yarra | Little Yarra River and Hoddles Creek | gap * | Refer to methods table | |
| Yarra | Merri Creek Lower | potentially declining * | O/E (<2001, 2001-2010, >2010) | Low |
| Yarra | Merri Creek Upper | potentially declining * | O/E (<2001, 2001-2010, >2010) | Low |
| Yarra | Mullum Mullum Creek | gap ** | Refer to methods table | |
| Yarra | Olinda Creek | stable ** | O/E (<2001, 2001-2010, >2010) | Mod |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Yarra | Plenty River (Source) | potentially declining ** | O/E (<2001, 2001-2010, >2010) | Low |
| Yarra | Plenty River Lower | declining ** | O/E (<2001, 2001-2010, >2010) | Mod |
| Yarra | Plenty River Upper | potentially declining * | O/E (<2001, 2001-2010, >2010) | Low |
| Yarra | Steels and Pauls Creek (Rural) | potentially declining ** | O/E (<2001, 2001-2010, >2010) | Low |
| Yarra | Steels and Pauls Creek (Source) | gap ** | Refer to methods table | |
| Yarra | Stringybark Creek | gap * | Refer to methods table | |
| Yarra | Watsons Creek | stable * | O/E (<2001, 2001-2010, >2010) | Mod |
| Yarra | Watts River (Rural) | potentially declining ** | O/E (<2001, 2001-2010, >2010) | Low |
| Yarra | Watts River (Source) | gap * | Refer to methods table | |
| Yarra | Woori Yallock Creek | stable ** | O/E (<2001, 2001-2010, >2010) | Mod |
| Yarra | Yarra River Lower | stable * | O/E (<2001, 2001-2010, >2010) | Mod |
| Yarra | Yarra River Middle | stable ** | O/E (<2001, 2001-2010, >2010) | Mod |
| Yarra | Yarra River Upper (Rural) | potentially declining * | O/E (<2001, 2001-2010, >2010) | Low |
| Yarra | Yarra River Upper (Source) | potentially declining | O/E (<2001, 2001-2010, >2010) | Low |

# Appendix G - Riparian Birds

*Table 36. Trajectory results for riparian birds for each sub-catchment and data sources used to determine the status.*

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Dandenong | Bayside | declining | 2023 RBI is one category below target | Low |
| Dandenong | Blind Creek | Stable | 2023 RBI is same or greater than the target | Mod |
| Dandenong | Corhanwarrabul, Monbulk and Ferny Creeks | Stable | 2023 RBI is same or greater than the target | Mod |
| Dandenong | Dandenong Creek Lower | Stable | 2023 RBI is same or greater than the target | Mod |
| Dandenong | Dandenong Creek Middle | Stable | 2023 RBI is same or greater than the target | Mod |
| Dandenong | Dandenong Creek Upper | Stable | 2023 RBI is same or greater than the target | Mod |
| Dandenong | Eumemmerring Creek | declining | 2023 RBI is one category below target | Low |
| Dandenong | Kananook Creek | Stable | 2023 RBI is same or greater than the target | Mod |
| Maribyrnong | Boyd Creek | Gap | | |
| Maribyrnong | Deep Creek Lower | Gap | | |
| Maribyrnong | Deep Creek Upper | Stable | 2023 RBI is same or greater than the target | Mod |
| Maribyrnong | Emu Creek | Gap | | |
| Maribyrnong | Jacksons Creek | Stable | 2023 RBI is same or greater than the target | Mod |
| Maribyrnong | Maribyrnong River | Stable | 2023 RBI is same or greater than the target | Mod |
| Maribyrnong | Moonee Ponds Creek | Stable | 2023 RBI is same or greater than the target | Mod |
| Maribyrnong | Steele Creek | Gap | | |
| Maribyrnong | Stony Creek | Gap | | |
| Maribyrnong | Taylors Creek | Gap | | |
| Werribee | Cherry Creek | Gap | | |
| Werribee | Kororoit Creek Lower | Stable | 2023 RBI is same or greater than the target | Mod |
| Werribee | Kororoit Creek Upper | Gap | | |
| Werribee | Laverton Creek | Stable | 2023 RBI is same or greater than the target | Mod |
| Werribee | Lerderderg River | Gap | | |
| Werribee | Little River Lower | Stable | 2023 RBI is same or greater than the target | Mod |
| Werribee | Little River Upper | Stable | 2023 RBI is same or greater than the target | Mod |
| Werribee | Lollypop Creek | Stable | 2023 RBI is same or greater than the target | Mod |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Werribee | Parwan Creek | Stable | 2023 RBI is same or greater than the target | Mod |
| Werribee | Skeleton Creek | Stable | 2023 RBI is same or greater than the target | Mod |
| Werribee | Toolern Creek | Stable | 2023 RBI is same or greater than the target | Mod |
| Werribee | Werribee River Lower | Stable | 2023 RBI is same or greater than the target | Mod |
| Werribee | Werribee River Middle | Stable | 2023 RBI is same or greater than the target | Mod |
| Werribee | Werribee River Upper | Gap | | |
| Westernport | Bass River | Gap | | |
| Westernport | Bunyip Lower | Gap | | |
| Westernport | Bunyip River Middle and Upper | declining | 2023 RBI is one category below target | Low |
| Westernport | Cardinia, Toomuc, Deep and Ararat | Stable | 2023 RBI is same or greater than the target | Mod |
| Westernport | Dalmore Outfalls | Stable | 2023 RBI is same or greater than the target | Mod |
| Westernport | French and Phillip Islands | declining | 2023 RBI is one category below target | Low |
| Westernport | King Parrot and Musk Creeks | Gap | | |
| Westernport | Lang Lang River | Gap | | |
| Westernport | Mornington Peninsula North-Eastern Creeks | Gap | | |
| Westernport | Mornington Peninsula South-Eastern Creeks | declining | 2023 RBI is one category below target | Low |
| Westernport | Mornington Peninsula Western Creeks | Stable | 2023 RBI is same or greater than the target | Mod |
| Westernport | Tarago River | Gap | | |
| Yarra | Brushy Creek | Gap | | |
| Yarra | Darebin Creek | Stable | 2023 RBI is same or greater than the target | Mod |
| Yarra | Diamond Creek (Rural) | Stable | 2023 RBI is same or greater than the target | Mod |
| Yarra | Diamond Creek (Source) | Gap | | |
| Yarra | Gardiners Creek | declining | 2023 RBI is one category below target | Low |
| Yarra | Koonung Creek | Stable | 2023 RBI is same or greater than the target | |
| Yarra | Little Yarra River and Hoddles Creek | Gap | | |
| Yarra | Merri Creek Lower | Stable | 2023 RBI is same or greater than the target | Mod |
| Yarra | Merri Creek Upper | Stable | 2023 RBI is same or greater than the target | Mod |
| Yarra | Mullum Mullum Creek | Stable | 2023 RBI is same or greater than the target | Mod |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Yarra | Olinda Creek | Stable | 2023 RBI is same or greater than the target | Mod |
| Yarra | Plenty River (Source) | Gap | | |
| Yarra | Plenty River Lower | Stable | 2023 RBI is same or greater than the target | Mod |
| Yarra | Plenty River Upper | Stable | 2023 RBI is same or greater than the target | Mod |
| Yarra | Steels and Pauls Creek (Rural) | Gap | | |
| Yarra | Steels and Pauls Creek (Source) | Gap | | |
| Yarra | Stringybark Creek | Gap | | |
| Yarra | Watsons Creek | declining | 2023 RBI is one category below target | Low |
| Yarra | Watts River (Rural) | Stable | 2023 RBI is same or greater than the target | Mod |
| Yarra | Watts River (Source) | declining | 2023 RBI is one category below target | Low |
| Yarra | Woori Yallock Creek | Stable | 2023 RBI is same or greater than the target | Mod |
| Yarra | Yarra River Lower | Stable | 2023 RBI is same or greater than the target | Mod |
| Yarra | Yarra River Middle | Stable | 2023 RBI is same or greater than the target | Mod |
| Yarra | Yarra River Upper (Rural) | Stable | 2023 RBI is same or greater than the target | Mod |
| Yarra | Yarra River Upper (Source) | Gap | | |

# Appendix H – Wetland birds

Trajectory assessment for wetland fish is presented in Table 37.

*Table 37. Trajectory results for wetland birds for each sub-catchment and the data sources used to determine the status.*

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Dandenong | Bayside | n/a | No targets for wetland birds | |
| Dandenong | Blind Creek | n/a | No targets for wetland birds | |
| Dandenong | Corhanwarrabul, Monbulk and Ferny Creeks | Gap | | |
| Dandenong | Dandenong Creek Lower | Stable | 2022 WBI => baseline in 50% of WLs<br>67% wetlands could be assessed | Low |
| Dandenong | Dandenong Creek Middle | Stable | 2022 WBI => baseline in 50% of WLs<br>100% wetlands could be assessed | Mod |
| Dandenong | Dandenong Creek Upper | n/a | No targets for wetland birds | |
| Dandenong | Eumemmerring Creek | Gap | | |
| Dandenong | Kananook Creek | declining | 2022 WBI < baseline in 50% of WLs<br>67% wetlands could be assessed | Low |
| Maribyrnong | Boyd Creek | n/a | No targets for wetland birds | |
| Maribyrnong | Deep Creek Lower | n/a | No targets for wetland birds | |
| Maribyrnong | Deep Creek Upper | n/a | No targets for wetland birds | |
| Maribyrnong | Emu Creek | n/a | No targets for wetland birds | |
| Maribyrnong | Jacksons Creek | Gap | | |
| Maribyrnong | Maribyrnong River | Gap | | |
| Maribyrnong | Moonee Ponds Creek | Gap | | |
| Maribyrnong | Steele Creek | n/a | No targets for wetland birds | |
| Maribyrnong | Stony Creek | n/a | No targets for wetland birds | |
| Maribyrnong | Taylors Creek | n/a | No targets for wetland birds | |
| Werribee | Cherry Creek | Gap | | |
| Werribee | Kororoit Creek Lower | Gap | | |
| Werribee | Kororoit Creek Upper | Gap | | |
| Werribee | Laverton Creek | declining | 2022 WBI < baseline in 50% of WLs<br>50% wetlands could be assessed | Low |
| Werribee | Lerderderg River | n/a | No targets for wetland birds | |
| Werribee | Little River Lower | Gap | | |
| Werribee | Little River Upper | Gap | | |
| Werribee | Lollypop Creek | Gap | | |
| Werribee | Parwan Creek | Gap | | |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Werribee | Skeleton Creek | Gap | | |
| Werribee | Toolern Creek | n/a | No targets for wetland birds | |
| Werribee | Werribee River Lower | Gap | | |
| Werribee | Werribee River Middle | n/a | No targets for wetland birds | |
| Werribee | Werribee River Upper | n/a | No targets for wetland birds | |
| Westernport | Bass River | n/a | No targets for wetland birds | |
| Westernport | Bunyip Lower | Gap | | |
| Westernport | Bunyip River Middle and Upper | n/a | No targets for wetland birds | |
| Westernport | Cardinia, Toomuc, Deep and Ararat | Gap | | |
| Westernport | Dalmore Outfalls | n/a | No targets for wetland birds | |
| Westernport | French and Phillip Islands | n/a | No targets for wetland birds | |
| Westernport | King Parrot and Musk Creeks | n/a | No targets for wetland birds | |
| Westernport | Lang Lang River | Gap | | |
| Westernport | Mornington Peninsula North-Eastern Creeks | n/a | No targets for wetland birds | |
| Westernport | Mornington Peninsula South-Eastern Creeks | Gap | 1 WL in the SC and is on-track and hence stable. Unclear why it was rated as a gap.<br>50% wetlands could be assessed | Low |
| Westernport | Mornington Peninsula Western Creeks | Gap | | |
| Westernport | Tarago River | n/a | No targets for wetland birds | |
| Yarra | Brushy Creek | n/a | No targets for wetland birds | |
| Yarra | Darebin Creek | n/a | No targets for wetland birds | |
| Yarra | Diamond Creek (Rural) | n/a | No targets for wetland birds | |
| Yarra | Diamond Creek (Source) | n/a | No targets for wetland birds | |
| Yarra | Gardiners Creek | n/a | No targets for wetland birds | |
| Yarra | Koonung Creek | n/a | No targets for wetland birds | |
| Yarra | Little Yarra River and Hoddles Creek | n/a | No targets for wetland birds | |
| Yarra | Merri Creek Lower | Gap | | |
| Yarra | Merri Creek Upper | Gap | | |
| Yarra | Mullum Mullum Creek | Stable | 2022 WBI => baseline in 50% of WLs<br>100% wetlands could be assessed | Mod |
| Yarra | Olinda Creek | Stable | 2022 WBI => baseline in 50% of WLs<br>100% wetlands could be assessed | Mod |
| Yarra | Plenty River (Source) | n/a | No targets for wetland birds | |
| Yarra | Plenty River Lower | n/a | No targets for wetland birds | |

| Catchment | Sub-catchment | Trajectory status | Evidence | Confidence |
|---|---|---|---|---|
| Yarra | Plenty River Upper | Gap | | |
| Yarra | Steels and Pauls Creek (Rural) | n/a | No targets for wetland birds | |
| Yarra | Steels and Pauls Creek (Source) | n/a | No targets for wetland birds | |
| Yarra | Stringybark Creek | n/a | No targets for wetland birds | |
| Yarra | Watsons Creek | n/a | No targets for wetland birds | |
| Yarra | Watts River (Rural) | n/a | No targets for wetland birds | |
| Yarra | Watts River (Source) | n/a | No targets for wetland birds | |
| Yarra | Woori Yallock Creek | n/a | No targets for wetland birds | |
| Yarra | Yarra River Lower | Gap | | |
| Yarra | Yarra River Middle | Gap | | |
| Yarra | Yarra River Upper (Rural) | Gap | | |
| Yarra | Yarra River Upper (Source) | n/a | No targets for wetland birds | |

# Appendix I – summary table of focus sub-catchments including MDVs, MSVs, CCS, CCV

| Catchment | Sub-catchment | MDVs | MSVs | CCV | CCS | Group |
|---|---|---|---|---|---|---|
| Yarra | Diamond Creek (Source) | | | × | | A |
| Yarra | Little Yarra River and Hoddles Creek | | × | | | A |
| Yarra | Olinda Creek | | × | | | A |
| Yarra | Plenty River (Source) | | | × | × | A |
| Yarra | Plenty River Upper | | | × | | A |
| Yarra | Steels and Pauls Creek (Source) | | × | × | | A |
| Yarra | Watsons Creek | | | | × | A |
| Yarra | Watts River (Rural) | | | × | × | A |
| Yarra | Watts River (Source) | | | × | × | A |
| Yarra | Woori Yallock Creek | × | | × | × | A |
| Yarra | Yarra River Lower | × | | | | A |
| Yarra | Yarra River Middle | | × | | × | A |
| Yarra | Yarra River Upper (Rural) | | | × | × | A |
| Yarra | Yarra River Upper (Source) | | | × | × | A |
| Yarra | Darebin Creek | × | | | | B |
| Yarra | Gardiners Creek | × | | | | B |
| Yarra | Mullum Mullum Creek | | × | | | B |
| Werribee | Lerderderg River | | | × | × | A |
| Werribee | Werribee River Lower | × | | | | A |
| Werribee | Werribee River Middle | × | | × | | A |
| Werribee | Werribee River Upper | | | × | × | A |
| Werribee | Kororoit Creek Upper | | × | | | B |
| Werribee | Parwan Creek | | × | | | B |
| Werribee | Skeleton Creek | | × | | | B |
| Maribyrnong | Deep Creek Upper | × | | × | | A |
| Maribyrnong | Emu Creek | × | | | | A |
| Maribyrnong | Jacksons Creek | × | | | | A |
| Maribyrnong | Maribyrnong River | × | | | | A |
| Maribyrnong | Moonee Ponds Creek | | × | | | B |
| Maribyrnong | Taylors Creek | | × | | | B |
| Maribyrnong | Boyd Creek | | × | × | | B |
| Dandenong | Corhanwarrabul, Monbulk and Ferny Creeks | | × | | × | A |
| Dandenong | Dandenong Creek Upper | | × | | × | A |
| Dandenong | Blind Creek | | × | | | B |
| Dandenong | Dandenong Creek Lower | | × | | | B |
| Dandenong | Dandenong Creek Middle | | × | | | B |
| Westernport | Bunyip River Middle and Upper | | | × | × | A |
| Westernport | Cardinia, Toomuc, Deep and Ararat | × | | | | A |
| Westernport | Lang Lang River | × | | × | | A |
| Westernport | Mornington Peninsula South-Eastern Creeks | × | | | | A |
| Westernport | Tarago River | × | | | × | A |
| Westernport | Bass River | | | × | | A |
| Westernport | Bunyip Lower | × | | | | B |

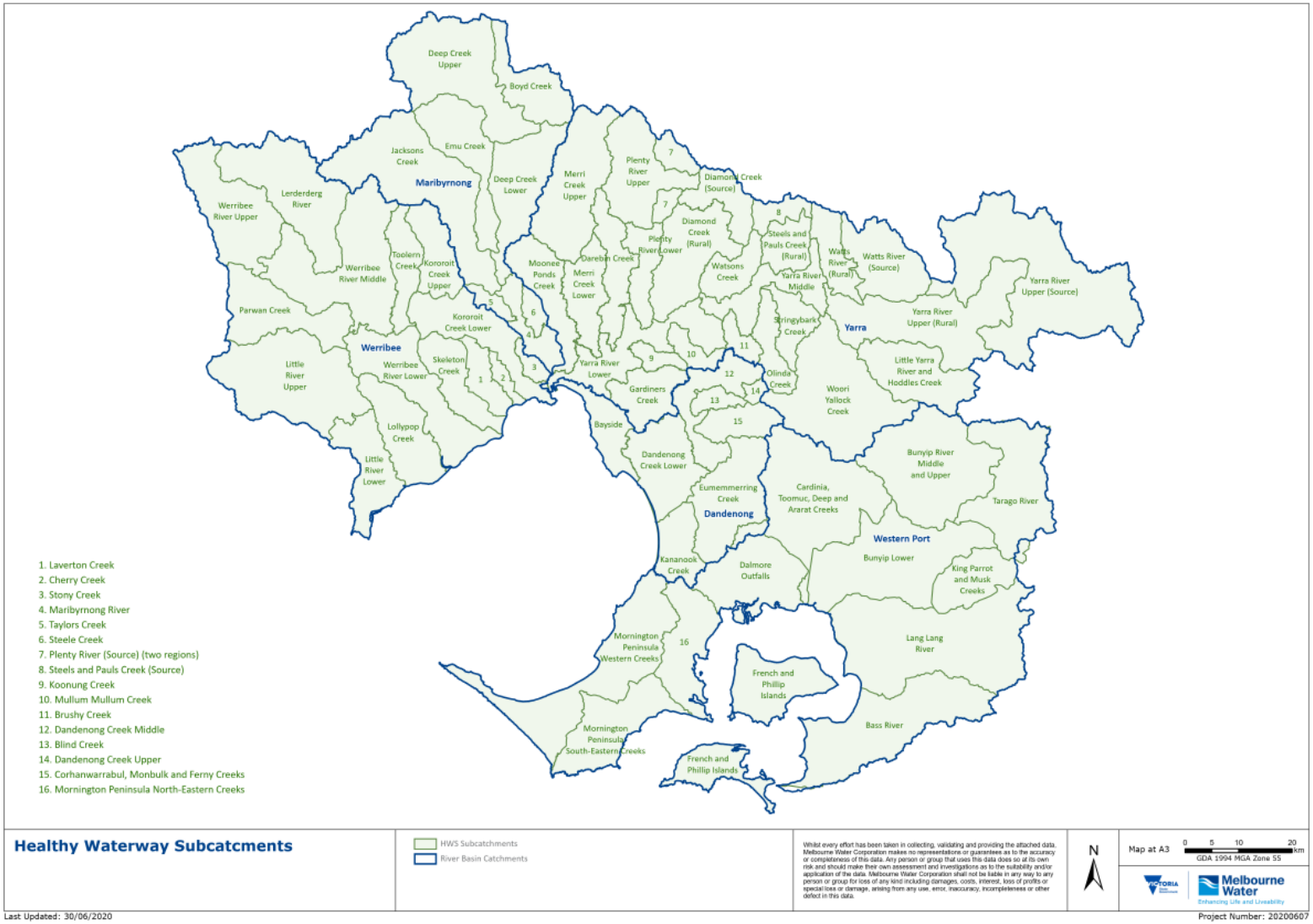
| Catchment | Sub-catchment | MDVs | MSVs | CCV | CCS | Group |
|---|---|---|---|---|---|---|
| Westernport | King Parrot and Musk Creeks | × | | × | | B |
| Westernport | Mornington Peninsula North-Eastern Creeks | | × | | | B |
| Westernport | Mornington Peninsula Western Creeks | | × | | | B |

# Appendix J - Associations between values, conditions and threats

*Table 38 Association between values and threats as documented in the threats paper. Bolded threats relate to bolded conditions which are strong relationships (with high or moderate confidence) as per the HWS conceptual models outlined in the Threats Paper (Melbourne Water 2022).*

| Key value | Conditions (priority) | Threats (priority) |
|---|---|---|
| Macroinvertebrates | **Physical form, Water quality**, **Water regime, Vegetation extent** | **Urbanisation (flow impacts), Urbanisation (water quality)**, Physical modifications, wastewater, recreational access (in forested areas), pest animals, **vegetation clearing, water extraction**, agriculture. |
| Platypus | Water quality, Macroinvertebrates, **Water regime**, **Vegetation extent**, **Physical form** | **Urbanisation (flow impacts),** Urbanisation (water quality), Physical modifications, Wastewater, **entrapment**, barriers, recreational access, **pest animal (stock)**, vegetation clearing, **water extraction and farm dams**, agriculture. |
| Birds | **Vegetation extent, vegetation quality**, **Water regime**, **Physical form**, Water quality, Pest animals | **Urbanisation (flow impacts),** Urbanisation (water quality), **Water extraction**, Physical modifications, litter, recreational access, **pest plants and animals (predators, stock)**, **vegetation clearing.** |
| Vegetation | **Physical form**, water quality, water regime | **Urbanisation (flow impacts),** Urbanisation (water quality), **Physical modifications**, wastewater, **recreational access**, **pest animals (stock, deer), vegetation clearing, water extraction**, agriculture, pest plants. |
| Fish | **Water regime, water quality,** physical form, **Vegetation extent**, **Connectivity of habitat** | **Urbanisation (flow regime), Urbanisation (Water quality),** Physical modifications, sewerage, **barriers**, pest animals (stock access), vegetation clearing, **water extraction**, agriculture. |
| Frogs | Vegetation extent, vegetation quality, **wetland water regime**, wetland habitat form, wetland buffer condition, water quality**, Pest animal, Disease, Connectivity of habitat** | **Urbanisation (flow impacts),** Urbanisation (water quality), Physical modifications, pest animals (deer), vegetation clearing, **water extraction**, agriculture. |

# Appendix K - Sub-catchment reference map



# Appendix L - Focus sub-catchments showing the HWS baseline conditions and key values for rivers.

| Catchment | Sub-catchment | Group | connectivity | physical form | stormwater | veg extent | veg Q | eflows | WQ | birds | fish | frogs | bugs | platypus | veg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dandenong | Blind Creek | B | Very low | High | Very low | Moderate | Low | Low | Very low | Moderate | Very low | Very low | Very low | Not applicable | Low |
| Dandenong | Corhanwarrabul, Monbulk and Ferny Creeks | A | Low | Moderate | Very low | Moderate | Low | High | Very low | Moderate | Low | High | Low | Moderate | Low |
| Dandenong | Dandenong Creek Lower | B | Moderate | High | Very low | Very low | Very low | Low | Very low | Moderate | Low | Very low | Very low | Very low | Low |
| Dandenong | Dandenong Creek Middle | B | Low | High | Very low | Moderate | Low | Very low | Very low | Moderate | Low | High | Very low | Very low | Low |
| Dandenong | Dandenong Creek Upper | A | Moderate | High | High | High | Low | High | High | No data | Low | High | Very high | Low | Moderate |
| Maribyrnong | Boyd Creek | B | Moderate | Moderate | Very high | Very low | Low | Very high | Moderate | No data | Low | No data | Moderate | Low | Low |
| Maribyrnong | Deep Creek Upper | A | Low | Low | Very high | Low | Moderate | Low | Moderate | Moderate | Low | Low | Moderate | Moderate | Low |
| Maribyrnong | Emu Creek | A | Very low | Moderate | Very high | Low | Low | High | Moderate | No data | Low | High | Moderate | Moderate | Low |
| Maribyrnong | Jacksons Creek | A | Very low | Moderate | High | Moderate | Moderate | Low | Moderate | Moderate | Very low | Very low | Moderate | Moderate | Low |
| Maribyrnong | Maribyrnong River | A | Moderate | High | Moderate | Low | Low | Moderate | Moderate | Moderate | Moderate | Very low | Low | Very low | Low |
| Maribyrnong | Moonee Ponds Creek | B | Low | Moderate | Low | Very low | Low | Low | Low | Moderate | Low | Low | Low | Very low | Low |
| Maribyrnong | Taylors Creek | B | Low | High | Very low | Very low | Low | Low | Very low | No data | Low | Moderate | Very low | Very low | Low |
| Werribee | Kororoit Creek Upper | B | Low | Moderate | High | Very low | Very low | Very high | Moderate | No data | Very low | High | Low | No data | Low |
| Werribee | Lerderderg River | A | Very low | Very high | Very high | Very high | High | Very high | Very high | No data | Low | Very high | Very high | Low | High |
| Werribee | Parwan Creek | B | Moderate | Very low | Very high | Very low | Very low | High | Moderate | No data | Very low | High | Moderate | Low | Low |
| Werribee | Skeleton Creek | B | Low | Moderate | Low | Very low | Low | High | Moderate | Moderate | Low | Low | Low | No data | Low |
| Werribee | Werribee River Lower | A | Low | Moderate | Moderate | Low | Low | Very low | Moderate | Moderate | Low | Moderate | Low | Low | Low |
| Werribee | Werribee River Middle | A | Very low | Moderate | High | Moderate | Moderate | Moderate | Moderate | No data | Very low | Moderate | High | Low | Moderate |
| Werribee | Werribee River Upper | A | Very low | High | Very high | High | Moderate | Very high | Moderate | No data | Low | Moderate | Very high | Moderate | Moderate |
| Westernport | Bass River | A | Moderate | Moderate | Very high | Low | Low | Very high | Low | No data | Low | No data | Moderate | Very low | Low |
| Westernport | Bunyip Lower | B | High | High | Very high | Low | Low | Very high | Low | No data | Moderate | Moderate | Moderate | Moderate | Low |
| Westernport | Bunyip River Middle and Upper | A | Low | Moderate | Very high | High | High | High | High | Moderate | Moderate | Moderate | Very high | High | Moderate |
| Westernport | Cardinia, Toomuc, Deep and Ararat | A | Moderate | Moderate | Moderate | Moderate | Low | High | Low | Moderate | Low | Moderate | Moderate | Moderate | Low |
| Westernport | King Parrot and Musk Creeks | B | Moderate | Moderate | Very high | Low | Low | High | Low | No data | Low | Very low | Moderate | Low | Low |

| Catchment | Sub-catchment | Group | connectivity | physical form | stormwater | veg extent | veg Q | eflows | WQ | birds | fish | frogs | bugs | platypus | veg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Westernport | Lang Lang River | A | Moderate | Low | Very high | Low | Low | High | Low | No data | Low | No data | Moderate | Low | Low |
| Westernport | Mornington Peninsula North-Eastern Creeks | B | Very high | High | Low | Low | Very low | High | Very low | Moderate | Low | Very high | Low | No data | Low |
| Westernport | Mornington Peninsula South-Eastern Creeks | A | Moderate | Moderate | Very high | Moderate | Low | High | Low | High | Moderate | High | Moderate | No data | Low |
| Westernport | Mornington Peninsula Western Creeks | B | High | Low | Low | Moderate | Low | High | Very low | Moderate | Low | Very high | Low | No data | Low |
| Westernport | Tarago River | A | Moderate | Moderate | Very high | Moderate | Moderate | Moderate | High | No data | Moderate | Very high | Very high | High | Moderate |
| Yarra | Darebin Creek | B | Low | High | Low | Very low | Low | High | Very low | Moderate | Very low | Very low | Low | Very low | Low |
| Yarra | Diamond Creek (Source) | A | Low | Very high | Very high | Very high | High | Very high | High | No data | Low | Moderate | Very high | Low | Moderate |
| Yarra | Gardiners Creek | B | Very low | High | Very low | Moderate | Low | Low | Very low | Moderate | Low | Moderate | Very low | Very low | Low |
| Yarra | Little Yarra River and Hoddles Creek | A | Moderate | High | Very high | Very high | High | High | High | No data | Moderate | High | Very high | High | Moderate |
| Yarra | Mullum Mullum Creek | B | High | Low | Very low | High | Moderate | Low | Very low | Moderate | Low | Moderate | Very low | Very low | Moderate |
| Yarra | Olinda Creek | A | Moderate | High | High | High | Low | Moderate | Moderate | Low | Low | Very low | Moderate | Moderate | Moderate |
| Yarra | Plenty River (Source) | A | Moderate | Very high | Very high | Very high | Very high | Moderate | High | No data | Low | Very high | Very high | Moderate | High |
| Yarra | Plenty River Upper | A | Very low | Moderate | Very high | Moderate | Moderate | High | Moderate | Low | Low | Low | High | Low | Moderate |
| Yarra | Steels and Pauls Creek (Source) | A | Moderate | Very high | Very high | Very high | High | High | Very high | No data | Low | Very high | Very high | Very low | High |
| Yarra | Watsons Creek | A | High | High | Very high | Very high | High | High | Moderate | Very high | Moderate | Very high | Very high | Very low | Moderate |
| Yarra | Watts River (Rural) | A | Moderate | Moderate | Very high | High | Moderate | High | Moderate | No data | Moderate | Moderate | Very high | Moderate | Moderate |
| Yarra | Watts River (Source) | A | Moderate | Very high | Very high | Very high | Very high | High | Very high | No data | Low | No data | Very high | Very high | High |
| Yarra | Woori Yallock Creek | A | Moderate | Moderate | Very high | High | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate | Very high | High | Moderate |
| Yarra | Yarra River Lower | A | Very high | High | Low | Moderate | Moderate | Moderate | Very low | Moderate | Moderate | Moderate | Low | Moderate | Low |
| Yarra | Yarra River Middle | A | Very high | High | High | Moderate | Low | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate | High | Moderate |
| Yarra | Yarra River Upper (Rural) | A | Moderate | High | Very high | High | Moderate | Moderate | High | Moderate | Moderate | Very low | Very high | High | Moderate |
| Yarra | Yarra River Upper (Source) | A | Moderate | High | Very high | High | Moderate | Moderate | High | No data | Low | No data | Very high | Very high | High |

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# More Information

Healthy Waterways Strategy

Access the Mid-term Review Summary Report >>
Access the Mid-term Review Science Inquiry Report >>
Access the Implementation Inquiry Report >>

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