2023 Freshwater Report Card – Technical Report

Tamar Estuary and Esk Rivers Program

June 2023

Document Information

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Person Responsible	Darren McPhee, TEER Program Manager

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2						

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Contents

Introduction

This technical report provides background to the calculation of grades for the 2023 Tamar Estuary and Esk Rivers (TEER) Program 2023 Freshwater Report Card. This report focuses on the available datasets used and other background information that collectively provides context to the reporting period. The methodology used to derive grades is described in detail in 2023 Freshwater Report Card - Methodology Report, available at http://www.teer.org.au/freshwaterreportcard. The 2023 Freshwater Report Card presents a snapshot of freshwater ecosystem health throughout the kanamaluka / Tamar estuary and Esk rivers catchment for the period 1 July 2018 to 30 June 2022. The TEER 2023 Freshwater Report Card is designed for a general community audience, while this accompanying technical report is intended to supplement the report card with additional detail of interest to technical readers.

This report first describes the broad geography of the Tamar estuary and Esk rivers catchment and sub-catchments, then outlines additional information on the reporting zones used in the report card. Key environmental features influencing freshwater ecosystem health, including indicators of climate and flow regime, are described for the reporting period associated with the report card. Datasets used to calculate the ecosystem health index (EHI) values that derive report card grades for the three ecosystem health components – aquatic habitat, aquatic life and riparian habitat – are then outlined. The report concludes with the final grades for each reporting zone and key findings for the reporting period.

While the TEER Program released a Freshwater Report Card in 2013, there have been significant changes to the methodology and datasets used for the 2023 Freshwater Report Card such that the two are not comparable. It is expected that future report cards will be released every four years and that the 2023 report card reporting framework will be used to develop future report cards, although changes to methodology and datasets used may occur as new and/or improved data become available.

1 The kanamaluka / Tamar estuary and Esk rivers catchment

The kanamaluka / Tamar estuary and Esk rivers catchment is the largest catchment in Tasmania, covering nearly 15% of Tasmania's landmass (Figure 1). The North and South Esk rivers drain into the kanamaluka / Tamar estuary, which extends approximately 70 km from Launceston to Bass Strait. The region sustains a diverse range of land uses including grazing, dairy, cropping, plantation and native forestry, mining, heavy industry, urban, rural residential and nature conservation areas. Launceston is a major urban centre in the catchment, with a population of around 90,000 people. The region provides substantial input to Tasmania's economy as well as sustaining key ecological assets and communities.

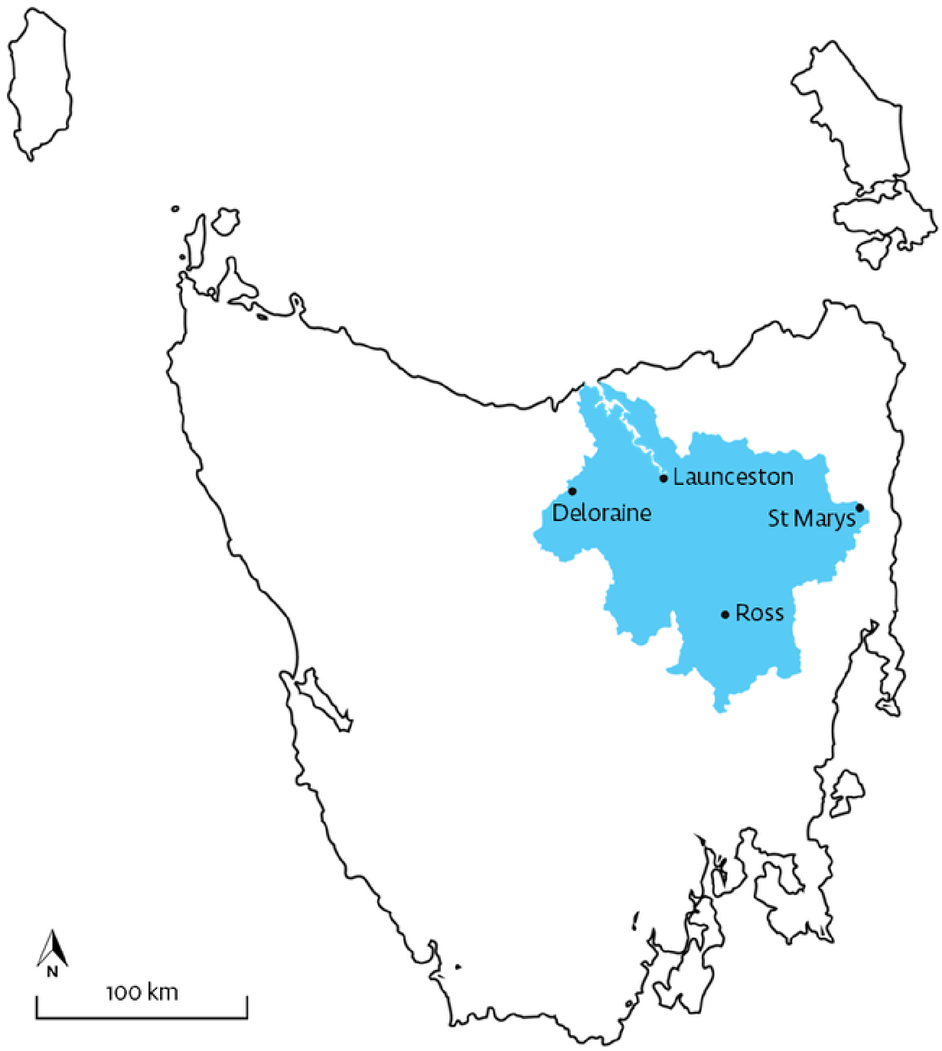

Figure 1. Location of the kanamaluka / Tamar estuary and Esk rivers catchment.

The North Esk River enters the kanamaluka / Tamar estuary at Launceston, with 13 km of the lower North Esk below the weir at Johnston Road, St Leonards, having tidal influence. The South Esk River enters the estuary through the Cataract Gorge, downstream of Lake Trevallyn. This river is fed by four major tributaries – the Meander River, Macquarie River, Brumbys Creek, and Lake River. Major sub-catchments of the broader kanamaluka / Tamar estuary and Esk rivers catchment are shown in Figure 2 and the area of each of these sub-catchments is summarised in Table 1. The total area of the catchment is over 11,000km^2, with the sub-catchment of the South Esk River and its tributaries draining over 9,000km^2.

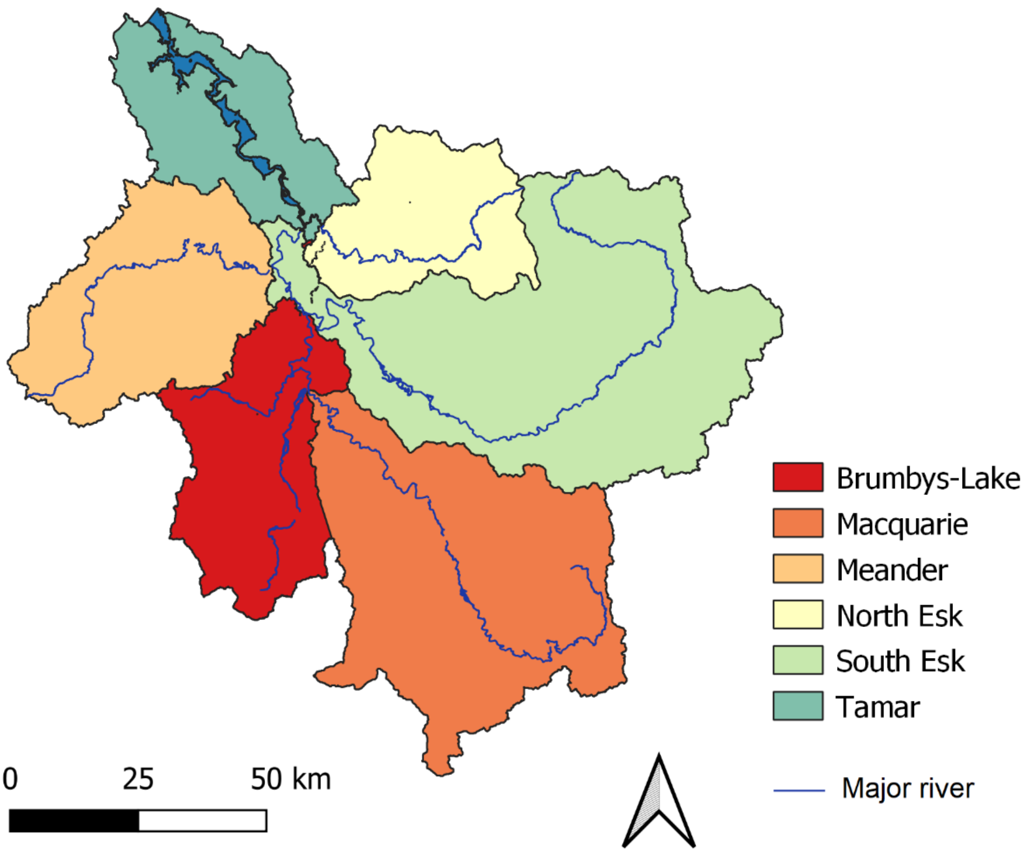

Figure 2. Major sub-catchments of the kanamaluka / Tamar estuary and Esk rivers catchment.

Table 1. Area of major sub-catchments of the kanamaluka / Tamar estuary and Esk rivers catchment (km²).

Sub-catchment	Area (km^2)
Brumbys-Lake	1,370
Macquarie	2,737
Meander	1,568
North Esk	1,052
South Esk	3,617
Tamar	1,035
Total	11,379

2 Freshwater Report Card zones

The 10 zones for which Freshwater Report Card grades were calculated are shown in Figure 3. The zoning splits the kanamaluka / Tamar estuary and Esk rivers catchment into upland and lowland sections of the Brumbys-Lake, Macquarie, Meander and South Esk sub-catchments, with another zone covering Launceston's urban area (part of the North Esk sub-catchment) and the remaining zone covering the remainder of the North Esk sub-catchment. No grades were calculated for the Tamar estuary sub-catchment area (shown in grey in Figure 3), due to unavailability of suitable data.

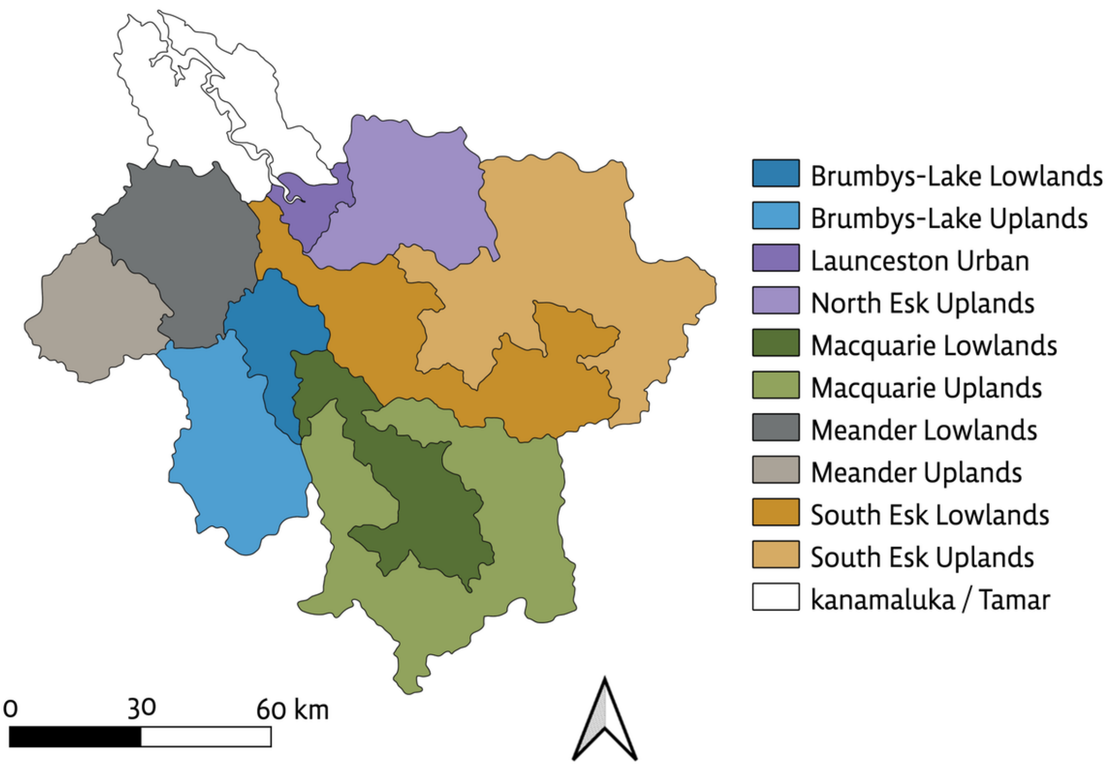

Figure 3. Spatial scales for reporting in the TEER Freshwater Report Card.

3 Reporting period

This section describes key features of the reporting period (July 2018 - June 2022) in terms of climate and flow regime. While climate and flow regime are important environmental factors for freshwater ecosystem health, they were not used to derive grades for the 2023 Freshwater Report Card. Natural variability in these environmental parameters can have a significant impact on freshwater ecosystem health, particularly on water quality and aquatic life. Climate and flow vary naturally across the catchment and across years. There may also be longer-term trends in climate attributable to human-induced climate change that will continue to drive shifts in natural systems into the future.

3.1 Rainfall

Figure 4 shows total rainfall across Tasmania during the reporting period. Rainfall varied across the catchment, ranging from 1600-2400 mm near Ross to 4800-6000 mm to the east of Launceston. The central parts of the catchment received 2400-3600 mm of rainfall over the reporting period.

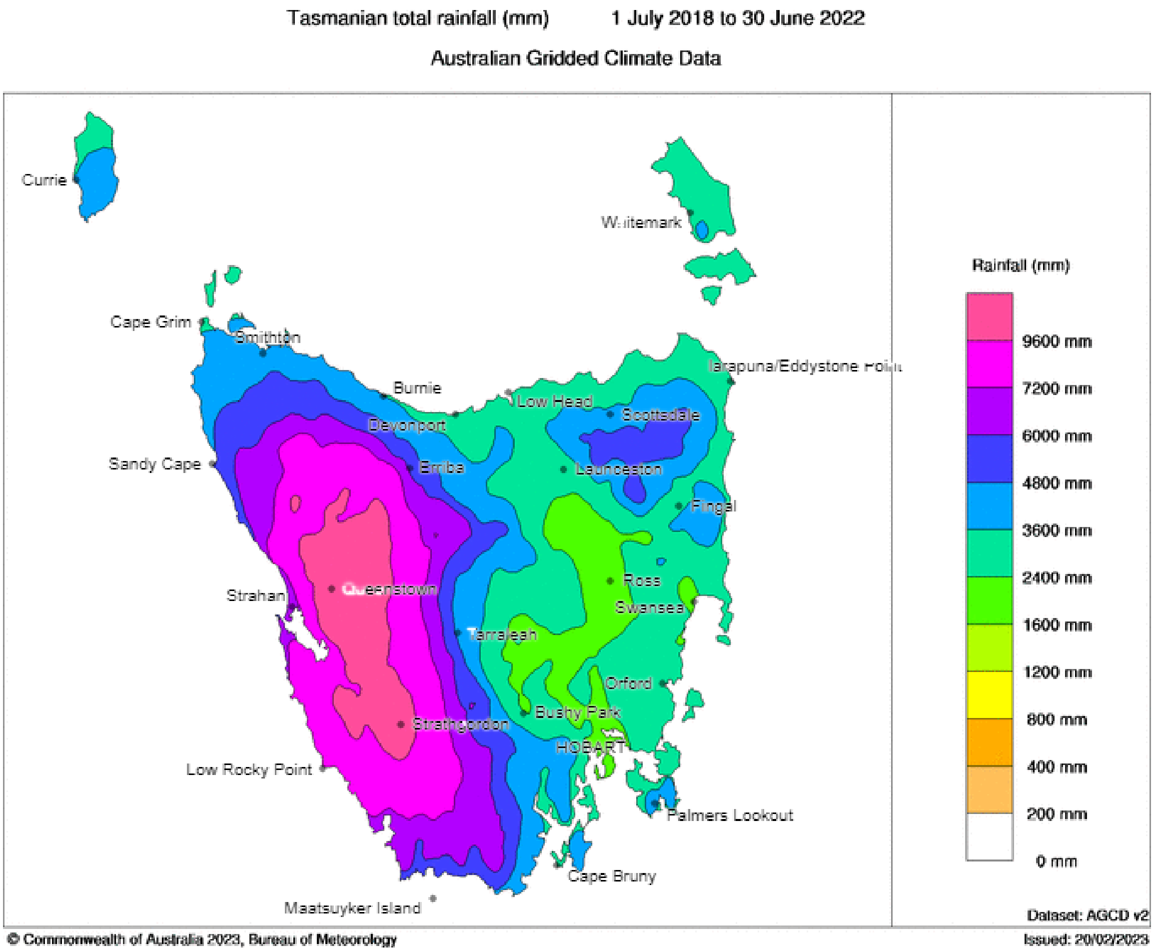

Figure 4. Total rainfall over the reporting period (1 July 2018 to 30 June 2022). Source: Bureau of Meteorology.

Figure 5 compares rainfall across Tasmania over the four-fiscal-year reporting period against comparable long-term rainfall data recorded between 1900 and 2022. This shows that rainfall over the reporting period spatially varied from very much below average south-west of Launceston, to below average for much of the central part of the catchment, to average towards Ross and to the east of Launceston. Overall, the reporting period in the kanamaluka / Tamar estuary and Esk rivers catchment was drier than the long-term average. This reflects the generally drier conditions seen across much of southern Australia through much of that period. Decreased average annual rainfall with increased frequency and intensity of extreme rainfall events are expected in the catchment in the future due to the effects of climate change (Remenyi *et al.*, 2020).

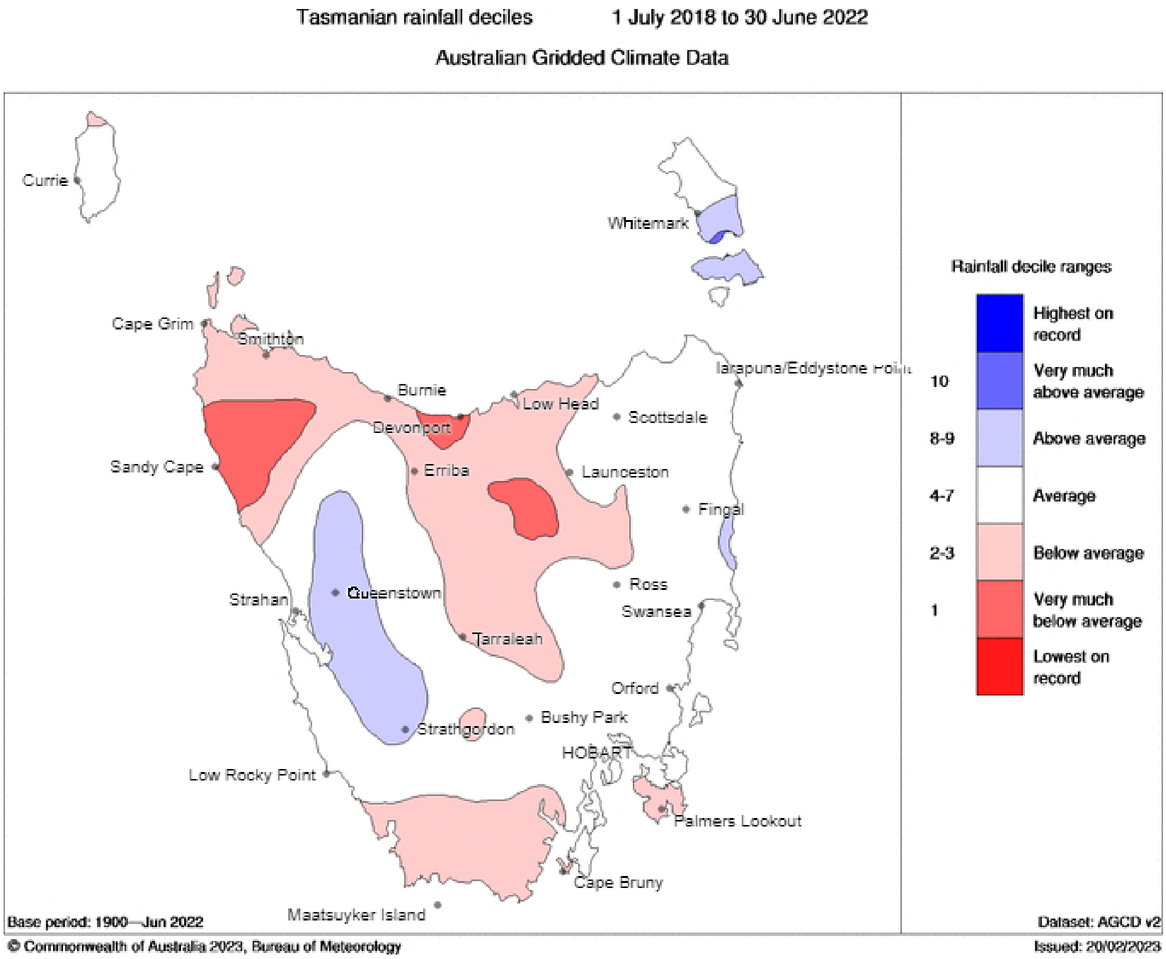

Figure 5. Comparison of rainfall over the reporting period (1 July 2018 to 30 June 2022) with long-term rainfall (1900-Jun 2022). Source: Bureau of Meteorology.

Figure 6 shows the differences in rainfall between years during the reporting period. While Figure 5 shows that overall cumulative rainfall over the four-year reporting period was either below or very much below average across most of the catchment, rainfall patterns between years are variable. 2018/19 and 2019/20 were both average to dry years across the catchment, while 2021/22 was above average to average across the catchment. There was considerable spatial variation in 2020/21 with western parts of the catchment having below average rainfall while eastern parts tended to have above average rainfall.

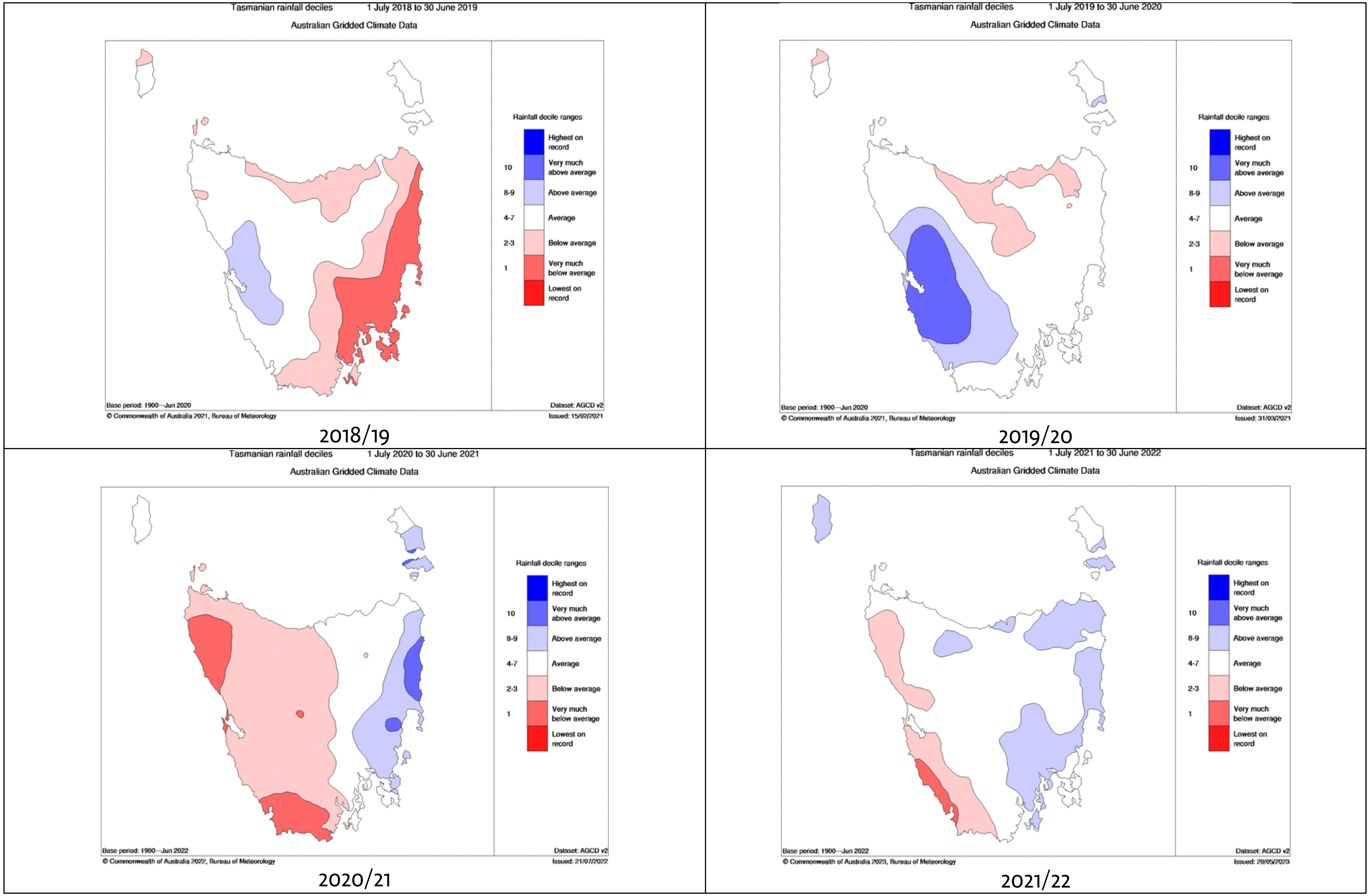

Figure 6. Comparison of rainfall over the reporting period (July 2018 to June 2022) with historic data. Source: Bureau of Meteorology.

3.2 Temperature

Figure 7 compares maximum temperatures across Tasmania for each fiscal year of the reporting period against comparable historic maximum temperature records (1900-2022). This shows that all four reporting years experienced generally higher maximum temperatures in the context of historic maximum temperature records, with areas in the catchment experiencing the highest temperatures (very much above average) in 2018/19, while in other years most areas of the catchment rated as ‘above average’.

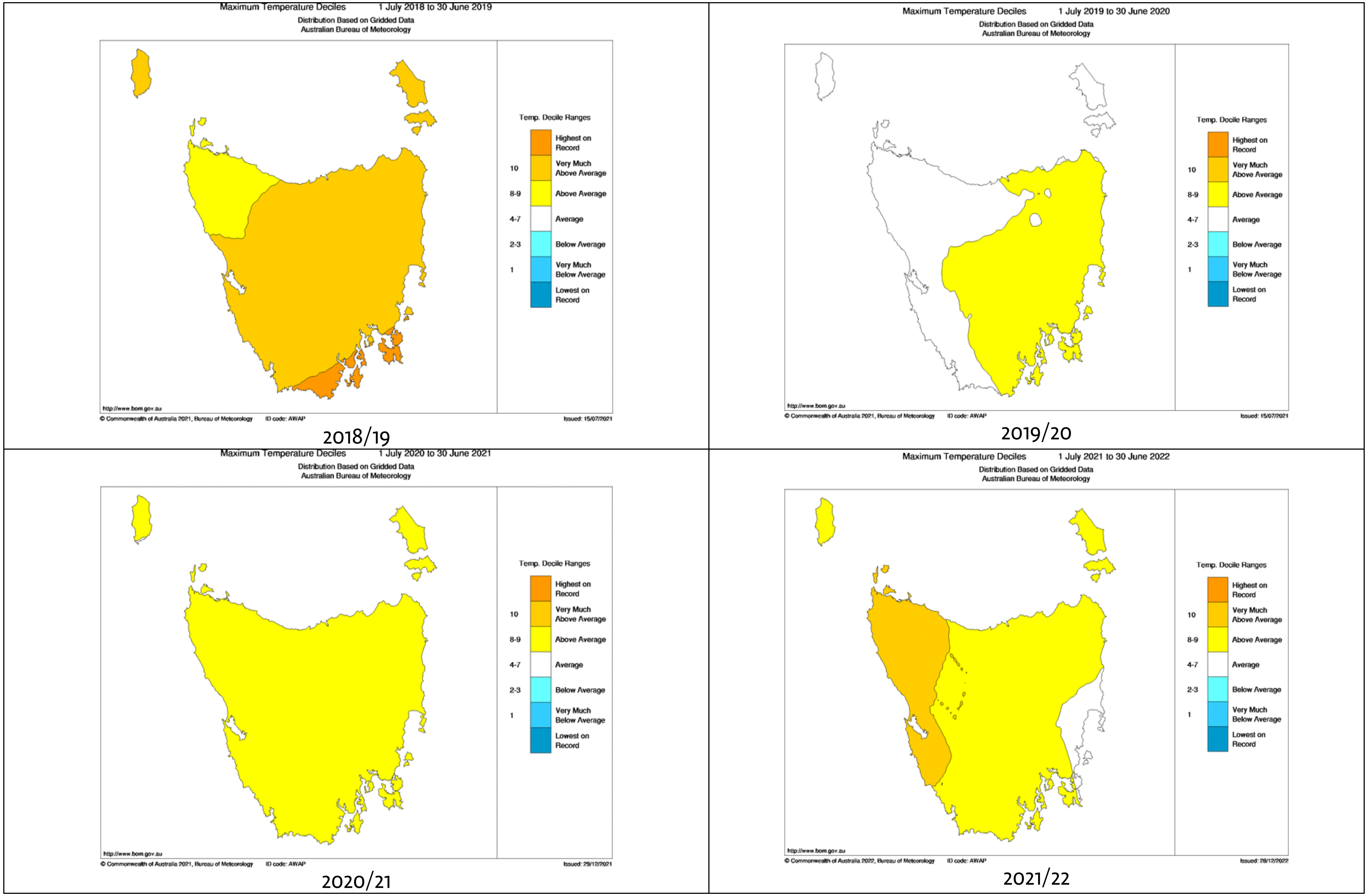

Figure 7. Comparison of maximum daily temperature over the reporting period (July 2018 to June 2022) with historic data. Source: Bureau of Meteorology.

3.3 Flow regime

Several aspects of flow regime are known to be important for ecosystem health. Rolls *et al.* (2012) explored the ecological effects of changes in low flow. They outline four principles which underpin the causal link between changes in low flow and ecological responses within riverine systems as:

- Principle 1: Low flows control the extent of physical aquatic habitat, thereby influencing the composition and diversity of biota, trophic structure, and carrying capacity.
- Principle 2: Low flows mediate changes in habitat conditions, which, in turn, drive patterns in the distribution and recruitment of biota.
- Principle 3: Low flows affect the sources and exchange of energy in riverine ecosystems, thereby affecting ecosystem production and biotic composition.
- Principle 4: Low flow restricts connectivity and diversity of habitat, increases the importance of refugia, and drives multiscale patterns in biotic diversity.

They identified six ecologically relevant hydrological attributes of low flow:

1. antecedent conditions
2. duration
3. magnitude
4. timing and seasonality
5. rate of change
6. frequency

Beca (2008) describes the importance of medium-to-high flow events. These can be important triggers for many biological processes including fish breeding events, maintenance of riparian habitats, increasing dissolved oxygen essential for aquatic fauna, and providing connectivity and allowing migration of species within river systems. Frequency, duration, magnitude, timing, and seasonality of these flows are all important aspects of the flow regime.

This section provides a simple analysis of some aspects of the flow regime over the reporting period compared with flow regime over the previous 26 years (July 1992 to June 2018). Indicators of flow regime considered are:

- The seasonality and magnitude of total flows using average daily summer, autumn, winter and spring flows over the period; and
- The magnitude and frequency of low flow volumes measured using the 5^{th}, 10^{th} and 20^{th} percentile of flows.

Given the variability of climatic conditions and consequential flow regimes across the catchment, flow is analysed at seven gauges across the catchment that reflect the major sub-catchments in the report (Figure 8). There are insufficient gauged data for the Brumbys-Lake system to allow for analysis of flow regime. The flow regimes in rivers in this system are affected by the Poatina power station and management of flows for hydropower generation from yingina / Great Lake and Arthurs Lake.

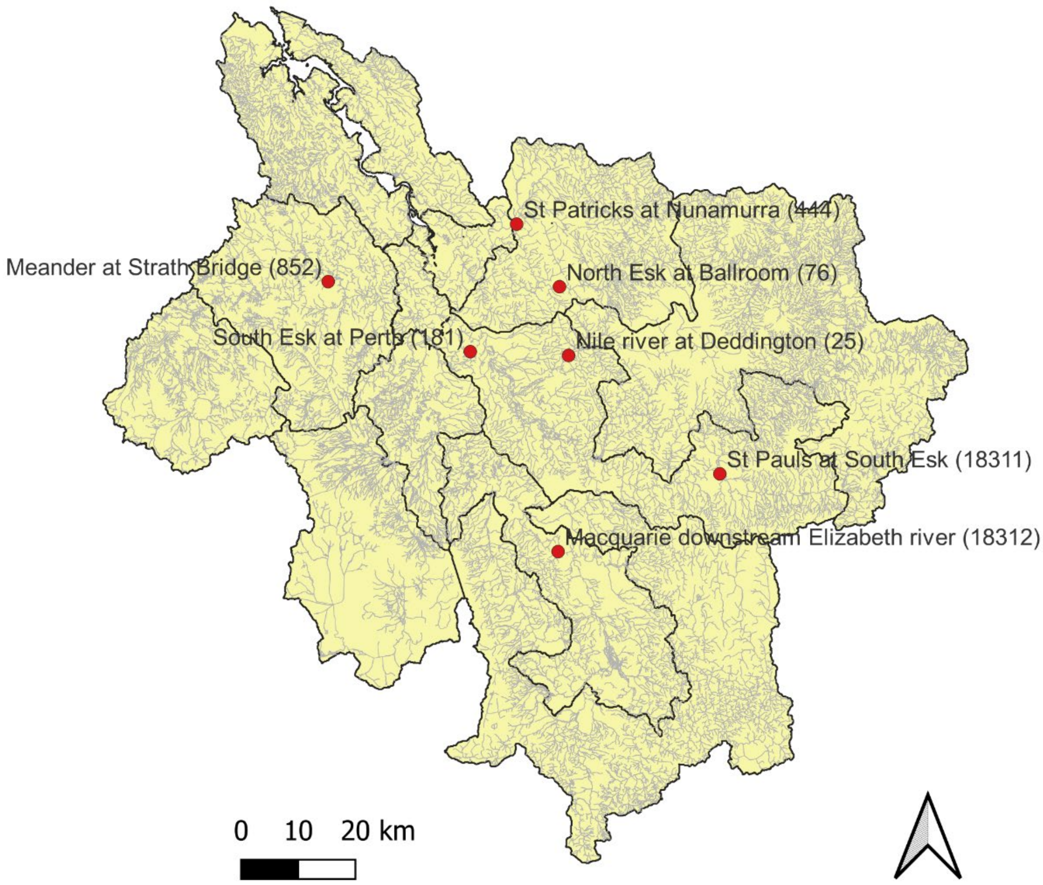

Figure 8. Map showing locations of flow gauges used to describe flow regime over the reporting period.

3.3.1 Seasonal variability of total flows

This section compares average daily flows over each season (summer, winter, autumn and spring) for each year of the reporting period against the median, 25th percentile and 75th percentile of these flows over the period July 1992 to June 2018.

3.3.1.1 North Esk gauges

Two flow gauges are used to describe flows in the North Esk – one in the St Patricks River at Nunamara (444) and the other in the North Esk River at Ballroom (76). Upstream of these gauges, these rivers drain approximately half each of the overall North Esk catchment.

Figure 9 summarises the seasonal pattern of average daily flows over the reporting period for the St Patricks River at Nunamara (444) and provides comparisons against historic patterns. This figure shows:

- Flow is generally characterised by wet winters and dry summers, with spring flows historically higher than autumn flows. While this pattern was evident for three of the four reporting years, 2020/21 was characterised by very high autumn flows, high spring flows and relatively low winter flows.
- Two of the reporting years (2018/19 and 2020/21) experienced an unusually wet winter (above the median), while flow during winter 2020/21 was below the 25th percentile of historic flows.

- Summers and autumns during the reporting period were significantly drier than the median for all but one year in each case – 2021/22 for summer flows and 2020/21 for autumn flows – with the latter being extremely high, at over twice the 75th percentile for historic autumn flows.
- Spring flows were very variable over the reporting period, being well below the 25th percentile in 2018/19 and 2019/20, then above the 75th percentile in 2021/22.

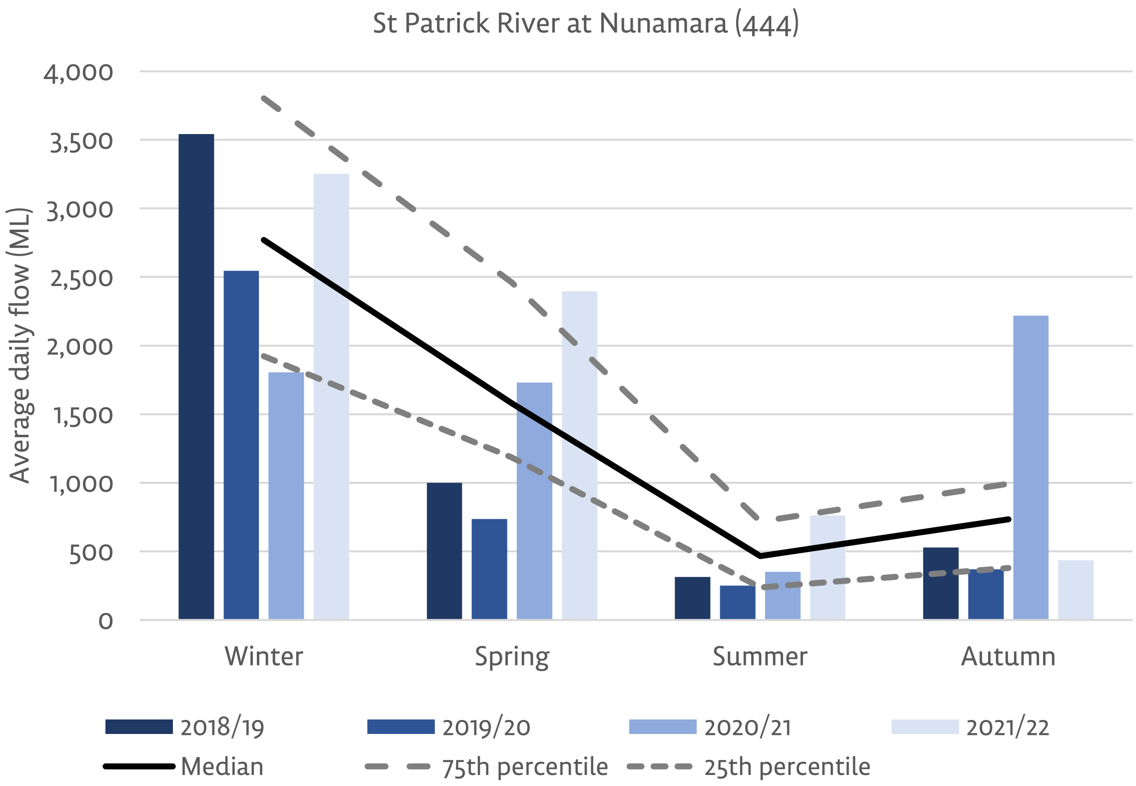

Figure 9. Comparison of average daily seasonal flows over the four-year reporting period (July 2018 to June 2022) against medians and 25th/75th percentiles derived from historic values (July 1992 to June 2018): St Patrick River at Nunamara (444).

Figure 10 summarises the seasonal pattern of average daily flows over the reporting period for the North Esk River at Ballroom (76) and provides comparisons against historic patterns. Seasonal flow patterns at this gauge are similar to those at the St Patricks River gauge, with winter and spring in 2021/22 having higher flows (both above the 75th percentile) at the North Esk gauge than at the St Patricks gauge. Autumn flows in 2018/19 are near the 75th percentile at this North Esk site, but below the median value at the St Patricks River site.

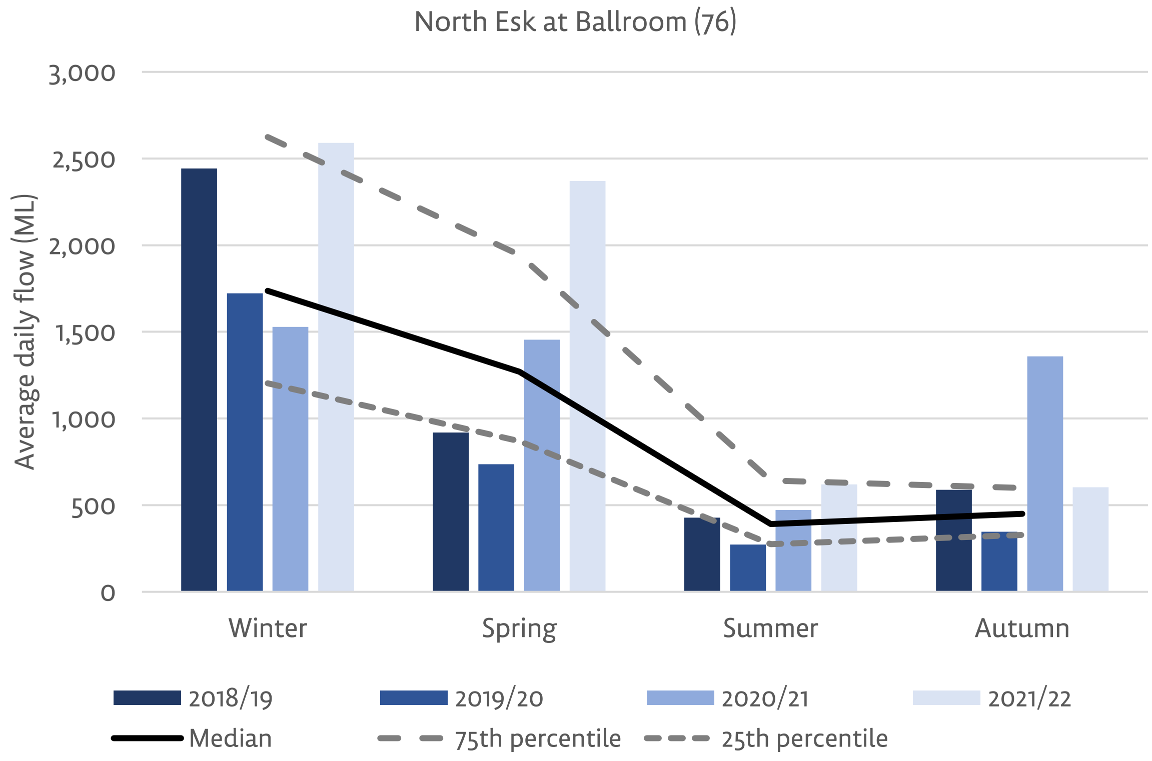

Figure 10. Comparison of average daily seasonal flows over the four-year reporting period (July 2018 to June 2022) against medians and 25th/75th percentiles derived from historic values (July 1992 to June 2018): North Esk at Ballroom (76).

3.3.1.2 South Esk gauges

Three gauges are used to describe flow patterns in the South Esk River catchment:

- St Pauls River at South Esk (18311) and Nile River at Deddington (25), which capture flows from those two major tributaries to the South Esk; and
- South Esk River at Perth (181), which describes flows in lower sections of the main South Esk River upstream of the Macquarie, Brumbys-Lake and Meander River catchments inflows.

Figure 11 summarises the seasonal pattern of average daily flows over the reporting period for the St Pauls River at South Esk (18311) and provides comparisons against historic patterns.

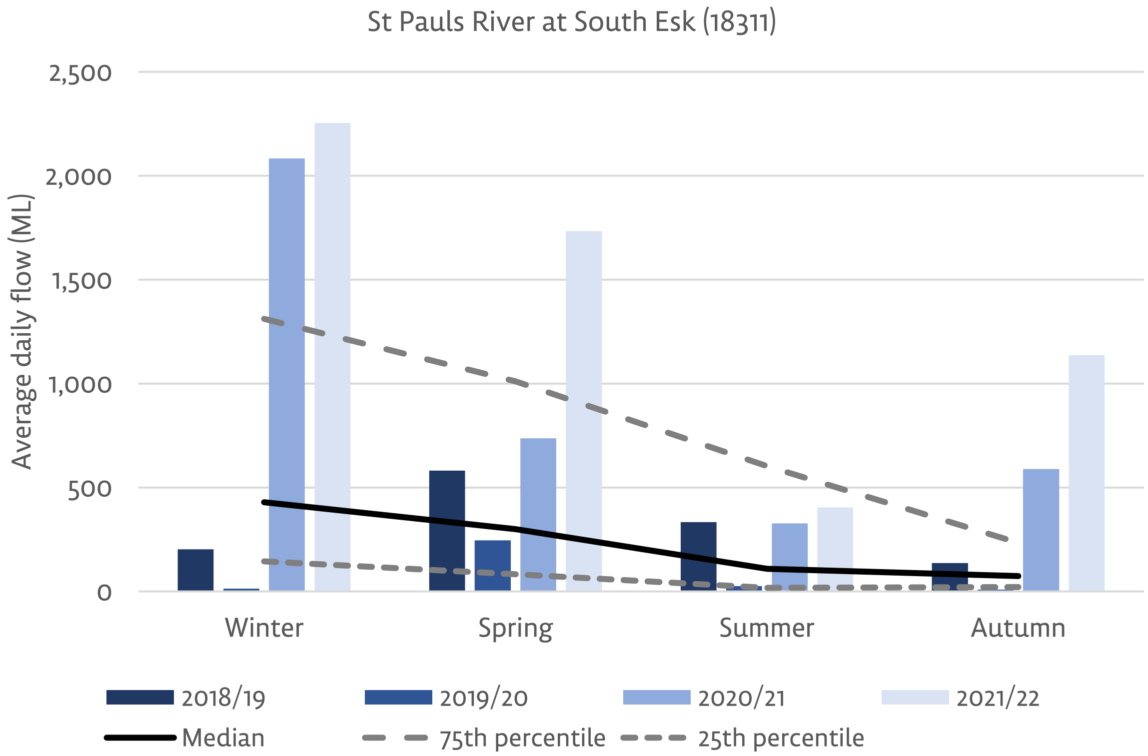

Figure 11. Comparison of average daily seasonal flows over the four-year reporting period (July 2018 to June 2022) against medians and 25th/75th percentiles derived from historic values (July 1992 to June 2018): St Pauls River at South Esk (18311).

Figure 11 shows:

- Flow varied significantly among years, with the pattern of winter dominance seen in flows at the North Esk gauges and in historic percentiles only seen at the St Pauls River gauge for two of the four reporting years.
- Flows in 2019/20 were well below the 25th percentile in winter and autumn, and below the median in other seasons.
- While winter flows were exceptionally low in 2018/19, flows in other seasons of that year were above the historic median.
- By contrast, 2020/21 and 2021/22 were extreme wet years characterised by wet winters and autumns that were well above the 75th historic percentile. Spring of 2021/22 was also exceptionally wet.

Flows recorded at the Nile River at Deddington (25) gauge show a more consistent seasonal pattern of flows among years (see Figure 12) than was the case for the St Pauls River gauge. In general, average daily flows are more similar among years for each season and generally more comparable with the range between the 25th and 75th percentiles of historic data. Winter flows were generally higher than those for other seasons, though this balances more closely with wet springs and autumns in some years. Summer was consistently the driest season across the reporting period. Three of the four years had winter flow above median levels, though this was generally within the range of the 75th percentile; unlike the St Pauls River flows, which were well above the 75th percentile. Winter and spring flows in 2021/22 were relatively high (at or above the 75th percentile), while autumn of 2020/21 was associated with flows substantially greater than the 75th percentile of historic autumn flows.

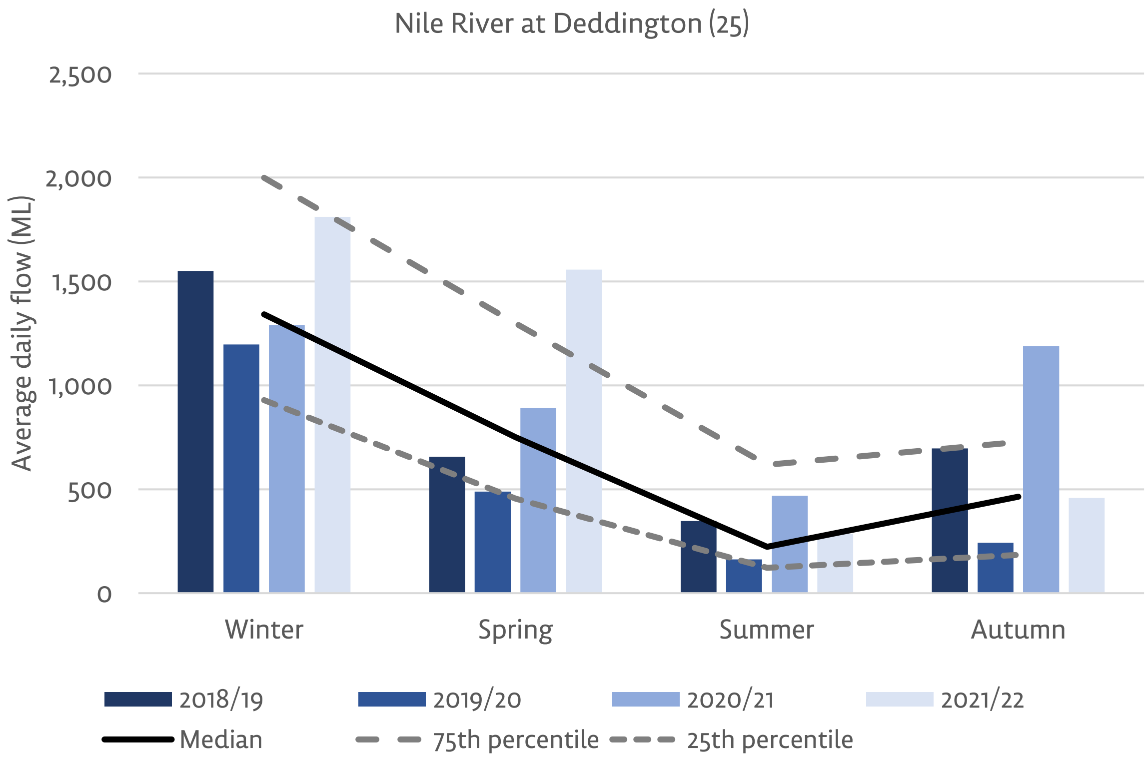

Figure 12. Comparison of average daily seasonal flows over the four-year reporting period (July 2018 to June 2022) against medians and 25th/75th percentiles derived from historic values (July 1992 to June 2018): Nile River at Deddington (25).

Figure 13 summarises the seasonal pattern of average daily flows over the reporting period for the South Esk River at Perth (181) and provides comparisons against historic patterns. This shows:

- General winter and spring dominance of flows historically with relatively drier summers and autumns.
- 2018/19 and 2019/20 were generally dry years. Flows for all seasons of 2019/20 were below the 25th percentile. Flows during 2018/19 were closer to the historic median, with the exception being spring, which was below the 25th percentile.
- In contrast, 2020/21 and 2021/22 were both relatively wet years. In particular, flows in 2021/22 were greater than the historic 75th percentile for all seasons except summer, when they were still well above the median.

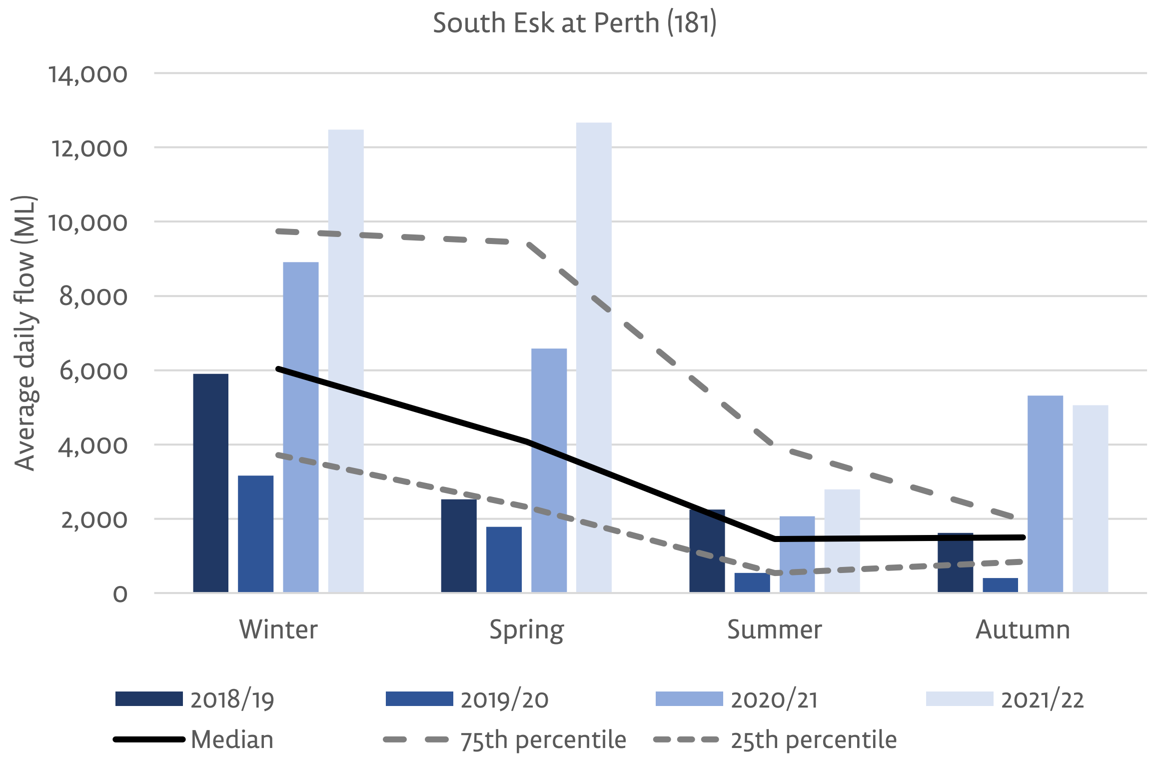

Figure 13. Comparison of average daily seasonal flows over the four-year reporting period (Jul 2018 to Jun 2022) against medians and 25th/75th percentiles derived from historic values (Jul 1992-Jun 2018): South Esk at Perth (181).

3.3.1.3 Meander gauge

Flow regime in the Meander catchment was considered via a single gauge – Meander River at Strath Bridge (852). This gauge is located above the confluence with significant tributaries such as the Liffey River. Figure 14 summarises the seasonal pattern of average daily flows over the reporting period and provides comparisons against historic patterns.

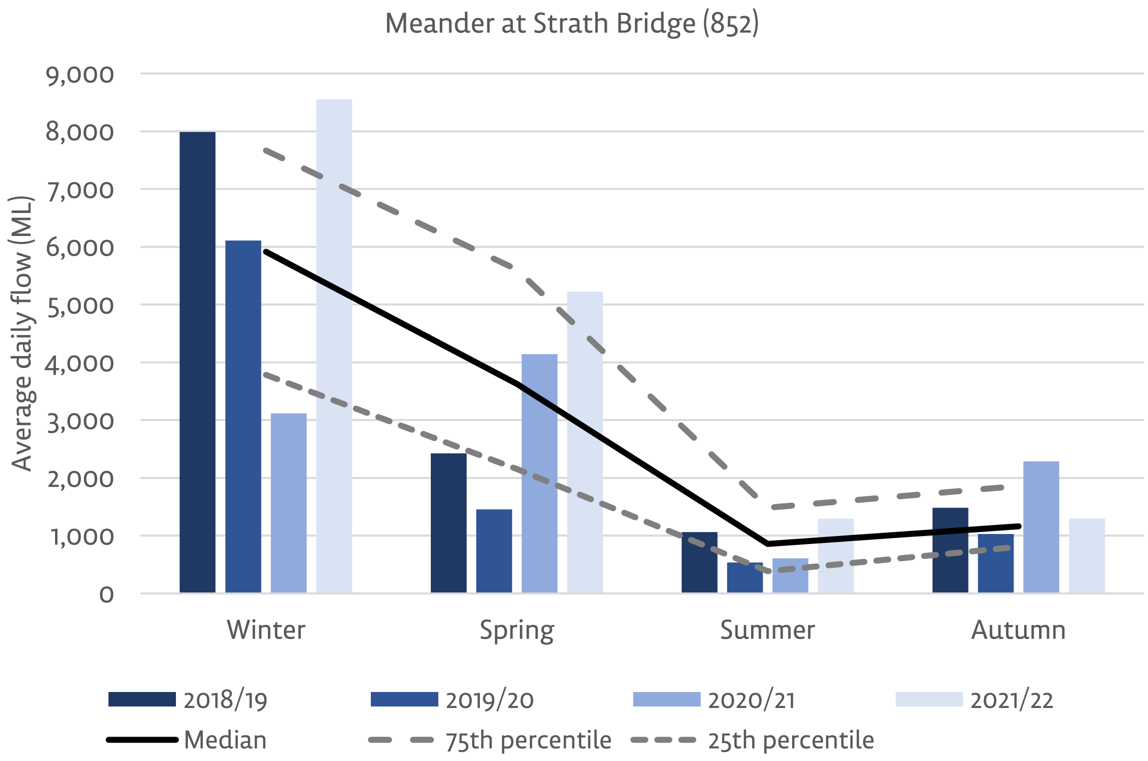

Figure 14. Comparison of average daily seasonal flows over the four-year reporting period (Jul 2018 to Jun 2022) against medians and 25th/75th percentiles derived from historic values (July 1992 to June 2018): Meander at Strath Bridge (852).

Figure 14 shows a general pattern of high flows in winter and spring and generally low flows during summer. Unlike other gauges, relatively high flows were recorded during the winter of 2018/19 and 2019/20 (i.e., above the 75th percentile and just above the median, respectively). Spring and summer flows were both relatively low during these years. The general pattern of flows was different in 2020/21, with very low winter flows (below 25th percentile) and wetter-than-median spring and autumn periods. Average daily flows during 2021/22 were generally high, particularly in winter and spring.

3.3.1.4 Macquarie gauge

Flows in the Macquarie catchment are described using a single gauge – Macquarie River downstream Elizabeth River (18312). Figure 15 summarises the seasonal pattern of average daily flows over the reporting period and provides comparisons against historic patterns.

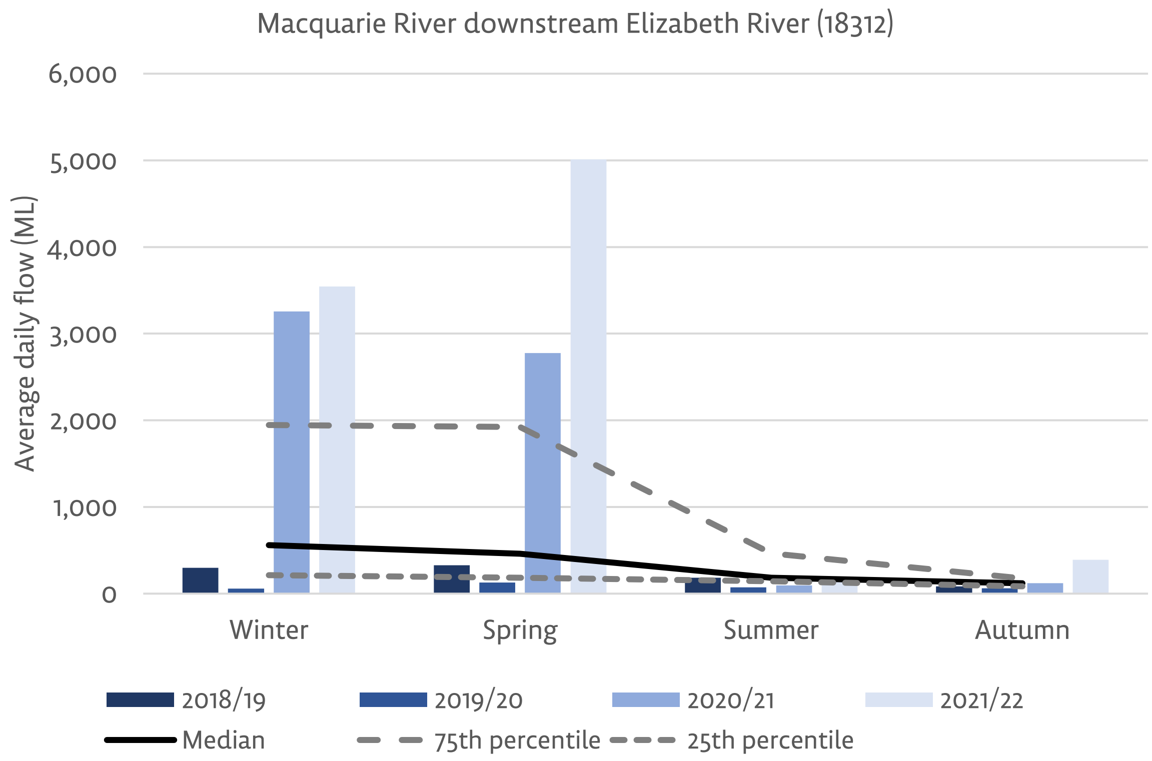

Figure 15. Comparison of average daily seasonal flows over the four-year reporting period (Jul 2018 to Jun 2022) against medians and 25th/75th percentiles derived from historic values (July 1992 to June 2018): Macquarie River downstream Elizabeth River (18312).

Figure 15 shows that 2018/19 and 2019/20 were both relatively dry years, with flows in 2019/20 well below the 25th percentile in all seasons. By contrast, 2020/21 and 2021/22 were characterised by very high winter and spring flows – both well above the 75th percentile of historic flows. This interannual variability in winter and autumn flows is also reflected in the historic flow trendlines, with the relatively elevated 75th percentile trendline indicating that some winters and/or springs are particularly wet.

3.3.2 Low flows

As mentioned above, low flows are another characteristic of flow regimes that are important to aquatic life. The seasonal patterns of flow described above are generally dominated by the influence of high and medium flow events. This section compares low-flow percentiles (5th, 10th and 20th percentile = Q5, Q10 and Q20 respectively) over the whole four-year reporting period against those over the historic period (July 1992 to June 2018) for each gauge. Figure 16 shows the difference between the four-year reporting period and the historic period for each low-flow percentile (i.e., percent greater or less than the historic value) for each gauge. A value of zero indicates these percentiles have the same value, while positive values indicate the percentage by which the reporting period value is greater and negative values are the percentage by which it is lower (than the historic value).

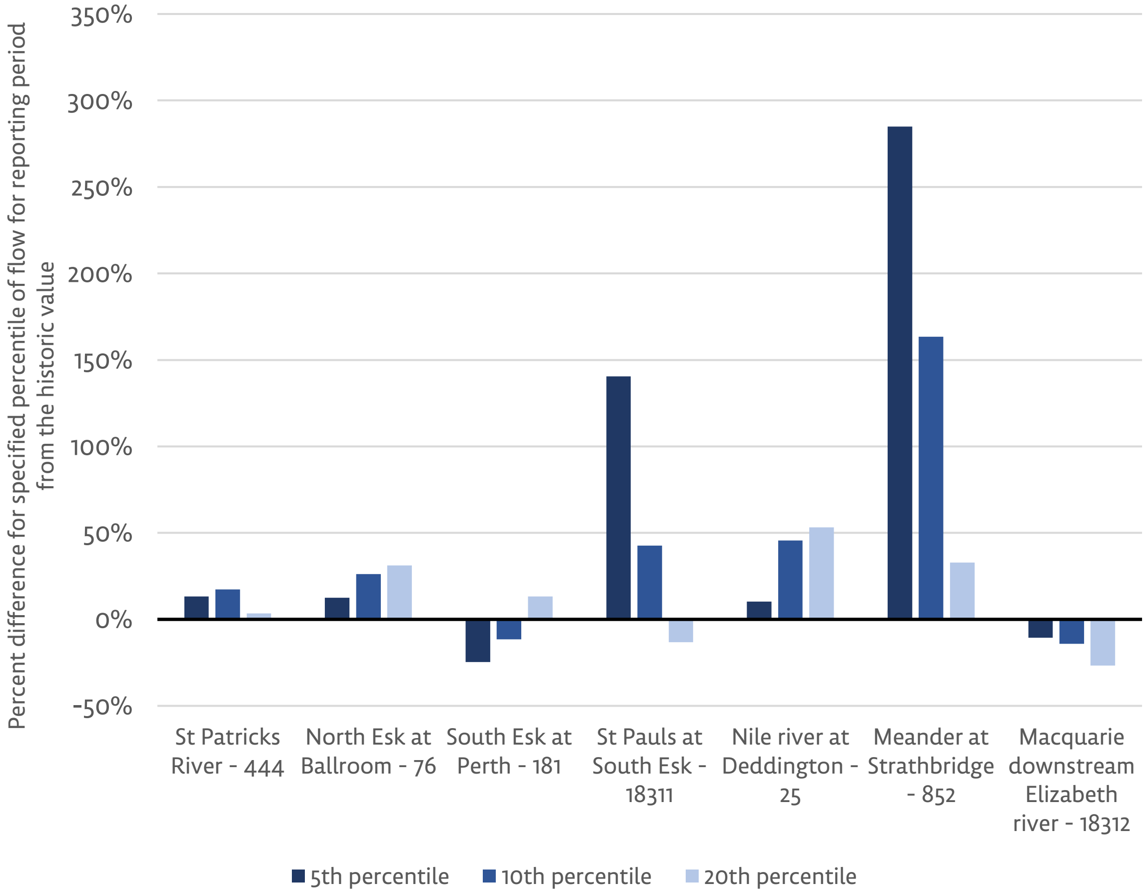

Figure 16. Comparison of low-flow daily flow percentiles (for the reporting period July 2018 to June 2022) against those derived from historic data (July 1992 to June 2018) for all gauges. Raw data are cumecs (m^3/s), while the y-axis scale is the percent difference (increase/decrease) of the reporting period percentile from the historic percentile value.

Figure 16 shows that very low flows (i.e., Q5 and Q10) were at least slightly higher over the four-year reporting period than over the preceding 26 years for all gauges except the South Esk at Perth (181) and Macquarie River downstream Elizabeth River (18312). All three low flow percentiles at the Macquarie River site had lower flow volumes in the reporting period than historically. The two lowest flow percentiles (Q5 and Q10) were lower than the historic value at the South Esk at Perth but the Q20 was higher. Very low flows at the St Pauls River site (18311) were substantially higher than the historic period while the Q20 fell slightly. The Meander River at Strath bridge had the greatest increase in low flows, with Q5 and Q10 increasing by over 250% and 150%, respectively. This is likely due at least in part to changes in summer flows as a result of releases of water for irrigation purposes from the Meander Dam, which commenced operations in February 2008 (i.e., more than halfway through the historic record).

4 Other factors affecting freshwater ecosystem health

In addition to climate and flow, other factors that weren't used to derive grades that can influence freshwater ecosystem health include land use and barriers to movement (e.g., dams and weirs). These two factors can provide important context to the report card grades and are summarised in the following section.

4.1 Land use

Figure 17 shows a map of land use in the catchment split into four simplified categories: forest, including green space, native and production forests; agriculture, including both dryland and irrigated grazing, dairy, cropping and horticultural areas; urban, which includes major urban areas as well as smaller towns and villages; and water, which includes dams, streams, and creeks.

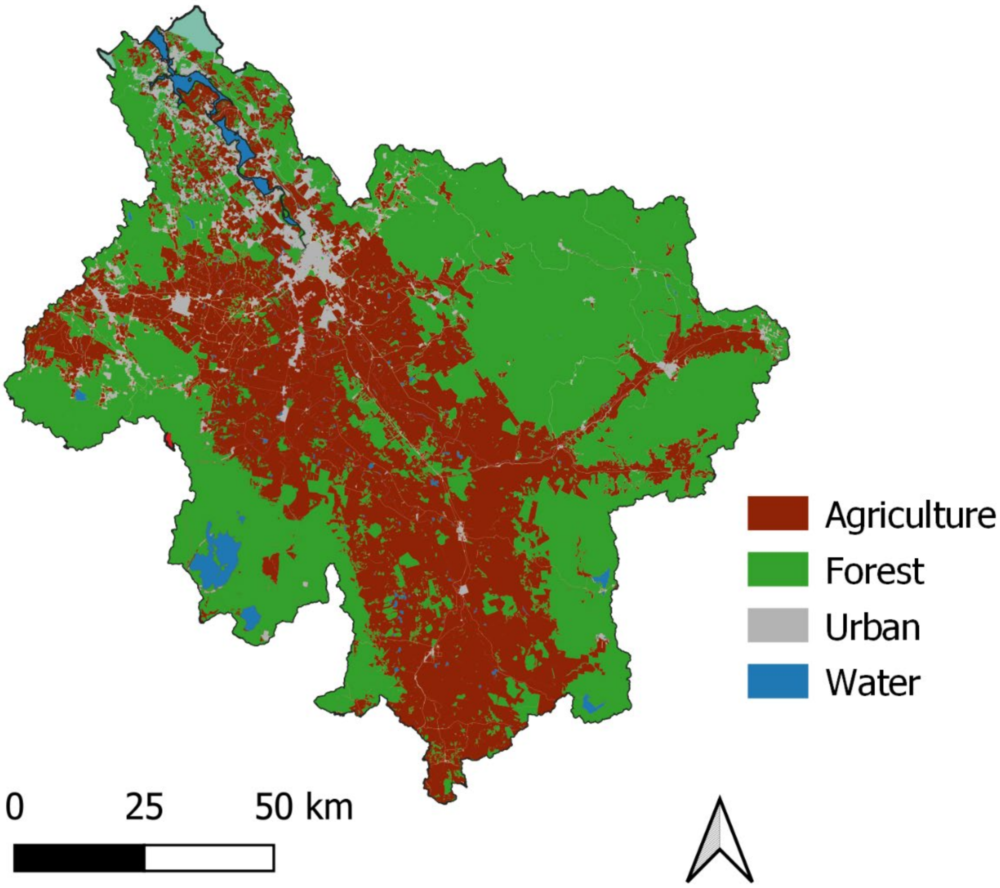

Figure 17. Spatial distribution of broad land use types across the kanamaluka / Tamar estuary and Esk rivers catchment. Source: Based on classification of Tasmanian Land Use 2019 spatial layer, Department of Natural Resources and Environment Tasmania.

There is a general dominance of agricultural land use in lowland areas of the catchment. Urban land use also tends to be primarily in lowland areas of the South Esk, North Esk, Meander and Brumbys-Lake, although the Meander uplands also contain significant areas of urban land use. Forest dominates the upland areas of the Brumbys-Lake, South Esk, Meander and North Esk sub-catchments.

A more detailed breakdown of land use in each of the reporting zones is provided in Table 2. Table 2 shows proportions of the total area of each freshwater report card reporting zone (and the entire kanamaluka / Tamar estuary and Esk rivers catchment excluding the Tamar sub-catchment) covered by a range of different land uses. This summary breaks agricultural land use into: ‘cropping and horticulture’; ‘grazing’; and ‘irrigation’. Forest land use is divided into ‘production forests’, which includes both native production forests and plantations, and ‘green space’, which includes areas of native vegetation set aside for protection. The ‘other’ category includes a range of infrastructure including roads, railways, water extraction and transmission, as well as mines and quarries.

Table 2. Proportion of total reporting zone area under different land uses (note the ‘Total’ area excludes the Tamar sub-catchment, which is not considered in the 2023 Freshwater Report Card). Note: percentages have been rounded to the nearest whole number. Source: Tasmanian Land Use 2019 spatial layer, Department of Natural Resources and Environment Tasmania.

Reporting zone	Cropping & horticulture	Grazing	Green space	Irrigation	Other	Production forestry	Urban	Water
Brumbys-Lake Lowlands	1%	45%	8%	39%	1%	2%	3%	1%
Brumbys-Lake Uplands	0%	13%	47%	5%	0%	26%	1%	8%
Launceston Urban (including North Esk lowlands)	0%	41%	13%	1%	7%	6%	31%	1%
Macquarie Lowlands	0%	71%	12%	14%	1%	1%	1%	1%
Macquarie Uplands	0%	49%	24%	5%	0%	20%	0%	2%
Meander Lowlands	1%	39%	16%	13%	2%	22%	6%	2%
Meander Uplands	0%	15%	49%	11%	1%	18%	5%	1%
North Esk Uplands	0%	23%	30%	1%	1%	42%	2%	0%
South Esk Lowlands	1%	48%	30%	10%	1%	7%	2%	1%
South Esk Uplands	0%	14%	42%	1%	0%	42%	1%	0%
Total	0%	35%	30%	8%	1%	23%	2%	2%

Table 2 shows:

- The cropping and horticulture category of land use covers very small areas of the landscape across all zones (~1% or less).
- The Brumbys-Lake lowlands reporting zone comprises large proportions of grazing (45%) and irrigation (39%) land uses. While urban areas cover 3%, this is larger than the proportion of urban land use in the total catchment (2%) and the 4th largest proportion of urban land use across all zones. There is very little green space or forestry in this zone.
- The Brumbys-Lake uplands zone is dominated by green space (47%) and production forestry (26%), with a smaller proportion of area occupied for grazing.
- The Launceston urban zone consists of over 30% urban land-use area and 7% categorised as ‘other’ land use. There is also a significant area of grazing (41%), with a further 19% either green space or production forest.
- There is very little green space or production forest in the Macquarie lowlands, with over 70% used for grazing and 14% for irrigation.
- The Macquarie uplands has the lowest proportion of green space of any uplands zone, with green space covering just less than a quarter of the total area. Production forestry covers a further 20%, while nearly 50% of the zone is used for grazing and a further 5% for irrigation.

- The Meander lowlands zone has the second largest percentage of urban land across all zones (6%). Over half of the zone is used for grazing (39%) and irrigation (13%). There is relatively little forest cover and most forested areas are used for production forestry rather than green space.
- The Meander uplands zone is nearly half green space, with a further 18% of the zone used for production forestry. The zone has the 3rd largest proportion of urban area (5%) of any of the zones. It also has a relatively large proportion of irrigated land (11%) compared to other upland zones.
- Over 70% of the North Esk zone is covered by forest land uses (30% green space and 42% production forestry), with the remainder of the zone primarily used for grazing and very small areas of urban and irrigation land uses.
- The South Esk lowlands zone is largely used for agriculture (48% grazing and 10% irrigation). There is a relatively small area of production forestry, with most of the remaining zone area being green space (30%).
- The South Esk uplands zone is predominantly used for forest land uses (42% green space and 42% production forestry). Grazing covers almost all of the remaining area in this zone.

4.2 Aquatic habitat – barriers to movement and river regulation

There is a range of instream structures that can act as barriers to fish movement. These include dams, culverts, bridges, and weirs. There is no comprehensive, catchment-wide, open-access dataset that identifies the locations of these structures and/or assesses their potential or actual impact on fish movements and migrations. However, older data from the North Esk River sub-catchment exists (DPIPWE, 2003) and is shown in Figure 18. This figure shows 35 barriers in total, nine of which have a rating of 1, indicating they present an extreme barrier to fish passage. These occur on tributaries of the North Esk River. The St Patricks River has several moderate barriers. It is likely that these data are out of date and new barriers may exist now, or that these barriers have since been modified to improve fish passage.

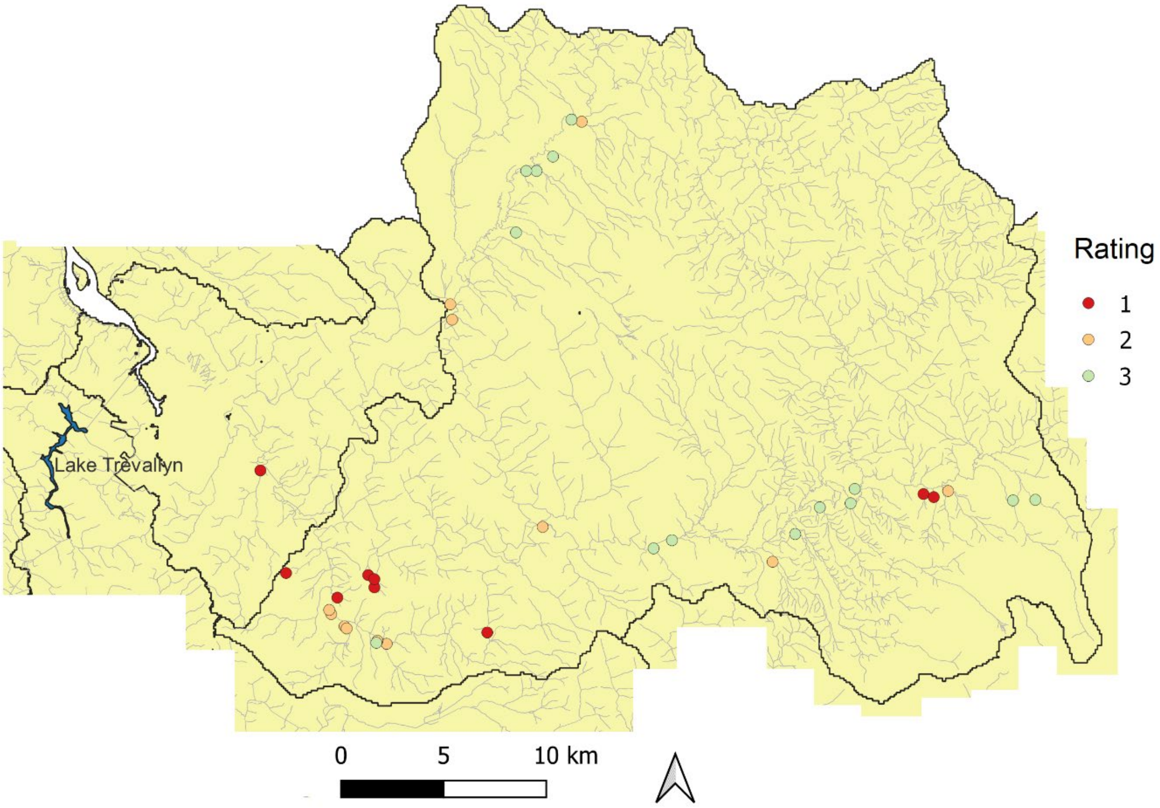

Figure 18. Barriers to fish passage identified in a 2003 North Esk River dataset. Rating of 1 to 3 indicates the severity of barrier posed by the structure with a rating of 1 indicating an extreme barrier. These barriers are a mix of bridges, culverts, dams, and weirs. Source: DPIPWE (2003).

Another source of information on potential barriers to fish passage are the water bodies and irrigation dams in the catchment, as shown in Figure 19. Many of the water bodies are used for hydroelectric power generation or water extraction, including for irrigation. These dams can impact flow regimes and the water temperature within river networks, as well as presenting a barrier to fish passage. Management practices can minimise or mitigate potential impacts to fish passage, including environmental flow releases, fish ladders and other structures that enable fish passage. No comprehensive assessment of the impacts of these instream barriers or mitigation structures on ecosystem health is available.

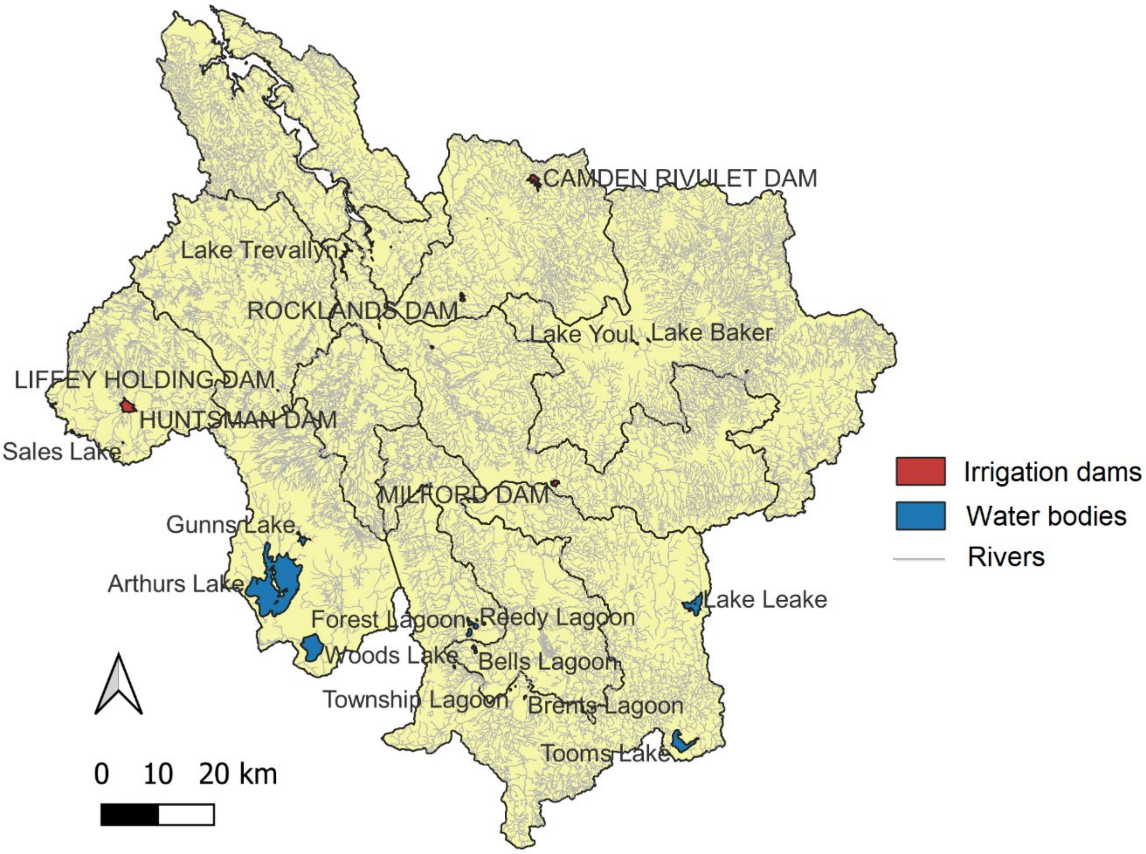

Figure 19. Locations of water bodies and irrigation dams in the catchment. Source: Irrigation Tasmania Dams and CFEV Waterbodies from www.theLIST.tas.gov.au ©State of Tasmania.

Another dataset that provides some information on the physical connectivity of aquatic habitat is the regulation index for rivers from the CFEV database (DPIPWE, 2005). This index describes the amount of regulation of the natural flow regime due to the effect of all water storage upstream. Similar to data on barriers to fish passage in the North Esk River described above, this CFEV information is outdated and unlikely to reflect current conditions. It does, however, provide an indication of some of the areas that have been more heavily regulated over a longer period. Table 3 summarises the proportion of stream length in each reporting zone categorised as having low, medium, and high regulation index.

Table 3. Proportion of stream length in reporting zone classified as having a low, medium and high regulation index. Note 'high' reflects a greater degree of regulation of the flow regime due to the effects of all water storage upstream. Note: percentages have been rounded to the nearest whole number. Source: CFEV database (DPIPWE 2005).

FRC zone	Not classified	Low	Medium	High
Brumbys-Lake Lowlands	2%	71%	13%	15%
Brumbys-Lake Uplands	7%	86%	2%	5%
Launceston Urban (including North Esk Lowlands)	4%	86%	8%	2%
Macquarie Lowlands	1%	64%	9%	26%
Macquarie Uplands	1%	80%	10%	9%
Meander Lowlands	2%	77%	14%	7%
Meander Uplands	0%	91%	6%	2%
North Esk Uplands	1%	95%	2%	2%
South Esk Lowlands	1%	83%	7%	8%
South Esk Uplands	0%	98%	1%	1%

Table 3 shows that, at the time the dataset was created, the Macquarie lowlands (26%) and Brumbys-Lake lowlands (15%) had the greatest proportion of stream rated as having a high regulation index. Other reporting zones with a relatively high proportion of stream length (7% to 9%) with high regulation index are the Macquarie uplands, Meander lowlands and South Esk lowlands. These data predate the construction of the Meander Dam (Huntsman Lake), which is likely to have had a significant impact on flow regulation in the two Meander zones.

A comprehensive assessment of barriers to fish passage across the kanamaluka / Tamar estuary and Esk rivers catchment would provide useful information for understanding freshwater ecosystem health and the grades for indicators that were assessed in this report card.

5 Datasets and calculation of EHIs

Grades in the 2023 Freshwater Report Card are calculated for three components of ecosystem health:

- Aquatic life;
- Aquatic habitat; and
- Riparian habitat.

This section describes the datasets used to calculate grades reported in the report card. Note that the full methodology used to derive grades is described in the Freshwater Report Card Methodology Report, available at www.teer.org.au/freshwaterreportcard.

5.1 Aquatic life

Grades for aquatic life are based on macroinvertebrate data collected by TEER Program partners across the catchment using the AUSRIVAS method. Sites for which data were available and the partners who collected data at each site is shown in Figure 20. Note that several of the datasets are collected for compliance purposes for point-source contributions such as wastewater treatment plants. In these cases, only upstream sites, above the point-source mixing zone, are included in the report card. Downstream sites were deemed to be reflective of localised mixing zone impacts and so are not appropriate for assessing overall zone health. There are a total of 49 macroinvertebrate sampling sites in the catchment and the number of sites with macroinvertebrate data that were provided by each of the partners being:

- City of Launceston (CoL) – 6 sites
- Hydro Tasmania – 8 sites
- Department of Natural Resources and Environment Tasmania (NRE Tas) – 16 sites
- Petuna Aquaculture – 1 site
- TasWater – 11 sites
- Tasmanian Irrigation (TI) – 7 sites

These are spread across the kanamaluka / Tamar estuary and Esk rivers catchment with all reporting zones having at least one macroinvertebrate sampling site. In general, macroinvertebrate data is collected in spring and autumn of sampling years. The number of observations available at each site over the reporting period varies. Appendix 1 has a full list of the location of sites and the number of observations available at each site for the report card.

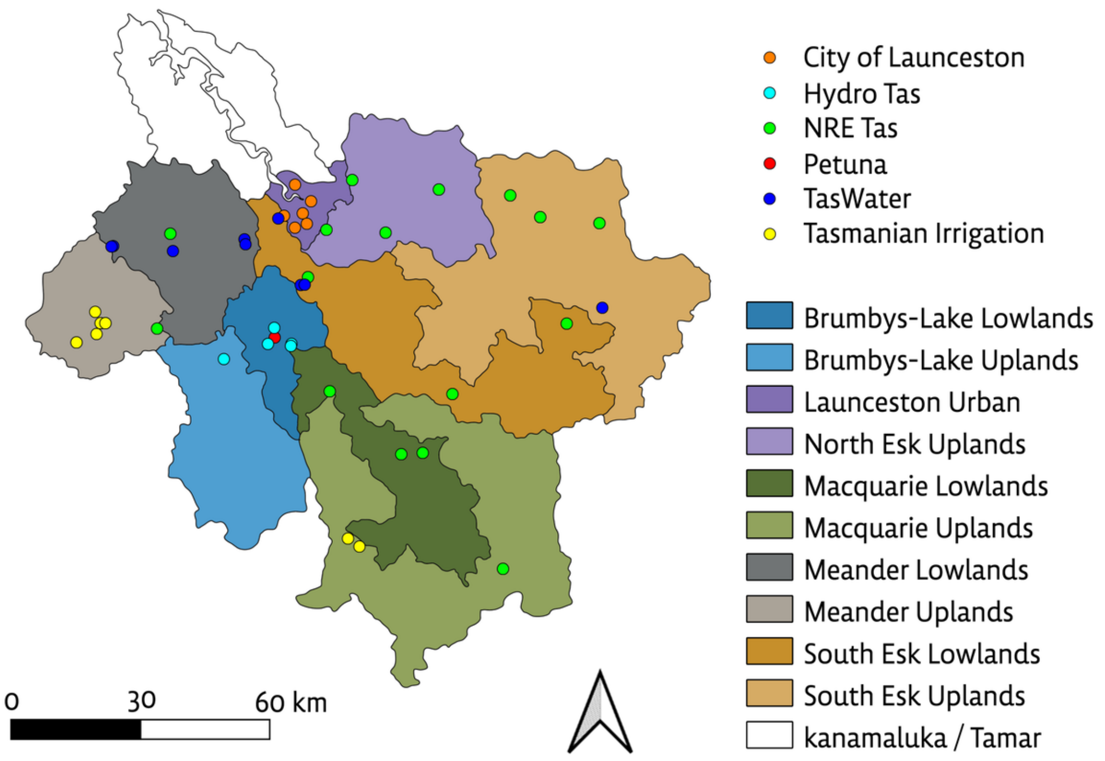

Figure 20. Location of macroinvertebrate sampling sites used in 2023 TEER Freshwater Report Card. Note: monitoring site colours indicate the organisation who provided the data.

A score for each site was calculated based on AUSRIVAS bands averaged across observations at the site as described in the Freshwater Report Card Methodology Report. The average score at each site in each reporting zone is demonstrated in Figure 21. A score of 4 indicates 'excellent' condition (all observations at the site fall in AUSRIVAS X band), while lower scores indicate a declining condition.

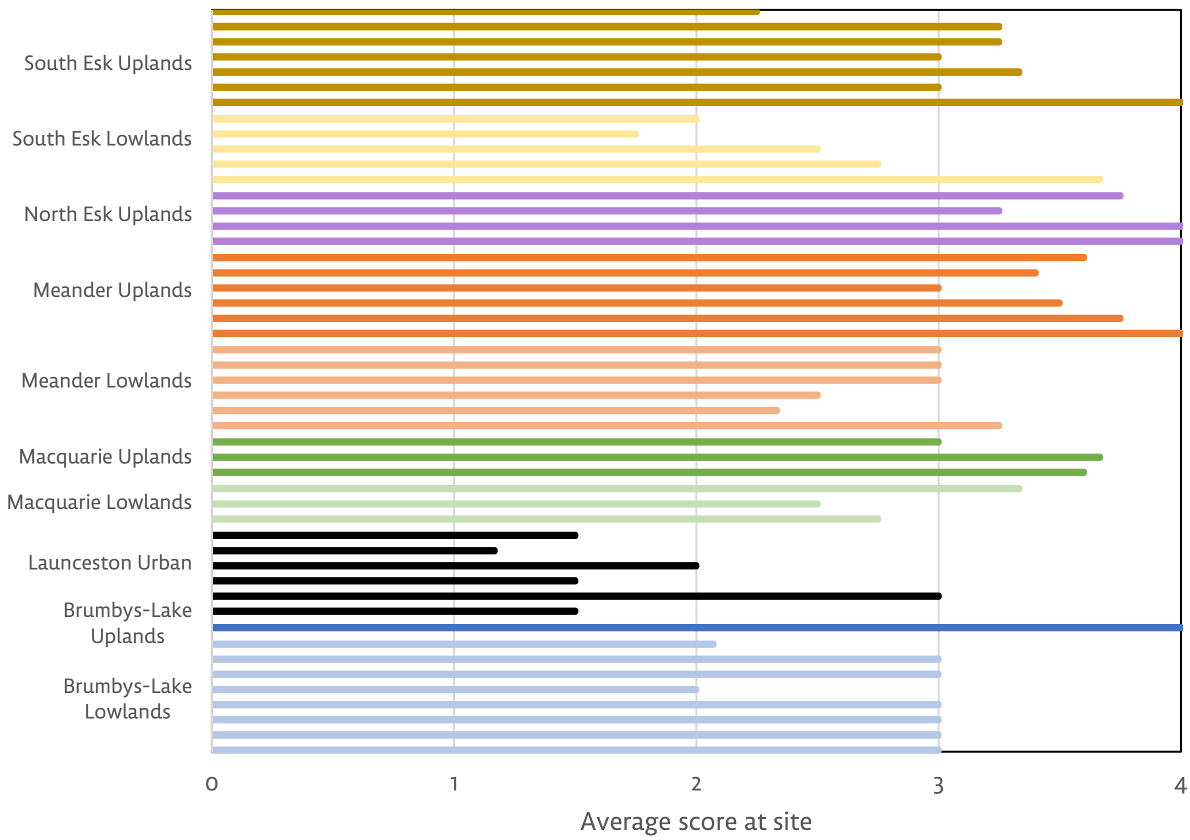

Figure 21. Average macroinvertebrate score for sites in each reporting zone. Note: dashed vertical lines indicate transition between freshwater reporting zones.

Figure 21 shows that while there is variability of scores between sites within a reporting zone, generally the variability between zones is greater than the variability within zones. Sites in upland zones are generally associated with higher scores, with the Brumbys-Lake uplands, North Esk and Meander uplands having the highest scores. The Launceston urban zone has the lowest scores, with most sites having scores between 1 and 2.

Table 4 summarises the average score and resultant ecosystem health index (EHI) value derived using these scores for each reporting zone. It also provides information on the number of sites and total number of observations in each reporting zone used to calculate these values.

Table 4. Number of sites, total number of observations, average zone score and EHI for macroinvertebrates.

Indicator	Number of sites	Total number of observations	Average score	EHI
Brumbys-Lake Lowlands	8	28	2.76	0.69
Brumbys-Lake Uplands	1	2	4	1
Launceston Urban	6	28	1.78	0.444
Macquarie Lowlands	3	11	2.86	0.715
Macquarie Uplands	3	12	3.42	0.856
Meander Lowlands	6	20	2.85	0.712
Meander Uplands	6	28	3.54	0.885
North Esk Uplands	4	15	3.75	0.938
South Esk Lowlands	5	17	2.53	0.633
South Esk Uplands	7	21	3.15	0.789

This table shows that there is limited data for Brumbys-Lake uplands zone, with only one site having two observations. All other zones have a minimum of three sites and over 10 observations. The datasets for the Brumbys-Lake lowlands, Launceston urban and Meander uplands are particularly data-rich with a total of six to eight sites having a total of 28 observations.

The EHI values by reporting zone are lowest in the Launceston urban zone (below 0.5). The South Esk lowlands and Brumbys-Lake lowlands both have EHI between 0.6 and 0.7. The highest EHI are in the Brumbys-Lake uplands and North Esk, with values above 0.9. In all cases, the EHI for aquatic life is lower in the lowland portion of each sub-catchment than the upland portion.

5.2 Aquatic habitat

Grades for aquatic habitat in the report card are based on an assessment of water quality in each zone compared with guideline values derived from H1 Hydrological Region water quality objectives as described in the Freshwater Report Card Methodology Report. As noted above, other factors such as barriers to movement and flow which influence aquatic habitat are not used to calculate grades. Sites used for assessing water quality in the 2023 Freshwater Report Card are shown in Figure 22. This figure shows a total of 89 water quality monitoring sites used in the report card with data provided by TEER Program partners as follows:

- CoL – 6 sites
- Hydro Tasmania – 4 sites
- NRE Tas – 21 sites
- Petuna Aquaculture – 2 sites
- TasWater – 31 sites
- TI – 24 sites

Note: not all water quality parameters (DO % saturation, turbidity, TN, TP, and NOx) are collected at all sites. Data collection varies from grab samples to continuous monitoring by data loggers at different sites. Appendix 1 provides a table of sites used in the report card including the location, partner who provided the data and number of observations of each water quality parameter at the site over the reporting period.

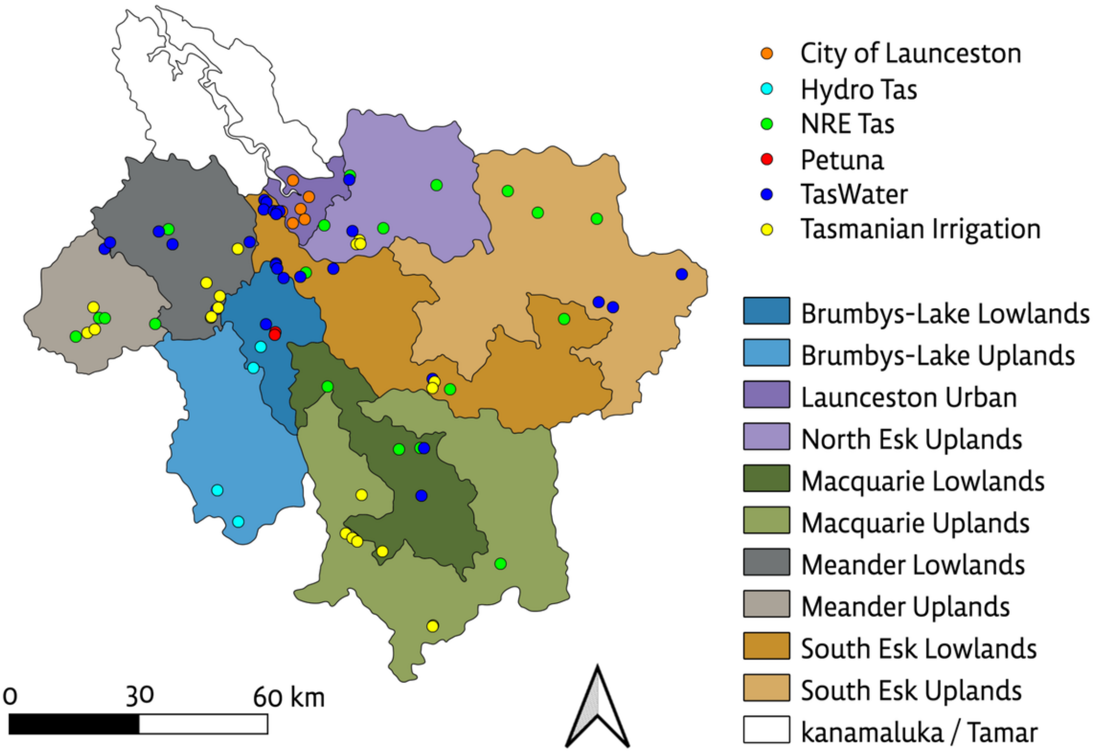

Figure 22. Location of water quality sites used in 2023 Freshwater Report Card. Note: monitoring site colours indicate the organisation who provided the data.

Calculation of scores for water quality parameters is based on the median observed value over the reporting period. Generally, six observations are required to provide a robust estimate of the sample median. Given the variability in the number of observations at some sites, those sites with a smaller number of observations (i.e., below six were aggregated with nearby sites in order to provide a more robust estimate of the median and make better use of the full dataset available (i.e., rather than excluding sites with less than six observations). Table 5 summarises the aggregate sites used to calculate scores in each reporting zone. Note that the aggregate site number is an identification number used to group data in calculation of the score. The site table in Appendix 1 gives the aggregate site number for each site to indicate which sites are grouped together for the analysis. Where sites have sufficient data to calculate a median, the 'aggregate' site is that single site. This method provides a balance between overweighting the zone average based on the number of observations at a site, which vary substantially between sites, and overweighting the results from a single site with less data compared to other sites with more comprehensive datasets.

Table 5. Aggregated monitoring sites and number of observations of each water quality parameter available for derivation of median value used in EHI calculation.

Zone name	Aggregate site number	Number of observations available				
		DO % Sat	Turbidity	TN	TP	NOx
Brumbys-Lake Lowlands	10	11	0	11	11	11
Brumbys-Lake Lowlands	17	44	123	95	95	96
Brumbys-Lake Lowlands	48	1461	1461	0	0	0
Brumbys-Lake Lowlands	49	36	0	33	33	15
Brumbys-Lake Lowlands	50	29	0	30	30	31
Brumbys-Lake Uplands	1	1461	1461	0	0	0
Brumbys-Lake Uplands	2	1370	1370	0	0	0
Brumbys-Lake Uplands	3	1461	1461	0	0	0
Launceston Urban	7	6	5	0	0	0
Launceston Urban	8	10	11	0	0	0
Macquarie Lowlands	5	21	92	56	56	56
Macquarie Lowlands	29	43	43	13	13	13
Macquarie Lowlands	36	9	11	0	0	0
Macquarie Lowlands	37	39	0	40	40	40
Macquarie Uplands	26	41	41	13	13	13
Macquarie Uplands	27	43	43	14	14	14
Macquarie Uplands	28	43	43	12	12	12
Macquarie Uplands	30	85	85	41	41	41
Macquarie Uplands	35	9	9	0	0	0
Meander Lowlands	4	11	88	57	57	57
Meander Lowlands	6	17	50	64	64	62
Meander Lowlands	12	43	0	42	42	42
Meander Lowlands	25	5	88	55	55	54
Meander Lowlands	42	47	0	65	65	66
Meander Lowlands	43	44	44	13	13	13
Meander Lowlands	44	40	39	12	12	12
Meander Lowlands	45	43	44	14	14	14
Meander Lowlands	46	43	43	13	13	13
Meander Lowlands	47	44	43	13	13	13
Meander Uplands	11	0	78	54	54	53
Meander Uplands	22	45	31	13	13	13
Meander Uplands	23	52	52	0	0	0
Meander Uplands	24	46	45	13	13	13
North Esk Uplands	31	85	87	10	10	10
North Esk Uplands	32	40	41	7	7	7
North Esk Uplands	33	8	63	50	50	50
North Esk Uplands	34	7	30	0	0	0
South Esk Lowlands	9	0	12	37	37	34
South Esk Lowlands	15	0	24	25	25	24

South Esk Lowlands	16	0	24	25	25	24
South Esk Lowlands	18	43	0	43	43	43
South Esk Lowlands	19	42	0	42	42	42
South Esk Lowlands	20	165	198	17	17	17
South Esk Lowlands	21	44	0	22	22	22
South Esk Lowlands	38	16	8	22	22	21
South Esk Lowlands	40	7	109	59	59	60
South Esk Lowlands	51	0	25	24	24	24
South Esk Uplands	13	0	55	18	18	18
South Esk Uplands	14	0	0	14	14	14
South Esk Uplands	39	6	6	0	0	0
South Esk Uplands	41	6	0	7	7	7

5.2.1 Dissolved oxygen % saturation EHI

Figure 23 shows the median DO % saturation for each aggregate monitoring site by zone compared to the reporting thresholds. Note that score bands for DO have both upper and lower thresholds (i.e., increasing above the upper thresholds or decreasing below the lower threshold both lead to a decrease in score). This figure has two components – a) showing the entire dataset with all observations and thresholds, and b) focusing on data and thresholds falling between 80% and 110% saturation.

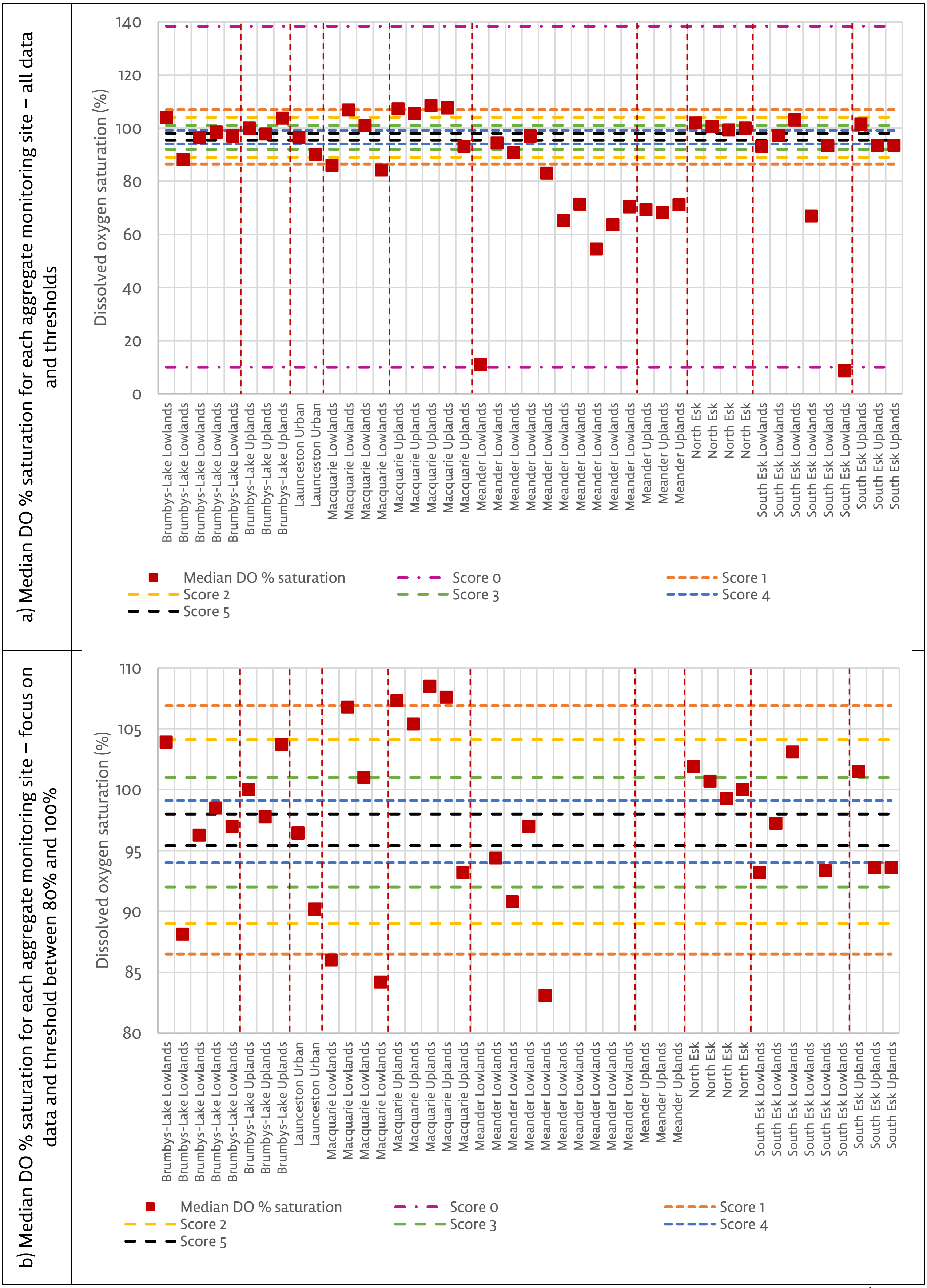

Figure 23. Comparison of median DO % saturation at aggregate sites with thresholds used for calculating scores a) all data and thresholds b) focus on data and thresholds between 90% and 100% saturation. Dashed red vertical lines indicate the transition between reporting zones.

Figure 23 shows:

- Observations in the extreme low score ranges Launceston urban, Macquarie lowlands, Meander lowlands and South Esk lowlands with very low dissolved oxygen saturation and the Macquarie uplands where high dissolved oxygen saturation exceeds upper thresholds for score 1.
- The Brumbys-Lake lowlands have the largest number of sites where observations fall in the 5 and 4 to 5 score bands with two extreme values, one high DO % saturation and one low, having scores between 1 and 2.
- Decreases in score in the North Esk occur due to high DO % saturation rather than low values.

Table 6 summarises the number of aggregate sites, total number of observations, average scores and overall DO % saturation component EHI for each zone.

Table 6. Number of sites, total number of observations, component scores and DO % saturation EHI for all reporting zones.

Zone	Number of aggregate sites	Total number of observations	Average score	DO % sat EHI
Brumbys-Lake Lowlands	5	1581	3.65	0.731
Brumbys-Lake Uplands	3	4292	3.55	0.71
Launceston Urban	2	16	3.7	0.74
Macquarie Lowlands	4	112	0.75	0.15
Macquarie Uplands	5	221	1.61	0.322
Meander Lowlands	10	337	1.65	0.329
Meander Uplands	3	143	0.78	0.156
North Esk Uplands	4	140	3.33	0.666
South Esk Lowlands	6	317	2.56	0.511
South Esk Uplands	2	12	3.32	0.664

Table 6 shows that DO % saturation EHI are very low in the Macquarie lowlands and Meander uplands, with values below 0.2 in these zones. The Brumbys-Lake zones and Launceston urban zone have the highest EHI, all over 0.7. In general DO % saturation EHI are well below EHI for macroinvertebrates.

5.2.2 Turbidity EHI

Figure 24 shows the median observed values of turbidity in each reporting zone compared to score thresholds. Note that the y-axis on this figure is in log-scale to allow differences between values and thresholds to be visualised more clearly.

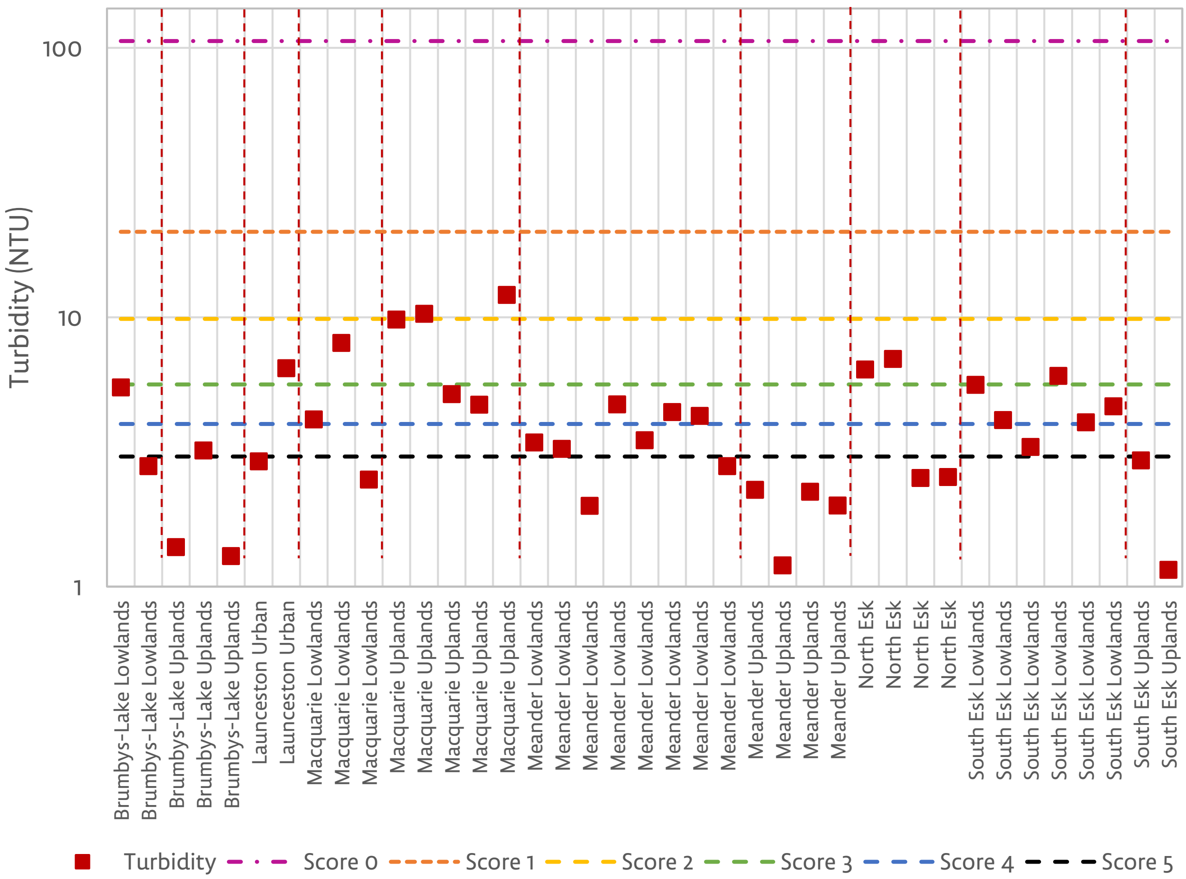

Figure 24. Comparison of median turbidity (NTU) at aggregate sites with thresholds used for calculating scores. Note y-axis is plotted on a log-scale to allow easier comparison of data with threshold values.

Figure 24 shows:

- All turbidity observations are below (i.e., better than) the threshold for a score of 1.
- The Brumbys-Lake uplands, Meander uplands and South Esk uplands have the most consistently low turbidity values with all sites below or just over the thresholds for a score of 5.
- The Macquarie uplands has the overall highest turbidity values and consequently the lowest turbidity scores.
- The Brumbys-Lake lowlands, Meander lowlands, South Esk lowlands, North Esk and Launceston urban have a mix of turbidity values mostly giving scores of between 3 and 5, or just exceeding the threshold for a score of 3.

Table 7 summarises the number of aggregate sites, total number of observations, average scores and overall turbidity component EHI for each zone.

Table 7. Number of sites, total number of observations, component scores and turbidity EHI for all reporting zones.

Zone	Number of aggregate sites	Total number of observations	Average score	Turbidity EHI
Brumbys-Lake Lowlands	2	1584	4.04	0.809
Brumbys-Lake Uplands	3	4292	4.95	0.989
Launceston Urban	2	16	3.9	0.78
Macquarie Lowlands	3	146	3.78	0.755
Macquarie Uplands	5	221	2.52	0.504
Meander Lowlands	8	439	4.38	0.875
Meander Uplands	4	206	5	1
North Esk Uplands	4	221	3.87	0.775
South Esk Lowlands	6	400	3.69	0.737
South Esk Uplands	2	61	5	1

Table 7 shows the EHI for turbidity are substantially higher than those for DO% saturation for all zones. This disparity is greatest in the Macquarie lowlands and Meander uplands where average DO EHI are below 0.2 and turbidity EHI are 0.755 and 1, respectively. The Brumbys-Lake lowlands, Brumbys-Lake uplands and South Esk uplands have the most consistently high EHI across both DO and turbidity.

5.2.3 Nutrient component EHI

The nutrient EHI is created by averaging scores cross TN, TP, and NOx where data are available. Figure 25 shows the median observed TN concentration at each aggregate site by reporting zone compared to score threshold values. Note there is no nutrient data at any of the Brumbys-Lake uplands or Launceston urban sites.

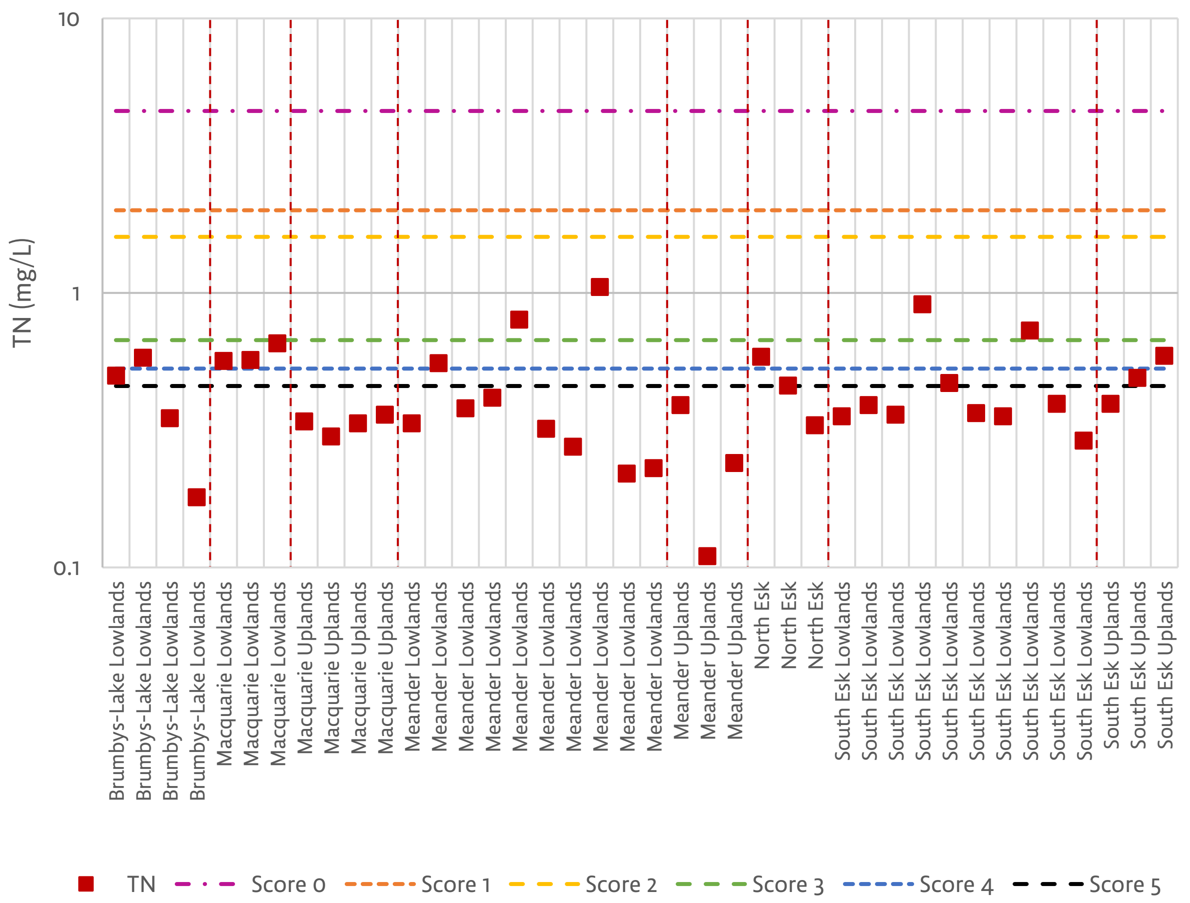

Figure 25. Comparison of median TN (mg/L) at aggregate sites with thresholds used for calculating scores. Note: y-axis is plotted on a log-scale to allow easier comparison of data with threshold values.

Figure 25 shows:

- While most sites in the South Esk lowlands have low TN concentrations (below the score of 5 threshold), this zone also has two of the sites with poorer TN concentrations between the thresholds for scores of 2 and 3.
- The best TN concentrations are at the Macquarie uplands and Meander uplands sites with all values below the threshold for a score of 5.
- The Brumbys-Lake lowlands, Macquarie lowlands, North Esk and South Esk uplands have mixed TN concentrations with concentrations varying fairly equally from below the score of 5 threshold to between the thresholds for 3 and 4.
- TN concentrations in the Meander lowlands are more mixed. The majority of sites have concentrations below the threshold for a score of 5 with one site sitting between a score of 3 and 4 and 2 sites between scores of 2 and 3.

Figure 26 shows the median observed TP concentration at each aggregate site by reporting zone compared to score threshold values. Note that like turbidity and TN, the y-axis is in log-scale to allow easier interpretation of the data.

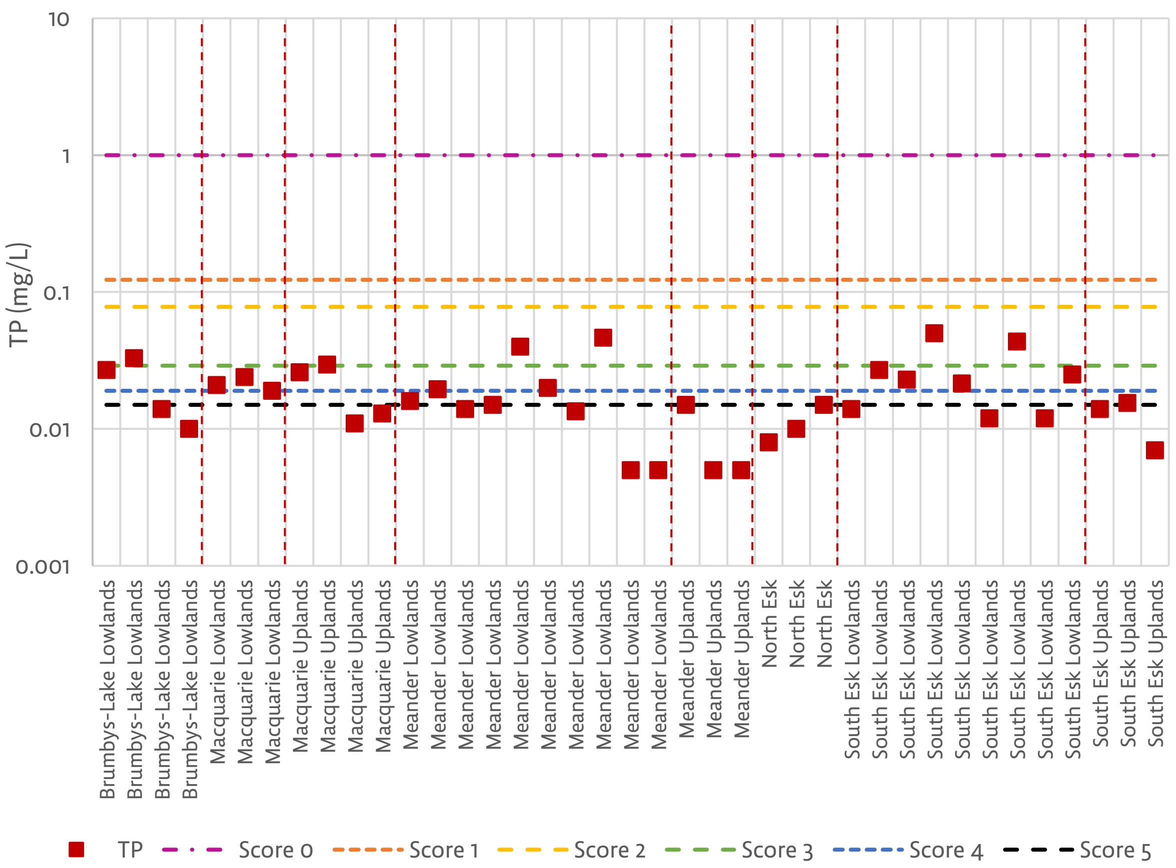

Figure 26. Comparison of median TP (mg/L) at aggregate sites with thresholds used for calculating scores. Note y-axis is plotted on a log-scale to allow easier comparison of data with threshold values.

Figure 26 shows:

- Overall patterns of observed TP concentrations between zones are similar to those of TN.
- The best TP concentrations occur at aggregate sites in the Meander uplands, North Esk and South Esk uplands, where all TP concentrations are at or just above the threshold for a score of 5.
- One site in the South Esk lowlands has TP unlike TN, relatively few sites in the South Esk lowlands achieve a score of 5 with most concentrations sitting between the thresholds for score of 3 and 4.
- The Brumbys-Lake lowlands, Macquarie lowlands and Macquarie uplands have TP concentrations generally sitting between the thresholds for 3 and 5.
- The Meander lowlands in general has slightly poorer TP concentrations with some sites having concentrations between the thresholds for scores of 2 and 3.

Figure 27 shows the median observed NOx concentration at each aggregate site by reporting zone compared to score threshold values. Note that like turbidity, TN and TP, the y-axis is in log-scale to allow easier interpretation of the data.

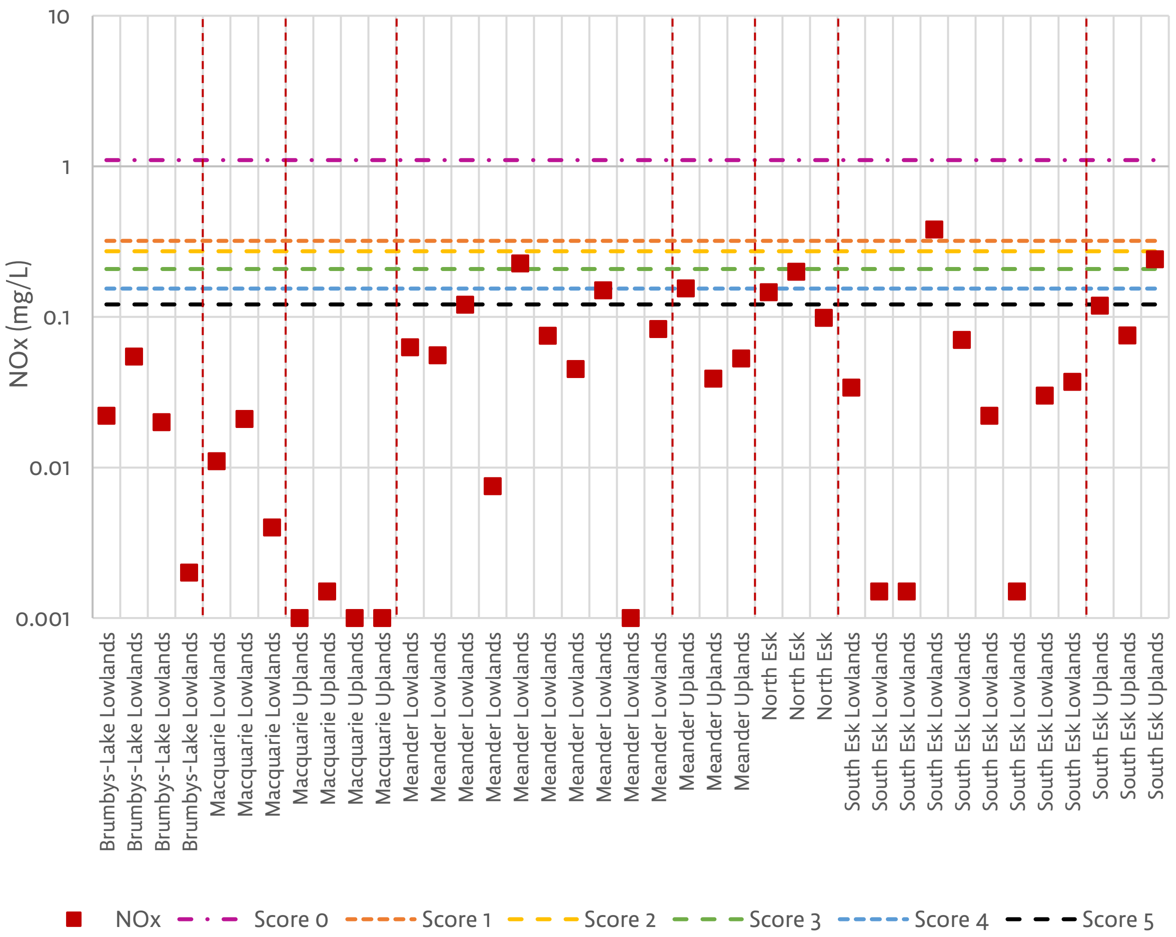

Figure 27. Comparison of median NOx (mg/L) at aggregate sites with thresholds used for calculating scores. Note: y-axis is plotted on a log-scale to allow easier comparison of data with threshold values.

Figure 27 shows:

- NOx concentrations are consistently below the threshold for a score of 5 at sites in the Brumbys-Lake lowlands, Macquarie lowlands and the Macquarie uplands.
- The poorest NOx concentrations occurred in the South Esk lowlands where one site had a concentration between thresholds for a score of 0 and 1. All other observations in this zone were below the threshold for a score of 5.
- NOx concentrations in the North Esk and Meander uplands are similar with a mix of observations below the threshold for a score of 5 and between thresholds for 3 and 5.
- NOx in the Meander lowlands and South Esk uplands is slightly poorer with most values below the threshold for a score of 5 or between thresholds for 4 and 5 but having a single observation above this range, between thresholds for a score or 2 and 3.

Table 8 summarises the number of observations and aggregate sites in each zone for TN, TP, and NOx as well as the average score for each parameter. The resultant nutrient component EHI for each zone is then provided.

Table 8. Number of aggregate sites, total number of observations, component scores and EHI for nutrients (TN, TP, NOx)

Indicator	Number of aggregate sites			Total number of observations			Average Score			Nutrient EHI
	TN	TP	NOx	TN	TP	NOx	TN	TP	NOx	
Brumbys-Lake Lowlands	4	4	4	169	169	153	4.52	4.03	5	0.903
Brumbys-Lake Uplands	0	0	0	0	0	0	NA	NA	NA	NA
Launceston Urban (including North Esk Lowlands)	0	0	0	0	0	0	NA	NA	NA	NA
Macquarie Lowlands	3	3	3	109	109	109	3.53	3.77	5	0.82
Macquarie Uplands	4	4	4	80	80	80	5	4.07	5	0.938
Meander Lowlands	10	10	10	348	348	346	4.43	4.3	4.68	0.894
Meander Uplands	3	3	3	80	80	79	5	5	4.66	0.978
North Esk Uplands	3	3	3	67	67	67	4.53	5	4.29	0.921
South Esk Lowlands	10	10	10	316	316	311	4.55	3.92	4.59	0.871
South Esk Uplands	3	3	3	39	39	39	4.38	4.96	4.16	0.9

Table 8 shows that there is significantly less nutrient data available for reporting than DO % saturation and turbidity, both in terms of the number of sites and the number of observations. The smallest number of observations outside the Brumbys-Lake uplands and Launceston urban is 39, with other zones having up to 348 observations. Overall, nutrient component EHIs are higher than DO % sat and turbidity EHIs, with the lowest value in the Macquarie lowlands of 0.82. All other zones have EHIs between 0.87 and 1.

5.3 Riparian habitat

The riparian habitat EHI is calculated using an estimate of native riparian vegetation extent across each zone using spatial datasets:

- TASVEG 4.0 which was released in 2020 as an open dataset by the Tasmanian Government. These data are available on the LIST and represent the best available knowledge of vegetation types during the reporting period; and,
- the National Forest and Sparse Woody Vegetation Data Version 6.0 - 2021 Release which is an open dataset provided by the Australian Government.

These datasets are shown in Figures 28 and 29 respectively.

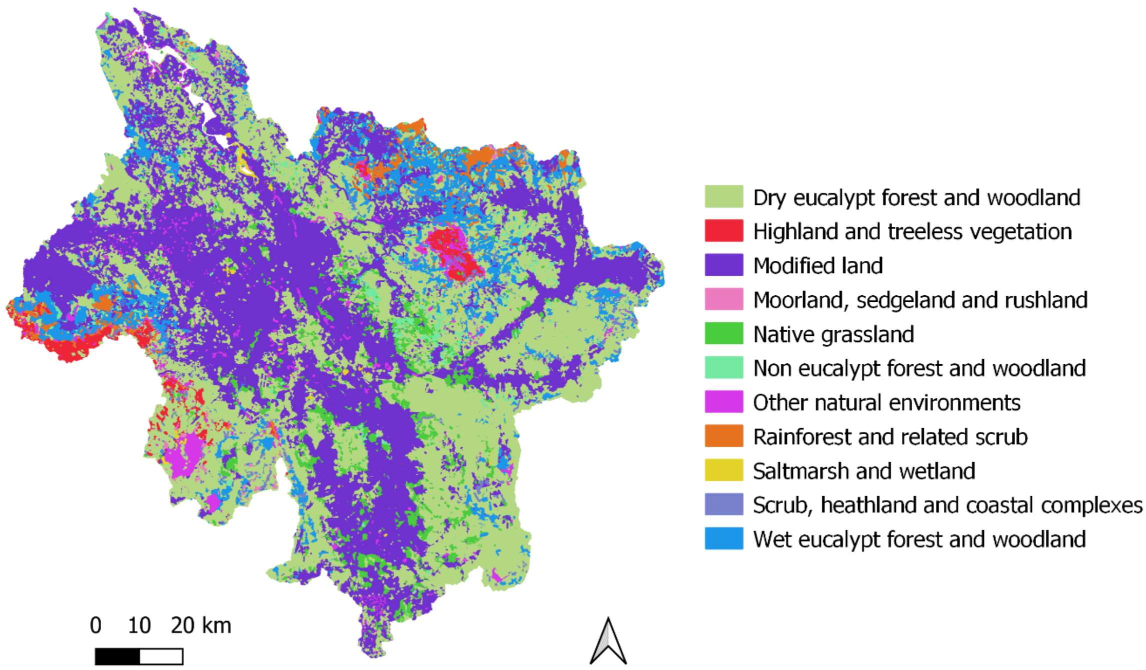

Figure 28. Vegetation group from TASVEG 4.0 for the kanamaluka / Tamar estuary and Esk rivers catchment. Source: DPIPWE, 2020.

The TASVEG dataset splits vegetation into a range of native vegetation classes and 'modified land'. The report card considers any areas mapped as one of these native vegetation classes to be native vegetation. Modified land is further classified into types within the TASVEG dataset as: agriculture, cleared, plantation, urban and weeds. Areas which are plantation or weeds are assumed to be non-native vegetation. Areas that are agriculture, cleared or urban are further classified using the woody vegetation layer shown in Figure 29.

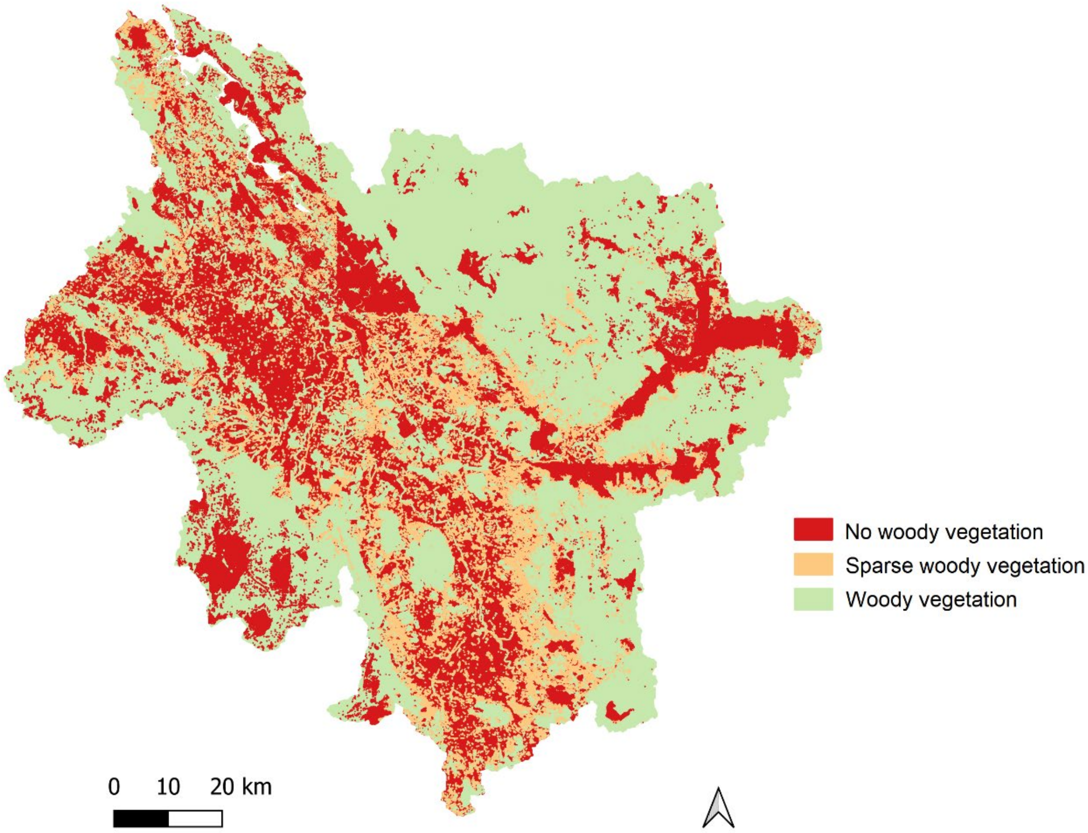

Figure 29. National Forest and Sparse Woody Vegetation Data Version 6.0 - 2021 Release for the kanamaluka / Tamar estuary and Esk rivers catchment. Source: Department of Climate Change, Energy, the Environment and Water (DCCEEW) (2022).

Figure 29 shows the catchment classified into areas of native vegetation based on remote sensing by assuming that 'woody vegetation' occurs in areas mapped as agriculture, cleared or urban are native vegetation. The riparian zone is assumed to extend 50 m from the centre of the mapped stream (CFEV Rivers) in agricultural areas and 30 m in urban areas.

Using this combination of datasets to classify areas into native and non-native vegetation and clipping to these buffers provides a riparian vegetation dataset that classifies the riparian zone into native and non-native vegetation areas as shown in Figure 30.

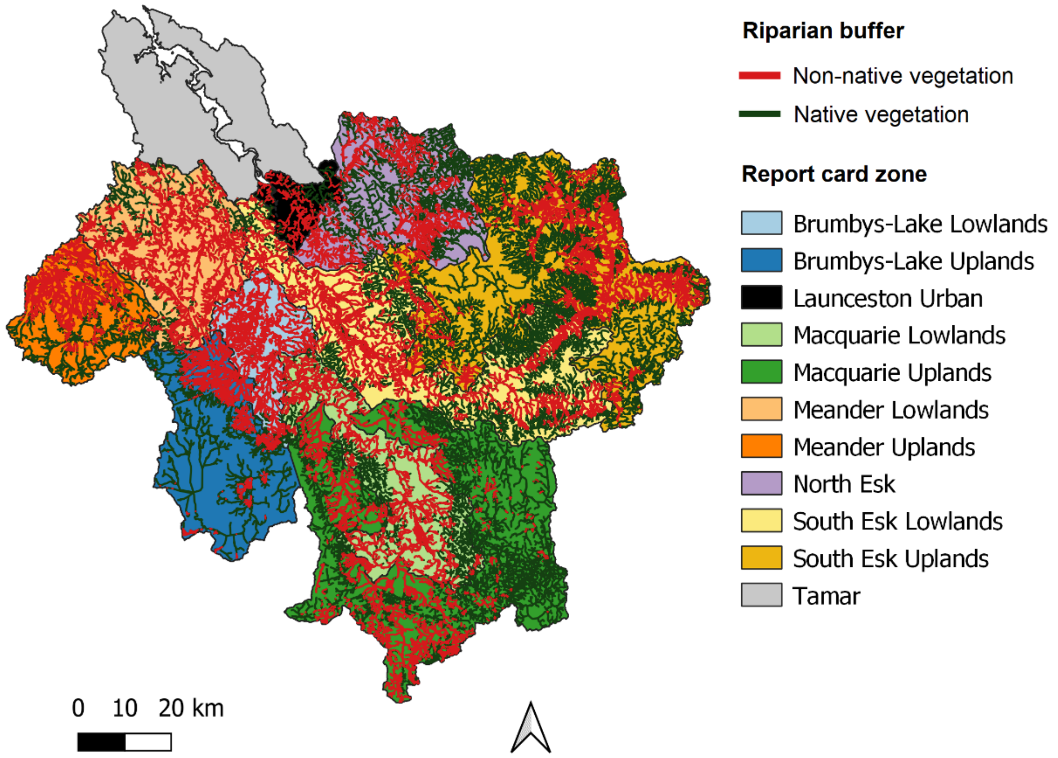

Figure 30. Map of riparian zone split into native and non-native vegetation types.

This map shows extensive areas of non-native vegetation in lowland areas of many sub-catchments as well as through the Macquarie uplands. Figure 31 shows a close up of the Brumbys-Lake lowlands and compares with the Google Earth image of the area. This figure demonstrates the very low proportion of the riparian zone that contains native vegetation in this area. The Google Earth image shows the high level of agricultural and irrigation development in this reporting zone, with streams generally being cleared to at or near their riverbanks.

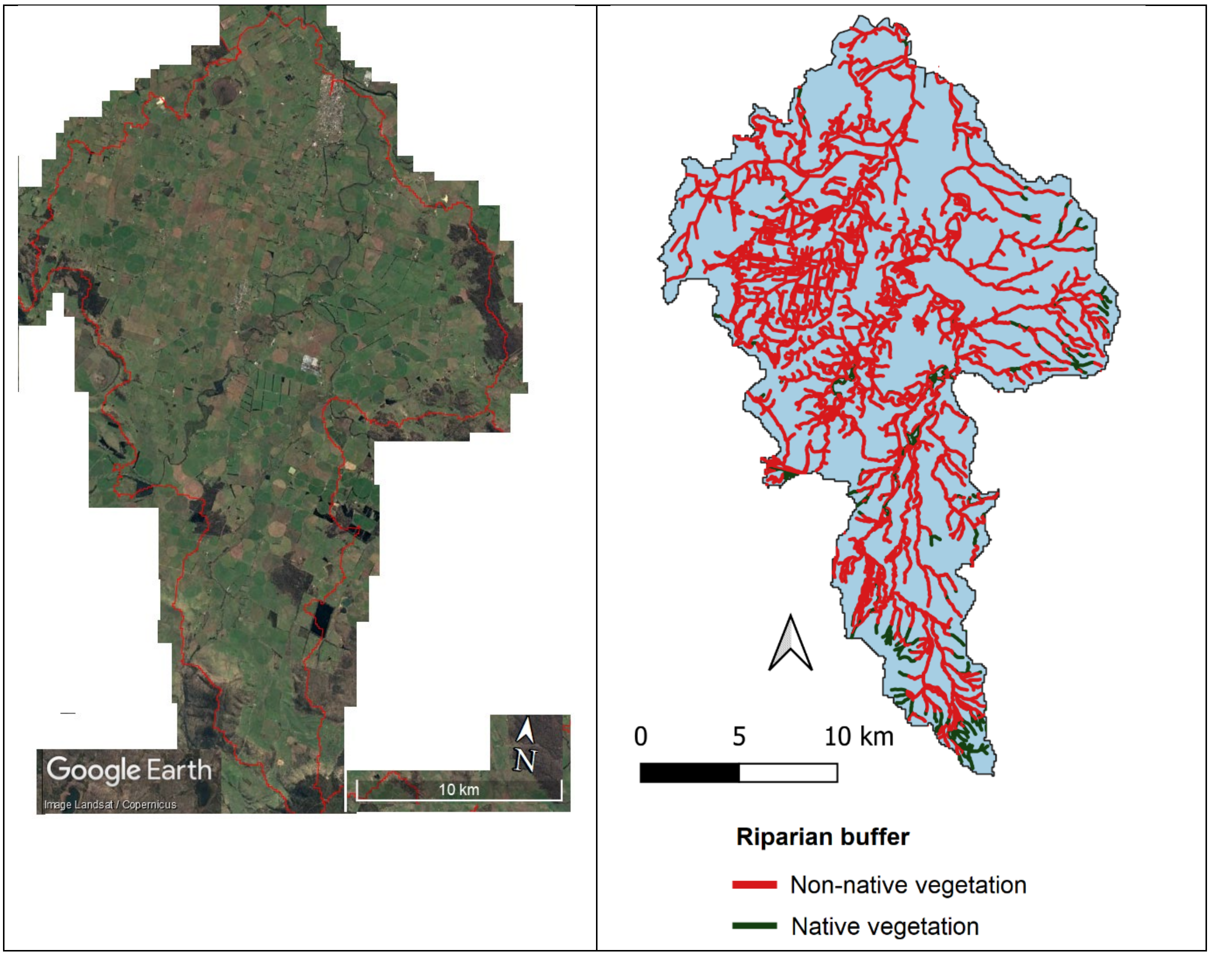

Figure 31. Example of classification of riparian vegetation versus satellite imagery – Brumbys-Lake lowlands.

Based on this riparian vegetation layer, the proportion of the riparian zone that is native vegetation has been calculated. This is used to calculate a score for use in the report card, as was described in the Freshwater Report Card Methodology Report. Figure 32 shows the estimated native riparian vegetation extent (i.e., proportion of the riparian zone that is native vegetation) for each reporting zone plotted against the score used to calculate the riparian habitat EHI in the report card. The black dashed line in Figure 32 shows the relationship between score and extent based on the conceptual model of landscape modification developed by McIntyre and Hobbs (1999) that was used in the report card.

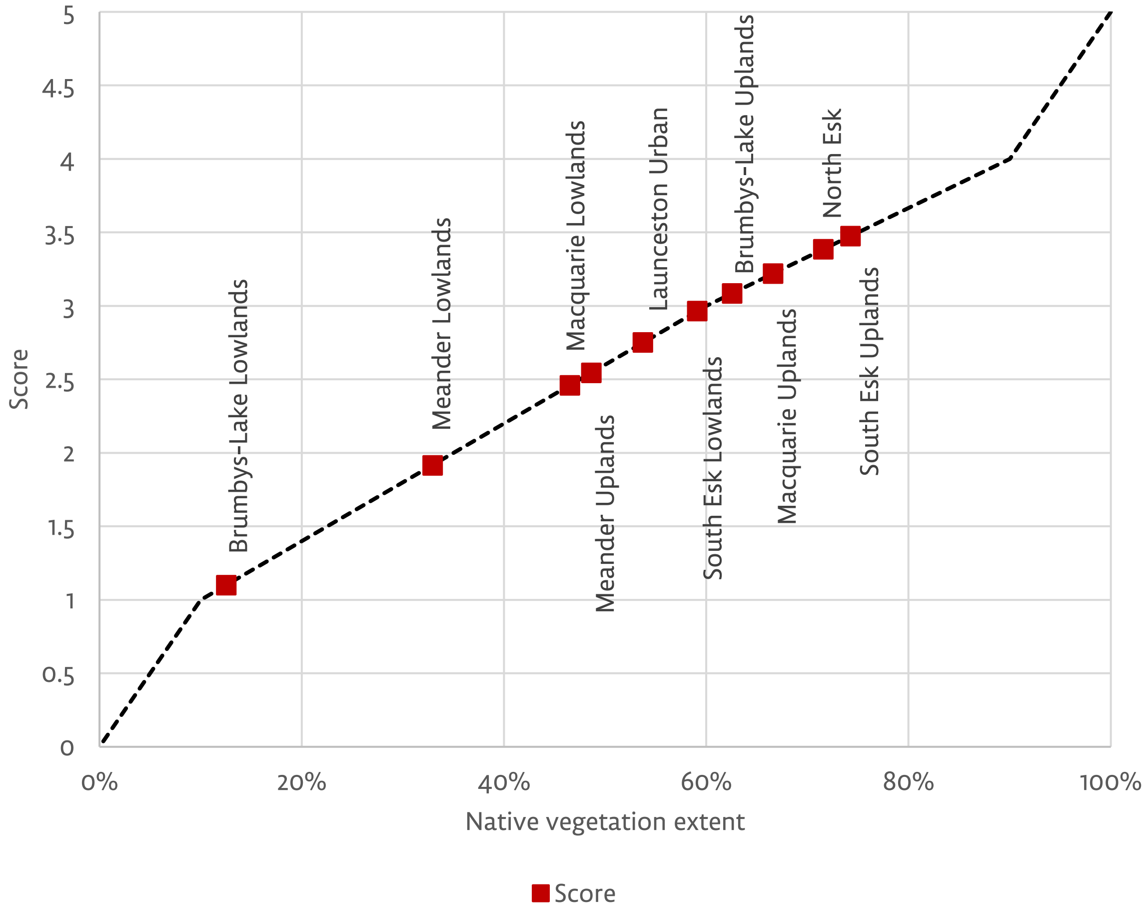

Figure 32. Riparian habitat score for Freshwater Report Card zones based on native vegetation extent.

Figure 32 shows a large range in riparian native vegetation extent varying from 13% in the Brumbys-Lake lowlands to 74% in the South Esk uplands. Note that using the classification of McIntyre and Hobbs (1999):

- The Brumbys-Lake lowlands, Launceston urban, Macquarie lowlands, Meander lowlands, Meander uplands and South Esk lowlands can all be considered to have fragmented native vegetation in the riparian zone. These areas can all be expected to have decreased connectivity and suffer from edge effects which impacts riparian vegetation condition. The extent of native vegetation in the Brumbys-Lake lowlands zone is just above the thresholds for relictual landscape (10%), which are the most highly modified landscapes and for which riparian habitat values are severely compromised.
- The Brumbys-Lake uplands, Macquarie uplands, North Esk, and South Esk uplands all have variegated native riparian vegetation. While these areas are in better condition than fragmented zones, they still suffer from a loss of connectivity and will experience some edge effects that will have impacts on riparian vegetation condition.
- No reporting zones have intact native riparian vegetation with the closest level of native riparian vegetation extent, the South Esk uplands, still having 16% less native vegetation than this threshold (90%).

Table 9 provides the native riparian vegetation extent results and riparian habitat EHI for each reporting zone.

Table 9. Riparian native vegetation extent and riparian habitat EHI for Freshwater Report Card zones.

Indicator	Extent	EHI
Brumbys-Lake Lowlands	13%	0.220
Brumbys-Lake Uplands	63%	0.617
Launceston Urban (including North Esk Lowlands)	54%	0.55
Macquarie Lowlands	47%	0.492
Macquarie Uplands	67%	0.644
Meander Lowlands	33%	0.383
Meander Uplands	49%	0.509
North Esk Uplands	72%	0.677
South Esk Lowlands	59%	0.593
South Esk Uplands	74%	0.695

Table 9 shows EHI values ranging from 0.220 in the Brumbys-Lake lowlands to a maximum of 0.695 in the South Esk uplands. EHI for riparian habitat are generally lower than was the case for other reporting components (aquatic life and aquatic habitat).

6 Grades and findings

The three component EHIs – aquatic life, aquatic habitat, and riparian habitat – were averaged to provide an overall EHI for each reporting zone. For further detail on how the grades are calculated, refer to the Freshwater Report Card Methodology Report. Grades are as follows:

A. Excellent - Conditions at most monitoring sites or for the majority of river reaches reflect high conservation status and/or show minimal impacts of disturbance.
B. Good - Most sites or river reaches have some impairment or disturbance impacts, but the condition represents a healthy modified condition.
C. Fair - Most but not all sites or reaches have a substantial level of disturbance or impairment with the zone having a mix of healthy, minimally impacted areas and degraded reaches.
D. Poor - Sites or reaches are a mix of substantially and severely impacted with very few sites or reaches in a healthy condition.
E. Very poor - Most sites or reaches have severe impairment or are severely degraded through disturbance.

Graduations within these grades of +/- indicate movement within the grade. Component and overall EHIs and grades for the 2023 Freshwater Report Card are provided in Table 10.

Table 10. Overall and component EHI and grades for each zone in the 2023 Freshwater Report Card.

Zone	Aquatic life		Aquatic habitat		Riparian habitat		**Total**	
	EHI	Grade	EHI	Grade	EHI	Grade	**EHI**	**Grade**
Brumbys-Lake Lowlands	0.69	C+	0.814	B+	0.22	E-	**0.575**	**C-**
Brumbys-Lake Uplands	1	A+	0.85	B+	0.617	C	**0.822**	**B+**
Launceston Urban	0.444	D-	0.76	B	0.55	D+	**0.585**	**C-**
Macquarie Lowlands	0.715	B-	0.575	C-	0.492	D	**0.594**	**C-**
Macquarie Uplands	0.856	A-	0.588	C-	0.644	C	**0.696**	**C+**
Meander Lowlands	0.712	B-	0.699	C+	0.383	E+	**0.598**	**C-**
Meander Uplands	0.885	A-	0.711	B-	0.509	D+	**0.702**	**B-**
North Esk Uplands	0.938	A	0.787	B	0.677	C+	**0.801**	**B+**
South Esk Lowlands	0.633	C	0.703	B-	0.593	C-	**0.643**	**C**
South Esk Uplands	0.789	B	0.855	A-	0.695	C+	**0.78**	**B**

The rank of EHI for each component and overall is given in Table 11.

Table 11. Rank of EHI by zone for components and overall. Ranks are from 1 = highest EHI (best condition) to 10 = lowest EHI (worst condition).

Zone	Aquatic life	Aquatic habitat	Riparian habitat	Overall
Brumbys-Lake Lowlands	8	3	10	10
Brumbys-Lake Uplands	1	2	4	1
Launceston Urban	10	5	6	9
Macquarie Lowlands	6	10	8	8
Macquarie Uplands	4	9	3	5
Meander Lowlands	7	8	9	7
Meander Uplands	3	6	7	4
North Esk Uplands	2	4	2	2
South Esk Lowlands	9	7	5	6
South Esk Uplands	5	1	1	3

These tables show:

- Grades for aquatic life and aquatic habitat are better than those for riparian habitat in almost all zones. Exceptions are Launceston urban where the aquatic life grade of D- is slightly below the D+ of riparian habitat, and the Macquarie uplands where the aquatic habitat grade of C- is slightly below the grade of C for riparian habitat. In both cases the difference is marginal.
- Grades for aquatic habitat varied from C to A-. Grades of aquatic life varied between D- and A+ and those of riparian habitat varied from an E- to a C+, indicating at best only fair riparian habitat across the reporting zones.

- Zones with the lowest component grades are the Brumbys-Lake lowlands with an E- for and the Meander lowlands with an E+ for riparian habitat. Launceston urban, the Meander uplands and Macquarie lowlands all had poor riparian vegetation (grades of D+, D and D+, respectively).
- Overall grades are lowest in the Brumbys-Lake lowlands, Launceston urban, Meander lowlands and Macquarie lowlands. These zones all had an overall grade of C-, indicating fair condition. These zones generally rank low in grade across all components with the exception of aquatic habitat in the Brumbys-Lake lowlands. In this case, the relatively high ranking of aquatic habitat is offset by a much lower ranking of aquatic life and riparian habitat EHI (3rd lowest and 1st lowest EHI across all zones, respectively).
- The North Esk and Brumbys-Lake uplands have the highest overall grade of B+ indicating good condition. These zones rank between the 1st and 4th highest EHI for all indicators.

7 How are TEER Program partners working to improve Freshwater Ecosystem Health in the kanamaluka / Tamar Estuary and Esk rivers catchment?

TEER Program partners are undertaking a range of investments that are expected to improve freshwater ecosystem health in the kanamaluka / Tamar Estuary and Esk rivers catchment.

7.1 TasWater – Reducing nutrients from wastewater treatment plants

The Longford wastewater treatment plant (WWTP) has been upgraded and was commissioned in early 2023. The new state-of-the-art WWTP is operational and is providing better environmental outcomes by improving compliance and the quality of effluent discharged into the South Esk River.

Improvements have reduced nutrient levels being discharged to the South Esk River, including ammonia, nitrogen and phosphorous with a subsequent expected improvement in the receiving environment water quality.

TasWater's Launceston Sewerage Improvement Program (LSIP) is a proposed program of work overtime that will result in the upgrade or rationalisation of the seven WWTP that currently serve the Greater Launceston area.

TasWater has begun the significant program of planning, analysis, and design work to confirm the preferred approach to delivering this once-in-a-generation opportunity to improve the way Launceston's sewage is treated.

LSIP includes the Prospect Vale WWTP and the proposed rationalisation and decommissioning of this WWTP will eliminate wastewater inputs into the lower South Esk River.

7.2 City of Launceston – Urban Waterway Management Program

City of Launceston's Urban Waterway Management Program commenced in 2022/23. It takes a multi-pronged approach to improve urban waterway health. The program includes:

- Assessment of urban waterways including collection of data on macroinvertebrates, aquatic habitat, and riparian habitat.

- Education, communication, and community engagement to promote urban waterways and increase recognition of their value as community assets, community green spaces and wildlife corridors.
- On-ground restoration works and water sensitive urban design (WSUD) projects such as investment in WSUD elements in Newnham creek, watercourse shaping and revegetation of Jinglers creek, revegetation of the open outfall drain at Launceston Waste Centre, and the Charles St arbour and rain garden.

These projects can be expected to improve water quality and other features of aquatic habitat and improve riparian habitat creating better environments for aquatic life.

7.3 Tamar Action Grants – NRM North

The Tamar Estuary River Health Action Plan (RHAP), released in 2017, is an initiative of the Tamar Estuary Management Taskforce (TEMT) and the Launceston City Deal, to improve the health of kanamaluka / Tamar estuary. Implementation of this Plan has been funded in a joint investment from the Australian Government, Tasmanian Government, TasWater and City of Launceston.

NRM North is contracted to deliver the Tamar Estuary River Health Action Plan – Catchment Works Program. The program provides funding to support a range of activities that help improve water quality by reducing pathogen concentrations in the kanamaluka / Tamar estuary.

The Tamar Action Grants are a component of this catchment works program and aim to improve water quality in the kanamaluka / Tamar estuary by excluding stock from waterways and rehabilitating riparian revegetation buffers on dairy and grazing farms.

By July 2022, there were 694 km of stream fencing projects either contracted or completed. These projects use fencing and provision of off-stream water in dairy and grazing areas to restrict stock access to streams, thereby reducing stream bank erosion and trampling, as well as pollution through manure deposited directly to the stream. The average width of riparian zone protected through these projects is 14 m, with some riparian buffers substantially wider than this. Revegetation of these riparian areas has occurred through natural regeneration as well as investment by landholders on some sections of the river. These large-scale investments are expected to significantly reduce nutrient, sediment, and pathogen runoff to streams, as well as reduce trampling of stream banks and riverbeds. They can be expected to improve riparian habitat, aquatic habitat, and subsequently aquatic life both in treated sections and in stream reaches downstream of these investments.

7.4 Hydro Tasmania

Hydro Tasmania has been embarking on improving the catchment health of Brumbys Creek for the last five years. A 10-year restoration plan will commence in 2023 that will aim to improve the aquatic health of Brumbys Creek, continue to reduce the willow infestation, and increase the amount of native riparian vegetation from the Poatina Reregulation Pond to Lees Bridge.

After several years of investigation, research and development, a downstream eel bypass was installed on Trevallyn Dam in June 2020 to aid the migratory journey of short finned eels in the South Esk catchment. The bypass has proven successful, and estimates indicate thousands of eels are using it each migration season. Hydro Tasmania will continue to monitor the operation of the bypass and consider additional, complementary measures to further reduce power station mortality.

7.5 Department of Natural Resources and Environment Tasmania

The River Health Advisory Project is being delivered as part of the Rural Water Use Strategy and has a focus on enhancing sharing of data information, developing a new Statewide Water Quality Monitoring Program, and enhancing the understanding of the drivers of river health.

The Government is working to ensure our water management framework addresses emerging risks to water quality, a changing climate and continues to meet the needs of all users, including the environment.

7.5.1 Key Water Projects under the Rural Water Use Strategy

The River Health Advisory Project which includes the Statewide Water Quality Monitoring Program and Water Managers and Data Custodian Working Group, is focusing on enhancing partnerships and exploring new initiatives to better understand, maintain and improve the overall health and water quality of Tasmania's waterways.

The projects are addressing the following three new actions under Goal 1 of the Rural Water Use Strategy:

- 1.8: Improve coordination and data sharing of river health and water quality data
- 1.9: Undertake targeted case study research and reporting to enhance understanding of drivers of changes in river health in catchments in Tasmania
- 1.10: Deliver a Strategic Directions for Healthy Waterway Paper

The River Health Advisory Project is bringing together the stakeholders responsible for the management of Tasmania's water resources and developing a pathway for improved engagement and coordination of catchment and waterway management.

Under the River Health Advisory Project, targeted case study research for the drivers of change has commenced with the aim of gaining a specific and detailed understanding into the primary drivers, stressors, and indicators of river health in the case study catchments.

The research methodologies being tested under the project will be developed into a statewide catchment research framework to guide future work in understanding catchment-specific pressures and drivers of river health. The Water Managers and Data Custodian Working Group which has membership from the Environment Protection Authority, Inland Fisheries Service, Hydro Tasmania, TasWater, Tasmanian Irrigation and NRE Tas has been reviewing all water quality and river health data collected across the state. This data review is informing the design of the new Statewide Water Quality Monitoring Program.

7.5.2 Current River Health Monitoring

Since 1994, NRE Tas has conducted broad-scale monitoring of river conditions in Tasmania under the River Health Monitoring Program. This monitoring provides important datasets on the health of rivers in Tasmania. The River Health Monitoring Program underwent a comprehensive review in 2018. The review investigated the suitability of monitoring sites and resulted in a change in the distribution and number of sites being monitored. The revised selection of 53 sites comprises more sites in developed catchments where there is high demand for water and/or changes of land use, and hence there is a greater need for river health information to support management and planning decisions.

The Program employs rapid sampling methods to assess river health, including Australian River Assessment System protocols, which focus on waterbug (macroinvertebrate) communities and riverine habitat quality, including water quality. Additional indicators of river health, focusing on riverbed sediment and algae, were recommended for inclusion in the River Health Monitoring Program, and these have been incorporated in the monitoring since autumn 2018. The addition of these indicators will provide a more holistic assessment of river health.

The full report on the River Health Monitoring Program review is publicly available on the NRE Tas website and NRE Tas also provide access to river health sampling results via the NRE Tas Water Information Tasmania web portal.

7.5.3 Water Resource Monitoring

For many years, NRE Tas has had a resource monitoring presence in the catchment and currently manage 18 stream gauging and 20 groundwater monitoring sites in the catchment providing information for the management of water resources across the catchment.

8 References

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Appendix 1. Monitoring locations

This appendix contains detailed site information including data custodian, coordinates, and number of observations at each site for data used in the 2023 Freshwater Report Card. Note the water quality table also includes the aggregate site number indicating which sites are aggregated for the purposes of calculating scores.

Macroinvertebrates

Table 12. Macroinvertebrate monitoring sites used to calculate aquatic life EHI.

FRC Zone	Site	Data owner	Easting	Northing	Number of observations
Brumbys-Lake Lowlands	Brumbys Creek - Downstream weir 2 (BC1)	Hydro Tas	506325	5381825	2
Brumbys-Lake Lowlands	Lower Macquarie River - Downstream Brumbys Ck (MU1)	Hydro Tas	507720	5385300	2
Brumbys-Lake Lowlands	Lower Macquarie River - Downstream Brumbys Ck (MU2)	Hydro Tas	507700	5385375	2
Brumbys-Lake Lowlands	Lower Macquarie River - Downstream Brumbys Ck (MU3)	Hydro Tas	507700	5385450	2
Brumbys-Lake Lowlands	Lower Macquarie River - Upstream Brumbys Ck (MD1)	Hydro Tas	511375	5381350	2
Brumbys-Lake Lowlands	Lower Macquarie River - Upstream Brumbys Ck (MD2)	Hydro Tas	511425	5381700	2
Brumbys-Lake Lowlands	Lower Macquarie River - Upstream Brumbys Ck (MD3)	Hydro Tas	511575	5381900	2
Brumbys-Lake Lowlands	Brumbys Creek above farm (PETUNA01)	Petuna	507800	5383250	14
Brumbys-Lake Uplands	Westons Creek - At Saundridge Rd (WC1)	Hydro Tas	496500	5378550	2
Launceston Urban	Corin Street	CoL	512445.8	5417030	4
Launceston Urban	Distillary Creek	CoL	515980.1	5413353	6
Launceston Urban	Jinglers Creek	CoL	514114.3	5410683	2
Launceston Urban	Kings Meadow Rivulet: Kate Reid	CoL	512370.4	5407540	6
Launceston Urban	Kings Meadow Rivulet: Punchbowl Reserve	CoL	515025.5	5408384	6
Launceston Urban	Newham Creek	CoL	509980.1	5410165	4
Macquarie Lowlands	Elizabeth River at Campbell Town (MACQ09)	NRE Tas	540536	5357655	4
Macquarie Lowlands	Macquarie River at Barton (MACQ36)	NRE Tas	519956	5371324	4
Macquarie Lowlands	Macquarie River at bridge ds of Hoggs Ford Road (MACQ81)	NRE Tas	535775	5357380	3
Macquarie Uplands	Macquarie River off Honeysuckle Rd (MACQ03)	NRE Tas	558198	5331930	5
Macquarie Uplands	Floods Creek above fish weir (Upstream) (MACQ97)	TI	523901	5338786	3
Macquarie Uplands	Floods Creek below dam (Downstream) (MACQ96)	TI	526430	5336991	4
Meander Lowlands	Meander River at Birralee Rd (MEAN03)	NRE Tas	484740	5406302	4
Meander Lowlands	Carrick upstream 1	TasWater	501200	5405000	6
Meander Lowlands	Carrick upstream 2	TasWater	501400	5403900	4
Meander Lowlands	Deloraine upstream 1	TasWater	471650	5403510	2
Meander Lowlands	Deloraine upstream 2	TasWater	472020	5403630	2
Meander Lowlands	Westbury (Quamby Brook)	TasWater	485300	5402450	2
Meander Uplands	Liffey River us Liffey (MEAN16)	NRE Tas	481816	5385291	4
Meander Uplands	Jackeys Creek d/s Jackeys Marsh (MEAN13)	TI	470300	5386500	4
Meander Uplands	Meander River at Meander Falls Road (MEAN31)	TI	463900	5382300	6

Meander Uplands	Meander River d/s proposed dam site (MEAN10)	TI	468378	5384116	4
Meander Uplands	Meander River upstream of Jackeys Creek (MEAN09)	TI	469186	5386513	5
Meander Uplands	Meander River upstream of Meander township (MEAN08)	TI	467998	5389092	5
North Esk Uplands	North Esk River at Ballroom (NESK07)	NRE Tas	532475	5406272	3
North Esk Uplands	North Esk River at Ben Nevis gates (NESK12)	NRE Tas	544320	5415758	4
North Esk Uplands	North Esk River at Corra Linn Gorge (NESK03)	NRE Tas	519381	5407015	4
North Esk Uplands	St Patricks River at Nunamara (NESK19)	NRE Tas	525147	5417972	4
South Esk Lowlands	South Esk River at Heffords Road (SESK58)	NRE Tas	572554	5386058	3
South Esk Lowlands	South Esk River at Llewellyn (SESK54)	NRE Tas	547145	5370619	4
South Esk Lowlands	South Esk River at Perth (SESK01)	NRE Tas	515231	5396568	2
South Esk Lowlands	Perth (Cox's creek and Cox's rivulet) Upstream 1	TasWater	514500	5394900	4
South Esk Lowlands	Perth (Cox's creek and Cox's rivulet) Upstream 2	TasWater	513650	5394850	4
South Esk Uplands	South Esk River at Cokers Rd (SESK08)	NRE Tas	560100	5414398	2
South Esk Uplands	South Esk River at Sandhurst Road (SESK59)	NRE Tas	566785	5409615	1
South Esk Uplands	South Esk River u/s Evercreech Road (SESK60)	NRE Tas	579937	5408270	3
South Esk Uplands	Fingal upstream edge 1	TasWater	580500	5389500	3
South Esk Uplands	Fingal upstream edge 2	TasWater	580500	5389600	4
South Esk Uplands	Fingal upstream edge 3	TasWater	580500	5389700	4
South Esk Uplands	Fingal upstream riffle	TasWater	580500	5389500	4

Water quality

Table 13. Water quality monitoring sites used to calculate aquatic habitat EHI. Note: 'aggregate site number' indicates where site data has been aggregated to derive a median value.

Zone Name	Site	Data Owner	Aggregate site number	Easting	Northing	Number of observations over the reporting period at site				
						DO % sat	Turbidity	TN	TP	NOx
Brumbys-Lake Lowlands	Woods Lake middle	Hydro Tas	48	505167	5380170	1461	1461	0	0	0
Brumbys-Lake Lowlands	Cressy STP Back Creek U/S Discharge (58815) (CSD01S06)	TasWater	10	506342	5385176	11	0	11	11	11
Brumbys-Lake Lowlands	Longford WWTP Back Creek Junction (58658) (LFD01S11)	TasWater	17	508548	5398342	42	0	41	41	42
Brumbys-Lake Lowlands	Longford Macquarie River (650099) (LOW51W03)	TasWater	17	510300	5395400	2	123	54	54	54
Brumbys-Lake Lowlands	Cressy Inlet	Petuna	49	508282	5382834	36	0	33	33	15
Brumbys-Lake Lowlands	Cressy Raw Intake	Petuna	50	508386	5383360	29	0	30	30	31
Brumbys-Lake Uplands	ARTHURS LAKE ON LAKE - MORASS BAY	Hydro Tas	1	495492	5348555	1461	1461	0	0	0
Brumbys-Lake Uplands	BRUMBYS CREEK 1.6KM UPSTREAM No.1 WEIR 1.6KM U/S No.1 WEIR	Hydro Tas	2	503493	5375511	1370	1370	0	0	0
Brumbys-Lake Uplands	POATINA RE-REGULATION POND	Hydro Tas	3	500091	5341556	1461	1461	0	0	0
Launceston Urban	Corin Street	CoL	8	509980.1	5410165	2	0	0	0	0
Launceston Urban	Distillery Creek	CoL	7	515980.1	5413353	3	2	0	0	0
Launceston Urban	Jinglers Creek	CoL	8	515025.5	5408384	2	3	0	0	0
Launceston Urban	Kings Meadow Rivulet: Kate Reid	CoL	8	514114.3	5410683	3	4	0	0	0
Launceston Urban	Kings Meadow Rivulet: Punchbowl Reserve	CoL	8	512370.4	5407540	3	4	0	0	0
Launceston Urban	Newham Creek	CoL	7	512445.8	5417030	3	3	0	0	0
Macquarie Lowlands	Elizabeth River at Campbell Town (MACQ09)	NRE Tas	36	540536	5357655	4	4	0	0	0
Macquarie Lowlands	Macquarie River at Barton (MACQ36)	NRE Tas	36	519956	5371324	2	4	0	0	0
Macquarie Lowlands	Macquarie River at bridge ds of Hoggs Ford Road (MACQ81)	NRE Tas	36	535775	5357380	3	3	0	0	0
Macquarie Lowlands	Ross WWTP Macq. River U/S (58755) (ROD01S04)	TasWater	37	540708	5347075	39	0	40	40	40
Macquarie Lowlands	Campbell Town Elizabeth River (650174) (CTW51W03)	TasWater	5	541300	5357600	21	80	56	56	56
Macquarie Lowlands	MWS_5	TI	29	531989	5334776	43	43	13	13	13

Macquarie Lowlands	Campbell Town STP Elizabeth River U/S (CTD01S08)	TasWater	5	540168	5357662	0	12	0	0	0
Macquarie Uplands	Macquarie River off Honeysuckle Rd (MACQ03)	NRE Tas	35	558198	5331930	5	5	0	0	0
Macquarie Uplands	MWS_2_DS	TI	35	543188	5318316	3	3	0	0	0
Macquarie Uplands	MWS_2_US	TI	35	543102.7	5318105	1	1	0	0	0
Macquarie Uplands	MWS_3_DS	TI	26	527445.5	5347357	41	41	13	13	13
Macquarie Uplands	MWS_3_US	TI	27	527420.6	5347258	43	43	14	14	14
Macquarie Uplands	MWS_4_DS	TI	28	526430	5336991	43	43	12	12	12
Macquarie Uplands	MWS_6	TI	30	525337.6	5337779	43	43	38	38	38
Macquarie Uplands	MWS_7_US	TI	30	523901	5338786	42	42	3	3	3
Meander Lowlands	Meander River at Birralee Rd (MEAN03)	NRE Tas	25	484740	5406302	3	4	0	0	0
Meander Lowlands	Deloraine STP Upstream (58630) (DLT01S04)	TasWater	12	471736	5403417	43	0	42	42	42
Meander Lowlands	Westbury STP U/S (58639) (WBT01S01)	TasWater	42	485639	5402977	47	0	65	65	66
Meander Lowlands	Carrick STP Meander River - bridge (CAT01S14)	TasWater	6	502806	5403388	17	25	37	37	36
Meander Lowlands	Westbury WTP Raw Water TAP (650254) (WHW51W05)	TasWater	25	482600	5405800	2	84	55	55	54
Meander Lowlands	Bracknell Liffey River Raw Intake (650097) (BNW51W02)	TasWater	4	495300	5388500	8	85	56	56	56
Meander Lowlands	WHS_1	TI	43	500124	5401906	44	44	13	13	13
Meander Lowlands	WHS_2	TI	44	496124	5391422	40	39	12	12	12
Meander Lowlands	WHS_3	TI	4	495714	5388835	3	3	1	1	1
Meander Lowlands	WHS_4	TI	45	493150	5394384	43	44	14	14	14
Meander Lowlands	WHS_5	TI	46	494213	5386873	43	43	13	13	13
Meander Lowlands	WHS_6	TI	47	494119.1	5386667	44	43	13	13	13
Meander Lowlands	Carrick STP Upstream (CAT01S15)	TasWater	6	500837	5403795	0	25	27	27	26
Meander Uplands	Jackeys Creek ds Jackeys Marsh (MEAN31)	NRE Tas	23	470637	5386642	2	2	0	0	0
Meander Uplands	Liffey River us Liffey (MEAN16)	NRE Tas	23	481816	5385291	3	4	0	0	0
Meander Uplands	Meander River at Falls Rd (MEAN13)	NRE Tas	22	464197	5382572	2	2	0	0	0
Meander Uplands	Meander River at Meander (MEAN08)	NRE Tas	24	467998	5389092	2	2	0	0	0
Meander Uplands	Meander River ds Meander Dam (MEAN10)	NRE Tas	23	468378	5384116	2	2	0	0	0
Meander Uplands	Meander River upstream Jackeys Creek (MEAN09)	NRE Tas	23	469297	5386709	2	2	0	0	0
Meander Uplands	Deloraine Meander River, Intake	TasWater	11	470500	5402000	0	78	54	54	53

	(650095) (DLW51W03)									
Meander Uplands	MDAM_1	TI	22	466682	5383430	43	29	13	13	13
Meander Uplands	MDAM_2	TI	23	468300	5384200	43	42	0	0	0
Meander Uplands	MDAM_3	TI	24	467993	5389088	44	43	13	13	13
North Esk Uplands	North Esk River at Ballroom (NESK07)	NRE Tas	33	532475	5406272	4	4	0	0	0
North Esk Uplands	North Esk River at Ben Nevis gates (NESK12)	NRE Tas	34	544320	5415758	4	4	0	0	0
North Esk Uplands	North Esk River at Corra Linn Gorge (NESK03)	NRE Tas	33	519381	5407015	4	4	0	0	0
North Esk Uplands	St Patricks River at Nunamara (NESK19)	NRE Tas	34	525147	5417972	3	4	0	0	0
North Esk Uplands	Distillery Creek St Patricks Weir (Nunamara) Raw Point (650109) (DCR51W04)	TasWater	34	525000	5417100	0	22	0	0	0
North Esk Uplands	NEIS_1	TI	31	526514	5402838	42	43	5	5	5
North Esk Uplands	NEIS_2	TI	32	527199	5403657	40	41	7	7	7
North Esk Uplands	NEIS_3	TI	31	527381	5402868	43	44	5	5	5
North Esk Uplands	North Esk Raw Tap on road to Chimney Saddle WTP (NERW51W06)	TasWater	33	525626	5405727	0	55	50	50	50
South Esk Lowlands	Prospect Vale WWTP Duck Reach (58818) (PVT01S10)	TasWater	21	509320	5410237	44	0	22	22	22
South Esk Lowlands	South Esk River at Heffords Road (SESK58)	NRE Tas	20	572554	5386058	4	4	0	0	0
South Esk Lowlands	South Esk River at Llewellyn (SESK54)	NRE Tas	20	547145	5370619	4	4	0	0	0
South Esk Lowlands	South Esk River at Perth (SESK01)	NRE Tas	38	515231	5396568	4	4	0	0	0
South Esk Lowlands	Longford WWTP South Esk Upstream (58659) (LFD01S12)	TasWater	19	508640	5398626	42	0	42	42	42
South Esk Lowlands	Longford WWTP Back Creek Upstream (58656) (LFD01S09)	TasWater	18	508893	5397529	43	0	43	43	43
South Esk Lowlands	Perth STP Upstream (58813) (PRD01S04)	TasWater	38	513998	5395642	8	0	14	14	14
South Esk Lowlands	Evandale STP Boyes Ck 100m U/S (EDD02S07)	TasWater	38	521318	5397399	4	4	8	8	7
South Esk Lowlands	Conara South Esk River Raw Intake (CNW51W02)	TasWater	20	543300	5372900	0	21	13	13	13
South Esk Lowlands	Conara SP1 WTP Raw TAP (CNW51W11)	TasWater	9	543300	5372900	0	12	37	37	34
South Esk Lowlands	Lake Trevallyn Blackstone Park (C2) (LKTRV02)	TasWater	15	505937	5410599	0	24	25	25	24
South Esk Lowlands	Lake Trevallyn Boat Ramp (C1) (LKTRV01)	TasWater	16	506574	5412127	0	24	25	25	24
South Esk Lowlands	LSIS_4	TI	20	543558	5372675	40	42	1	1	1

South Esk Lowlands	LSIS_7	TI	20	543708.8	5372287	38	42	1	1	1
South Esk Lowlands	LSIS_8	TI	20	543542.6	5372384	38	42	1	1	1
South Esk Lowlands	LSIS_9	TI	20	543249.3	5370894	41	43	1	1	1
South Esk Lowlands	South Esk Trevallyn Dam (650111) (SEWSP002)	TasWater	40	506071	5412732	7	109	59	59	60
South Esk Lowlands	West Tamar Mt Leslie Raw Water Basin (WTR53W07)	TasWater	51	508699	5409558	0	25	24	24	24
South Esk Uplands	South Esk River at Cokers Rd (SESK08)	NRE Tas	39	560100	5414398	2	2	0	0	0
South Esk Uplands	South Esk River at Sandhurst Road (SESK59)	NRE Tas	39	566785	5409615	1	1	0	0	0
South Esk Uplands	South Esk River u/s Evercreech Road (SESK60)	NRE Tas	39	579937	5408270	3	3	0	0	0
South Esk Uplands	Fingal STP 100m Upstream (FIW01S03)	TasWater	14	580241	5389757	0	0	14	14	14
South Esk Uplands	St Marys STP St Marys Rivulet U/S (SMW01S06)	TasWater	41	598796	5395883	6	0	7	7	7
South Esk Uplands	Fingal South Esk River (FIW51W02)	TasWater	13	583400	5388600	0	55	18	18	18