THE TASMANIAN FRESHWATER PROJECT
Freshwater Condition

An initiative of the Tasmanian Independent Science Council

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ABOUT THE TASMANIAN FRESHWATER PROJECT

What's happening with freshwater in Tasmania? What is the condition of our rivers, lakes, wetlands and estuaries? Are our water supplies clean, plentiful and well-managed? Who is minding the store and doing the maths? What are risks of getting it wrong?

Tasmania prides itself on having a clean, green image, underpinned by a perception of abundant and pristine freshwater resources. A closer look suggests that many of our rivers are already under significant stress and are likely to become further damaged as climate change progresses. Added to this is the increasing demand for further extractions to support ambitious irrigation, hydropower, aquaculture, mining and other developments. Can our freshwater systems sustain this potential rate of extraction?

In short - we don't know, in part due to a lack of robust monitoring, delayed reporting, limited metering of water use, and a tendency to set ambitious growth targets without first doing the maths. Finally, current water policies and regulations do not clearly underpin sustainable use, and pricing arrangements send conflicting signals.

The Tasmanian Freshwater Project is an initiative of the Tasmanian Independent Science Council. Its purpose is to provide an overview of this resource based on reports, publications and other information sources that are currently available. The Project also identifies major gaps in our understanding, raises key issues and recommends a number of actions to better conserve our freshwater systems and support sustainable use.

The Tasmanian Freshwater Project is envisaged as four main review papers:

- Freshwater condition
- Freshwater use
- Freshwater policy, planning and regulation
- Freshwater economics

This paper is the first to be published.

Acknowledgments

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About the Tasmanian Independent Science Council

The Tasmanian Independent Science Council is dedicated to science-based policy reform to ensure the long-term health of Tasmania's environment. The Council includes scientists and professionals who provide independent, non-government advice, focusing on policy reforms of significant State interest. We seek to inform public debate and influence legislative reform to improve outcomes for terrestrial, freshwater and marine ecosystems.

WHAT'S THE STATE OF OUR FRESHWATER SYSTEMS?

EXECUTIVE SUMMARY

What is the condition of Tasmania's rivers? Has there been a decline in river flow or water quality over the past 20 years? Has there been a loss of wetlands, riparian zones or the many water-dependent mammals, birds, fish, frogs, invertebrates and other species that require healthy freshwater ecosystems for their survival?

Unfortunately, the research relevant to all of these questions strongly indicates a decline. However, the reduction in systematic and coordinated monitoring across Tasmania, together with a near absence of reporting, makes the extent and severity of this decline difficult to grasp. Furthermore, we simply have no – or very limited – information for many of Tasmania's rivers, wetlands, estuaries and groundwater systems. Until this information is available, a highly precautionary approach is needed to prevent long-term, irreversible loss, particularly given the uncertainties around climate change.

A few examples:

- In December 2019/ January 2020, one of Tasmania's largest rivers - the South Esk at Perth – ceased to flow. Extremely low flows (less than 2 ML/day) persisted for several weeks (DPIPWE Water Portal) and are thought to be related to low rainfall combined with over-extraction of water for irrigation purposes. This event was not widely reported and has not been formally investigated.
- Historically, water quality in the River Derwent has been excellent, however starting in 2015 taste and odour problems began to disrupt the Hobart drinking water supply. These were linked to blue-green algae blooms that are associated with elevated nutrients (Benham, 2017), and potentially linked to construction of a large inland fish farm upstream. Since then, on-going summer water quality problems have necessitated costly additional water treatment, urban water restrictions and interruptions to irrigation supplies. This has been a key factor in the decision to build a new $220 million drinking water treatment plant at Bryn Estyn.
- A number of rivers on Tasmania's west coast and in the northeast are severely polluted by toxic levels of heavy metals associated with mining activity, particularly from legacy sites. Of these, the Queen and lower King River systems are the most damaged. These rivers are devoid of fish for a distance of over 25 km, downstream from the Mt Lyell mine, with macroinvertebrate diversity among the lowest reported in Australia. (Davies et al, 1996)
- Some rivers in the northwest are heavily polluted by agricultural run-off, including severe pollution of the Welcome River. Recent overstocking and poor management of dairy effluent lagoons at Australia's largest dairy farm has resulted in severe pollution incidents that are currently being investigated by the EPA. (SMH, 2021)
- Water quality downstream of large flow-through fish farms, including those on the Florentine, Derwent and Tyenna rivers is poor – particularly in summer and early autumn, when downstream nutrient levels can be over fifty times higher than upstream levels (DEP, 2018; Coughanowr, 1999).

Tasmania's freshwater resources can no longer be considered to be clean, green and abundant. DPIPWE's recent River Health Monitoring Program (RHMP) reviews (2018, 2020) recorded up to 43% of sites as impaired, with nearly 70% of these showing a decline during the final five years of the program. This poor outcome may well be an optimistic view, as the methods used and the sites monitored do not necessarily reflect worst case conditions.

River flows have declined in many rivers across the state, and accurate climate change impacts are difficult to predict other than increasing levels of variability both temporally and spatially. In short, we may already be at or beyond a tipping point, with serious concerns about the consequences of the next dry summer.

This decline in river condition is playing out within the context of poor information about existing water use (due to limited metering), together with ambitious growth targets for agriculture (x5), salmon farming (x2), renewable energy (x2), mining and tourism. All of these activities depend on clean and abundant freshwater supplies. Where will it come from, and will it be at the expense of the health of our priceless river systems?

At the same time, there has been a major reduction in the resources needed for informed water management and planning, with major cuts in funding for monitoring, assessment, compliance and reporting. DPIPWE's Water

Resources division is now one of the worst-funded sections in the Department (just above Racing Regulation) and is hard-pressed to undertake the work needed for current levels of water use, much less for ambitious new programs. Similarly, the EPA has only a few dedicated water quality officers.

On the positive side, considerable monitoring is still being done, particularly with respect to river flows and river health. Some sector or river-specific water quality monitoring is also done by the EPA, Hydro Tasmania, Tas Irrigation, mining and aquaculture, as well as by NGOs such as the Derwent Estuary Program and Tamar Estuary and Esk Rivers Program. However, much of this monitoring is uncoordinated and further hampered by a lack of synthesis and regular, transparent reporting. Tasmania's statutory five-yearly State of Environment Report is now two cycles overdue. Similarly, reports on DPIPWE's River Health Monitoring Program have been unnecessarily delayed or blocked.

Maintaining environmental flows is a key aspect of river health management, as the volume and timing of flows are essential to maintain water quality, prevent siltation and maintain freshwater habitats. Tasmania was previously a leader in the assessment of environmental flows, however support for this work has also dwindled by at least half. Furthermore, environmental flows have not been set for most Tasmanian rivers, including major waterways such as the Derwent, and many of the original assessments are now nearly twenty years old.

Rivers cannot be managed in isolation from the broader freshwater systems that sustain them - floodplains, groundwater, riparian zones, wetlands, and estuaries are all interconnected. Wetlands and riparian zones are at particular risk in Tasmania's agricultural and forest production areas and have limited statutory protection. Without sufficient flows, clean water and suitable habitat, water-dependent mammals, birds, fish, amphibians and other fauna cannot survive. Further monitoring and conservation of these species is needed, together with the habitats they require. Management of aquatic weeds, pests, harmful algae and disease are also areas in need of urgent attention. These and other issues are explored in more detail in the following chapter, with a summary of key recommendations provided below:

An ambitious program is urgently needed to look after our river systems, as a prerequisite to further water development programs. This should include the following key elements:

- A major increase in funding and other support for freshwater monitoring, assessment, compliance and reporting.
- Production of Tasmania's long-overdue State of Environment Report, including a detailed Freshwater Systems technical report.
- An improved state-wide monitoring program which integrates exiting programs into a comprehensive and cost-effective framework. This should include improved monitoring of river flows, water quality and river health and could build on the strong foundations of the RHMP.
- A review and reassessment of the environmental flows needed to sustain Tasmanian rivers both now and into the future.
- Improved protection and management of riparian zones and wetlands
- More targeted management of aquatic flora and fauna, including threatened and invasive species

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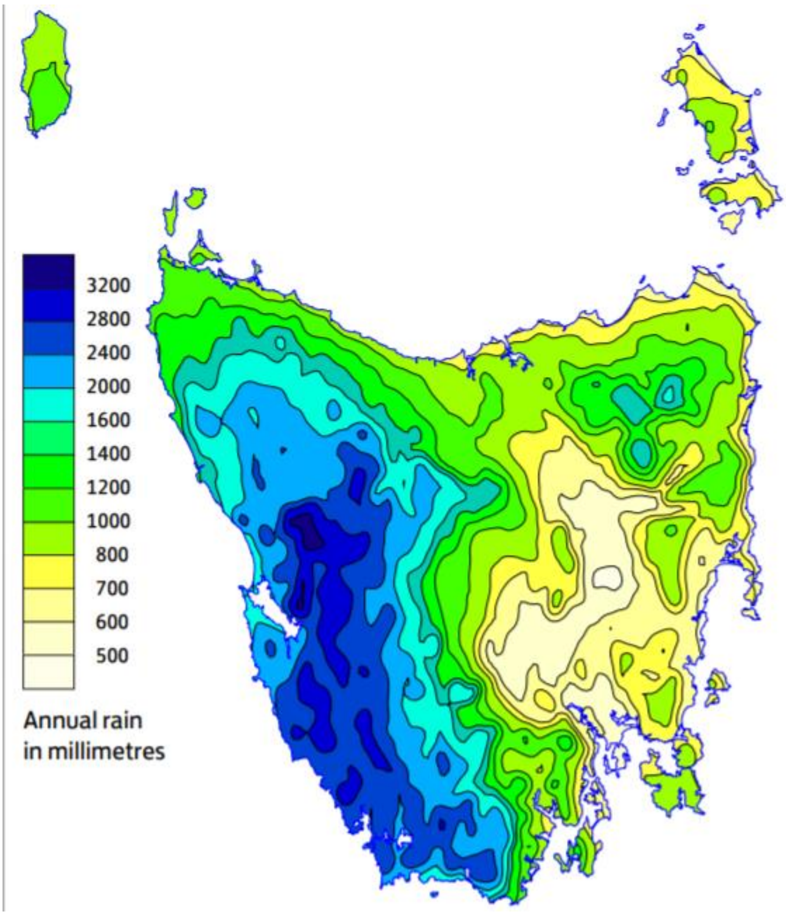
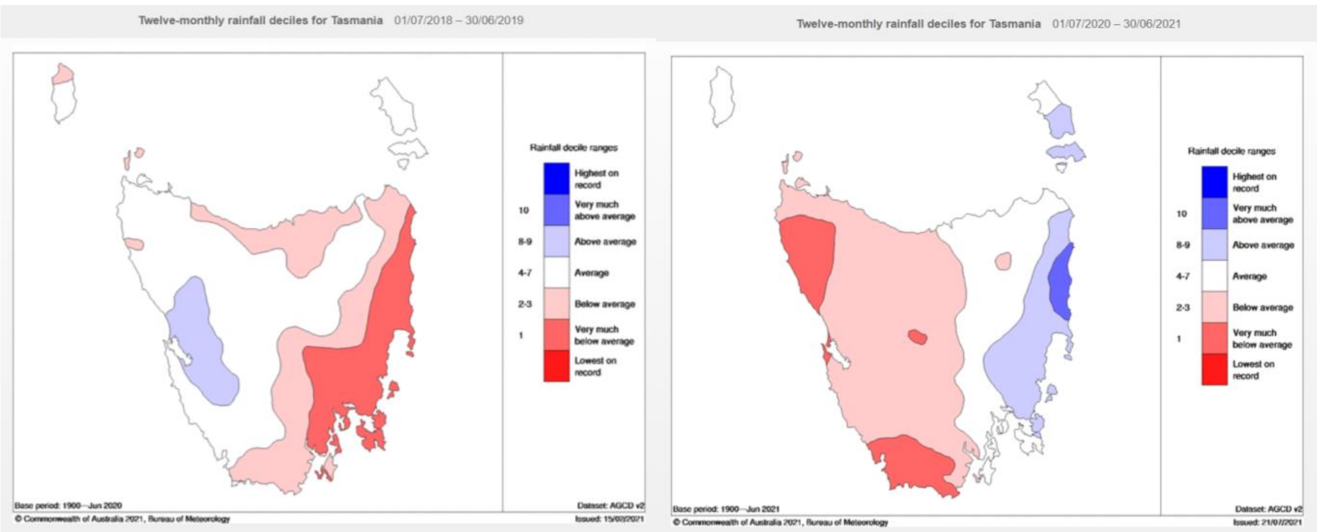
TASMANIAN FRESHWATER 101

Rainfall in Tasmania typically follows a strong gradient, decreasing from an average of more than 3200mm/year on the west coast to less than 600mm/year on the east coast and southern Midlands. While the west coast is particularly well watered, much of the rainfall here runs off quickly to the sea, due to the steep terrain. In contrast the Midlands and east coast tend to be relatively dry, and frequently impacted by drought. Since 2000, the state as a whole has experienced particularly dry conditions in 2004/5, 2006/7, 2007/8 and 2012/13. However, there is a high degree of variability between regions from year to year, as illustrated below, and climate change already appears to be modifying both average rainfall and its variability.



Average rainfall in Tasmania (Source: Hydro Tasmania, 2014)

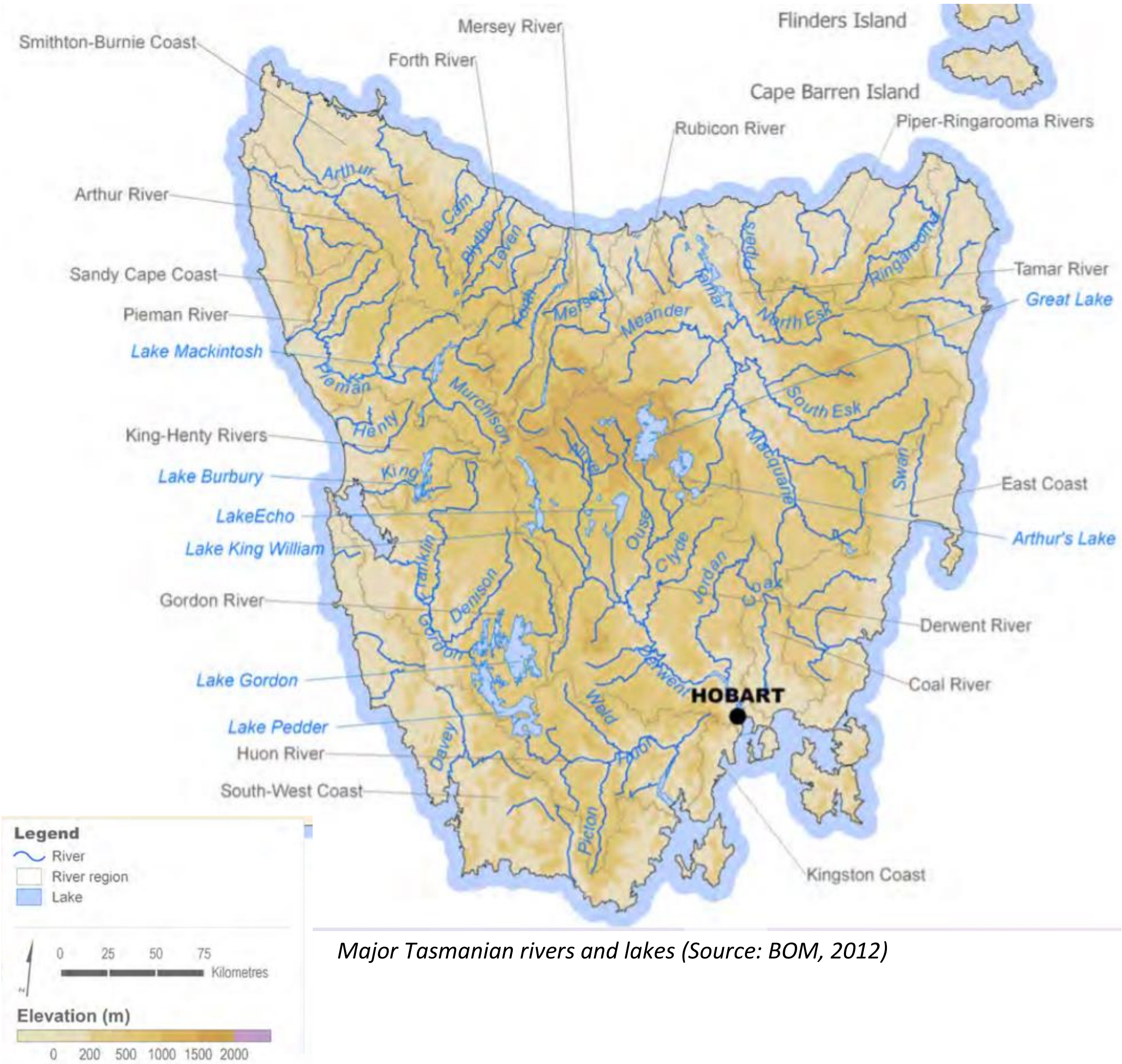


Contrasting rainfall patterns: 2018/19 vs 2020/21 (Source: BOM website)

There are thousands of waterways across Tasmania ranging from the tannin-rich streams and lakes of the highlands and southwest, to the clear, and sometimes ephemeral streams of the north and east. As would be expected - given Tasmania's varied climate, terrain and geology - river flows are highly variable both temporally and spatially.

The largest catchments in the state include those of the South Esk, Derwent, Gordon/Franklin, Pieman and Huon. rivers with the largest flows include those on the west coast with high rainfall (e.g. Gordon, Franklin) and those with large catchments that originate in high rainfall areas (e.g. Derwent, Huon, South Esk). Rivers in the drier east and southeast regions have the lowest flows, including some with intermittent flows during summer months (e.g. Prosser, Jordan, Coal, Swan). Many rivers in Tasmania have highly modified or reduced flow regimes associated with hydropower generation, water extractions and land-use changes. See BOM (2012) for a good overview of Tasmanian freshwater resources and the factors that influence river flows and water yields.

While the primary focus of this paper is on river systems, these cannot be understood or managed in isolation from their associated groundwater systems, or from the wetlands, riparian zones and estuaries that they sustain.



Major Tasmanian rivers and lakes (Source: BOM, 2012)

CLIMATE CHANGE 101

Two major climate change studies have investigated potential impacts on Tasmanian water resources: one with a focus on water availability (CSIRO, 2009) and a second with a broader climate focus (ACE CRC, 2010). Some of the findings of these reports are presented below, however, it is important to keep in mind that the methods and assumptions used may no longer reflect the latest science and that use of down-scaled models may imply greater precision than is warranted, particularly where results of multiple models are averaged. In many cases, different models predict not only varying magnitudes of change, but opposite directions.

The ***Tasmanian Sustainable Yield*****s** project (CSIRO, 2009) covered the period from 1924 through 2030, and considered impacts on surface water, groundwater and freshwater ecology. Project outputs included two state-wide overview papers (water availability and climate change impacts on run-off) and five regional papers (water availability). The west coast region was not included in this project. Water yield estimates were based on modelling as Tasmania does not have consistent metering of surface or groundwater extractions. A suite of river hydrologic models was developed, as well as groundwater models for three key areas, to determine sustainable yields. Potential impacts on ecology were based on flow stress rankings and included sub-catchments and 150 key ecological sites, including wetlands and estuaries with high conservation values.

The project estimated water yields associated with three periods: historical climate (1924 to 2007), recent/dry climate (1997 to 2007) which was driest period in 84 years, and future climate (2030). The climate change predictions were based on a group of 15 models, with three different temperature estimates. Three of these were selected for reporting, representing a wet extreme, a median and a dry extreme climate. The 2030 predictions also included a scenario based on current levels of development as well as a proposed development scenario that included 24 new irrigation schemes, increased groundwater extraction and a 5% increase in plantation forestry.

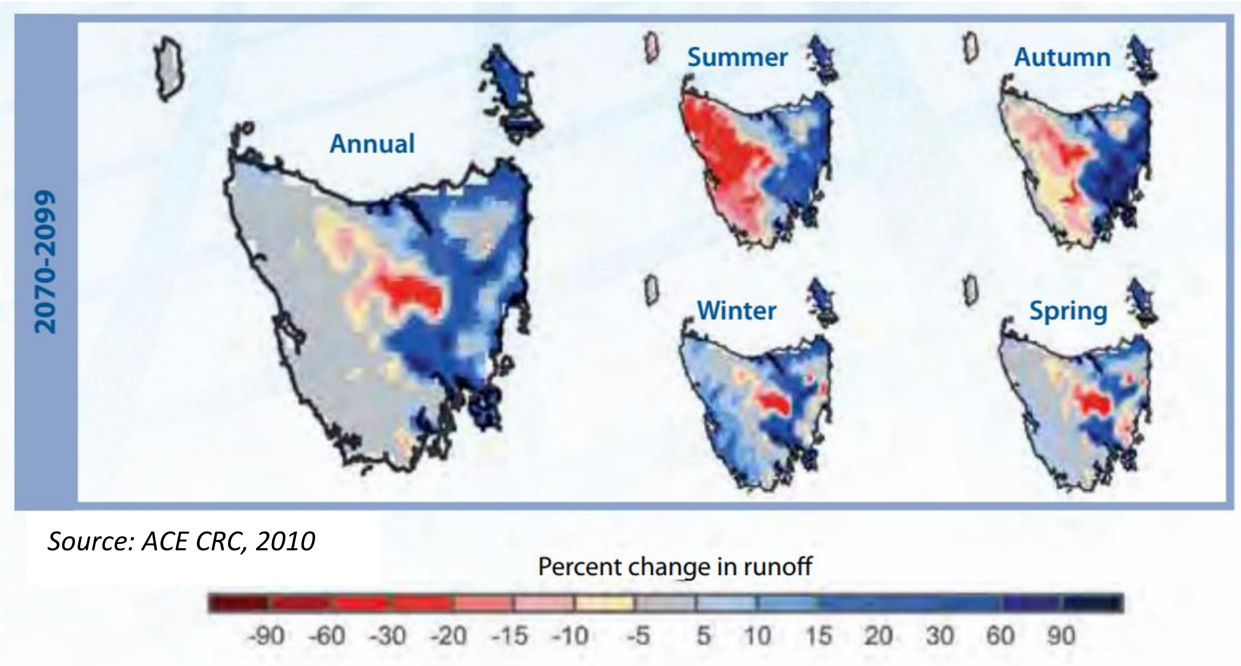
By 2030, predicted future changes to rainfall under the three temperature scenarios ranged from +1% to -7% (median -3%), while changes to run-off ranged from +1% to -10% (median -5%), reflecting higher evapotranspiration rates. However, results varied considerably between regions. Interestingly, the modelled impacts of the recent/drought period (1997 to 2007) were considerably worse than those modelled for the extreme dry climate change scenario, both with respect to water yields and flow stress on ecological systems.

The Antarctic Climate & Ecosystems CRC (ACE CRC) **Climate Futures project** modelled impacts up to 2100, including predictions of future temperature, rainfall and run-off. This involved the downscaling of six global models and assessment of two IPCC emissions scenarios (high/A2 and lower/B1) for the period 1961 to 2100. The average or 'central estimate' results from the six models were then used to assess potential climate change impacts for specific issues, including agriculture, water/catchments, extreme events, etc.

The project notes that temperatures in Tasmania were relatively stable in first half of 20th century but have risen by about 0.1°C/decade since ~1950. This is somewhat slower than national and global rates (e.g. 0.16°C/decade for Australia). Tasmania's daily minimum temperature has risen faster than the daily maximum, as is the case elsewhere. By 2100, the predicted **temperature** under the A2 scenario would increase by 2.9°C (this is less than the global increase of 3.4°C, due to the moderating influence of the Southern Ocean). This higher temperature is likely to lead to increasing pan evaporation (up to 19%) as well as changes in other meteorological conditions.

The Climate Futures project does not predict an overall significant change to annual **rainfall**, which is expected to stay in the historical range of 1390mm ±200mm. However, it does predict significant changes in regional patterns, with an increase over coastal regions and a decrease in central and northwest Tasmania. It also predicts significant changes in seasonality: the west coast is likely to have increased rainfall in winter and a decrease in summer; the Central Plateau shows a steady decrease in all seasons; and rainfall on the northeast coast is likely to increase in summer and autumn.

Run-off is affected by total rainfall as well as rainfall intensity and increased rates of evapotranspiration. Thus, changes to runoff are greater than changes to rainfall in many areas. While it is predicted that average run-off will increase by 1% by 2100, different models range from -4% to +15%. Change varies considerably between regions: with run-off in the Central Highlands predicted to decline by 30%, while some southeastern and northeastern regions could increase by more than 30%. As with rainfall, there are also marked seasonal changes in run-off.



Source: ACE CRC, 2010

Annual and Seasonal Runoff

Annual and seasonal changes to runoff from the reference period (1961-1990) for three future periods: 2010-2039, 2040-2069, 2070-2099. Runoff changes vary between regions and between the seasons. In many regions, runoff changes are proportionately larger than rainfall changes.

River flows were projected to 2100 for 78 catchments (70% of state area) using the same hydrologic models developed by CSIRO but comparing results to a shorter historical reference period (1961 to 1990). Flows to storages used for hydro operations and irrigation were also simulated. Results indicate that 32 of 78 modelled rivers are projected to have ±10% change in annual flows, with strong regional variations. On average, flows in 28 rivers are projected to decrease and 50 are projected to increase. Similarly, inflows to major storages vary regionally, with reduced run-off to Hydro and irrigation storages in the Central Highlands, and increased run-off to irrigation storages in the northeast and southeast. The Hydro has already observed declining inflows, and this is projected to continue, leading to reduction in power-generating capacity. However, it is important to note that the different models provide very different results.

The projects described above provide interesting and sometimes contrasting predictions of climate change impacts on Tasmania's freshwater resources. Of particular note is the predicted increasing variability in rainfall and run-off, both regionally and seasonally, which has important implications for planning and management. It is also important to keep in mind the limitations of these studies, which are not always clearly spelled out in the summary documents. In particular:

- IPCC predictions and climate change models have evolved considerably since 2010 and could well lead to very different predictions for Tasmanian water resources
- The two studies used different historical reference period used (49 vs 83 years), and there are increasing concerns about the relevance of historical data under a changing climate (e.g. Milly et al., 2008)
- Downscaling of global models to local scales may mask underlying large uncertainties and imply greater precision than is warranted
- Use of the central trend can also obscure major variations between models
- Lack of surface water and groundwater metering in Tasmania places too much reliance on models

Given these complexities and the high degree of variability associated with climate change, application of the precautionary principle is strongly recommended.

1. INTRODUCTION

The last state-wide review of freshwater systems in Tasmania was published in 2009, as part of the State of Environment Report (Tasmanian Planning Commission, 2009), and the data on which this was based was already several years out of date at that time. State of Environment reports are a statutory requirement of the Government and are required to be published every five years (State Policies and Projects Act 1003, Part 4). Unfortunately, Tasmania is now more than two cycles behind, and it is unclear when the next State of Environment (SOE) report will be prepared or released. The following section attempts to fill in some of this missing information, or at least to indicate what monitoring and reporting is currently being done and identify some key gaps. While the primary focus here is on river flows (including environmental flow assessments), water quality and river health, some discussion of associated freshwater habitats and species and invasive species is included.

2. RIVER FLOWS

Tasmania has had a relatively good flow monitoring network, in large part associated with our history of hydropower development. Considerable monitoring of river flows and lake levels is undertaken by DPIPWE, Hydro Tasmania, Tas Irrigation and several other organisations. Some of this information is available on the Tasmanian Government Web Portal. This includes flow data for 104 rivers, water levels in 83 groundwater bores, and water levels at 6 reservoirs, as shown in Figure 1. The web portal monitoring sites are primarily located in the north, east and south of the state, with very limited information in the west and southwest.

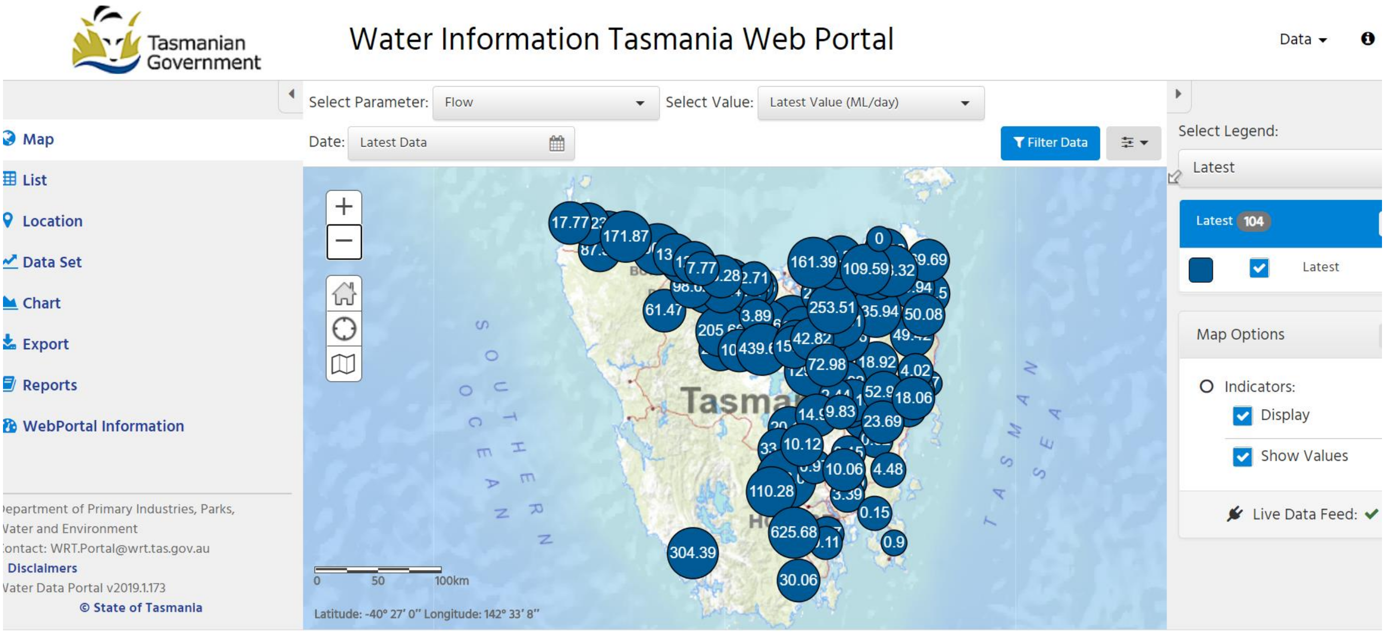


Figure 1: Location of flow and water level monitoring sites provided via the Tasmanian Government Web Portal

Tasmanian water data is also available via the Bureau of Meteorology's (BOM) website (Water Data On-line) at the sites shown in Figure 2. These include a larger number of Hydro Tasmania's monitoring sites in the west and southwest.

There has not been a recent published review of Tasmania's flow monitoring network with respect to its adequacy for freshwater planning, assessment and compliance purposes. This report was also not able to identify any comprehensive assessment of long-term flow trends, although some river and sector-specific work is being done in this area. In particular, an analysis of flow trends in Hydro catchments indicates a significant reduction in flows over the past 50 to 100 years (ACE CRC, 2010), and Derwent flows have declined by an estimated 30% since the 1920s (DEP, 2015).

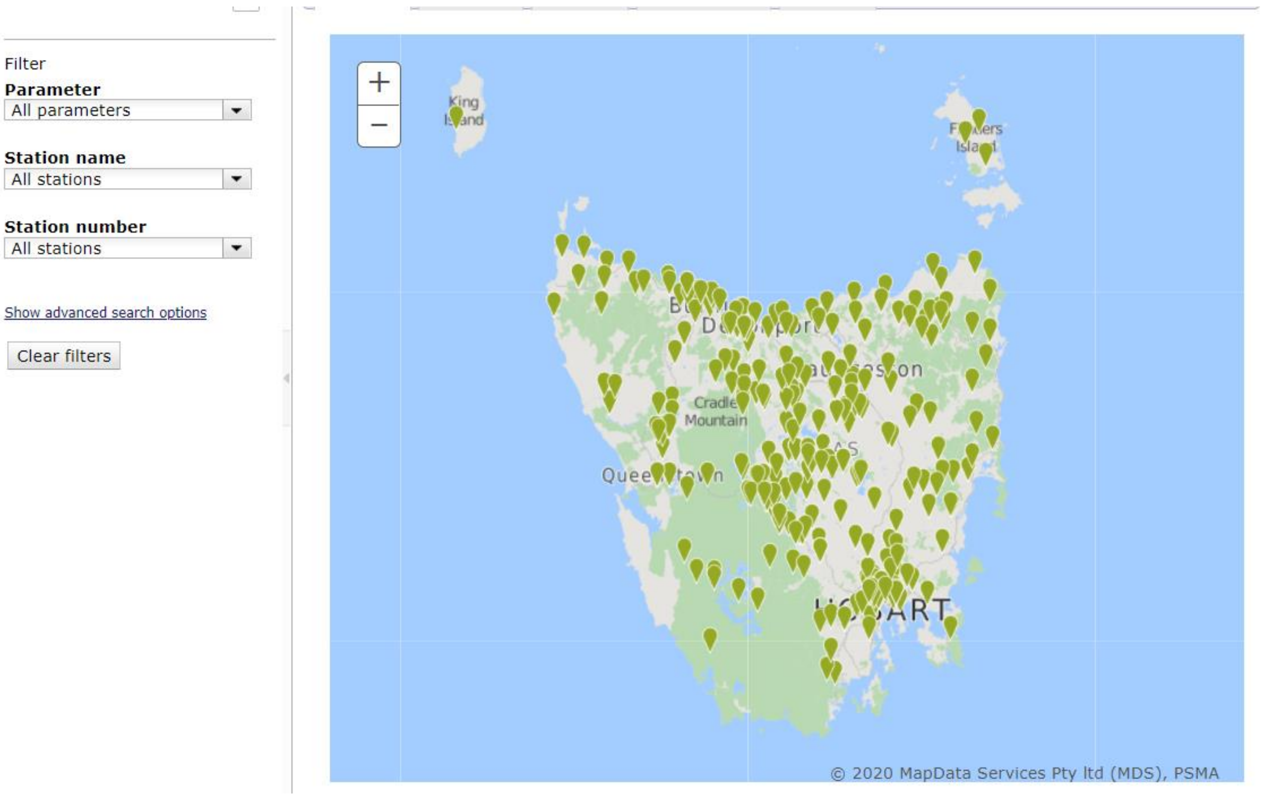


Figure 2: Location of monitoring sites provided via the Bureau of Meteorology Water Data On-line website

Groundwater provides essential base flows to rivers, particularly in areas with productive aquifers and during dry periods. Groundwater quality and yield is highly variable, depending on the aquifer type, the topographic location and the rainfall (AWRA 2012). Tasmania has extensive groundwater resources, with the most productive aquifers located in the north and northwest. A number of important groundwater monitoring programs and investigations were undertaken in the 2000s, including those by Bacon and Latinovic (2003), Harrington et al (2009), Sheldon (2011) and Household (2011). Some information on groundwater bores can be found on DPIPWE's Groundwater Information Access Portal, including location, date drilled, depth, initial yield, etc. However, information on extraction volumes is not included. As of 2017, there were over 11,000 bores included on this database. The Land Information System Tasmania (LIST) website also includes a layer showing 'groundwater bore holes and features'.

Another key influence on river flows is the capture of surface run-off in farm dams located on minor tributaries and drainage lines (also known as flood plain harvesting). This can represent a significant proportion of flow, particularly during summer months, and tends to be overlooked in water accounting with potentially severe consequences for both environmental flows and for downstream users.

2.1 Environmental Flows

Environmental flows (eflows) are the river flows needed to sustain a variety of river values, including water quality, maintenance of channels and a clean riverbed, healthy populations of aquatic invertebrates ('waterbugs'), fish, birds, platypus and other aquatic fauna, as well as to maintain wetlands, riparian zones and estuaries. Ideally, eflows should include both minimum flows as well as a series of higher flow events that are needed to clear channels, restore water quality, provide triggers for fish migration and spawning, and water wetlands and riparian zones. Given the modified flow regimes of many Tasmanian rivers it can sometimes be difficult to determine what constitutes a 'natural' flow regime, or how flows should be managed to protect key elements of the now-modified ecosystems.

Environmental flow assessments are used to estimate the volume and timing of flows required to sustain these values and are fundamental to informed water management planning and regulation. Assessment methods have evolved considerably over the past few decades - from simple 'desktop' hydrologic calculations, to risk-based methods to protect the habitats of key species, to more holistic ecosystem-based approaches. Each river is different, and a robust eflow assessment requires a good understanding local values and conditions, as well as access to long-term flow records, combined with modelling. Finally, predicted climate change impacts on eflows must also be included to ensure river health into the future.

Tasmania was a leader in eflow assessments in the early 2000s, and the DPIPWE website provides eflow reports for 23 rivers across Tasmania, using methods that have ranged from rudimentary desktop assessments to rigorous whole-of-ecosystem methods. The majority of these were done during the period from 1999 to 2002 as part of environmental flow-related projects funded through the Australian Government. Many of these earlier assessments focused on minimum summer flow requirements for instream fauna (such invertebrates and fish) by employing the Instream Flow Incremental Methodology (IFIM) or other desktop approaches. While these were a good start, they did not include eflows for other months, consideration of higher flow events or climate change projections. Many of these early eflow reports include the following statement: '*An important caveat to this report is that the Environmental Water Requirements (EWRs) recommended for each month are the minimum flows for a low risk of failure to meet ecological values. Since there is little regulation of this river during the months of peak flow, EWRs for this period have not been considered. If peak flow rates are impacted or threatened in any month, including the irrigation season, additional work will be required. Minimum flow rates for months outside the irrigation season have not been identified in this report and will also require additional work if significant water developments (e.g. dams) are proposed in this catchment.'*

For many catchments these conditions no longer apply as significant water developments have taken place.

Between 2007 and 2014, more comprehensive eflow assessments have been done for about ten rivers, using the Tasmanian Environmental Flows Framework (TEFF) (DPIPWE, 2010). This method involves considerable fieldwork, modelling, hydrologic analyses and recommend limits for both minimum and higher flow events throughout the calendar year. The TEFF also considers flows to support riparian, wetland and estuarine systems. While this is clearly an improved method, it has not yet been widely implemented, and previous eflow assessments are still based on the older, less rigorous methods. According to DPIPWE most eflows work is now done on an as-needs basis, specifically, where Water Management Plans require a full assessment (eg. Ringarooma, South Esk and Macquarie). Some smaller studies have also been undertaken in planning reviews and statement preparation including the Swan, Boobyalla, Tomahawk, Hurst Creek, Great Forester (McKerrows Marsh) and Clyde and Lakes Sorell /Crescent (DPIPWE pers comm, 2021).

The collected eflow reports described above include a wealth of information about river systems in Tasmania, however most are now 15 to 20 years old, and most Tasmanian rivers do not yet have published eflow assessments. This includes major systems such as the Huon and Gordon. It is deeply concerning that water management decisions continue to be made without this essential information. For example, there is currently a proposal to extract an additional 26,500 ML/yr from the Derwent River – primarily during summer – as part of the Tas Irrigation *Southeast Integration Project Scheme* (TI Newsletter, 2020). The only published eflow assessment for the Derwent (Davies et al, 2002) is now nearly 20 years old and even at that time recommended clear limits on additional extractions, including no additional summer takes. Without an updated eflow assessment – and in the absence of a Water Management Plan – how can this decision be made without significant risks to downstream environments and users?

Furthermore, it is unclear how past eflow studies and their recommendations have been incorporated into non-statutory Water Management Statements, or more generally, how follow-up monitoring and enforcement has been implemented.

3. LAND USE, WATER QUALITY AND RIVER HEALTH

3.1 Land use

In addition to adequate flows, river condition is closely tied to adjacent land uses and to the run-off and other pollution these generate, as well as to the condition and extent of the riparian zones that protect streambanks, filter run-off and provide shade and habitat for many aquatic species. Other factors include run-off from unsealed roads, gully erosion in catchments, spray drift, etc.

Land use mapping is an important tool to periodically document and analyse land use, enabling an understanding of change over time. The Tasmanian land use mapping program maps the State at catchment scale according to the national guidelines (ABARES 2011, 2015) and the Australian Land Use Management (ALUM) Classification system. Land use mapping has been undertaken on a number of occasions since 2000: e.g. in 2002, 2009/10, 2013, 2015 and 2019 (see DPIPWE website for details). These maps can be accessed on the LIST and/or the NRM Data Library Portal.

While some regional analyses of land-use change have been undertaken, such as by the Forest Practices Board, the Derwent Estuary Program and other catchment-specific projects, broader trends across the state as a whole have not been fully analysed beyond the level of land clearance (e.g. Kirkpatrick et al, 2007). It is also unclear how intensification of various land-uses is being addressed. A major impediment to comparative analyses has been the change in classification systems between different years, which can make direct comparisons between land uses difficult. The Waterbug Blitz is currently trialling a land use analysis tool to compliment the waterbug data on the site (Gooderham, pers comm 2021).

3.2 Water quality

As with flow monitoring, considerable water quality monitoring has been carried out by multiple organisations over many years, including DPIPWE, Hydro Tasmania, TasWater, Tas Irrigation, mining, aquaculture, as well as NGOs such as the DEP and TEER. However, monitoring activities between sectors tend to be poorly coordinated, and – with a few exceptions – there has been limited recent synthesis, review or reporting of this data either on a State-wide or catchment basis.

As previously noted, the last State of Environment report for Tasmania was published in 2009, and the freshwater section was based in part on information compiled by DPIPWE in the form of State of Rivers and Waterways Monitoring reports. The State of Rivers Reports provided information on the water quality, quantity and ecosystem health of Tasmanian waterways up until 2003, while the Waterways Monitoring Reports covered the period from 2004 to 2008. DPIPWE also undertook pesticide monitoring in a series of rivers from 2005 to 2014.

In 2020, DPIPWE recommenced some Annual River Reports, with a focus on six rivers that are managed under formal Water Management Plans. These rivers are the Mersey, Great Forester, Ringarooma, South Esk, Tomahawk and Boobyalla rivers. The reports provide a summary of the flow and conditions experienced in the reporting year. The reports also include information on rainfall and flow and how this compares to previous years, as well as information on land use, water allocation, restriction periods and river health. However, information on water quality is not included. DPIPWE are seeking to automate this reporting and where possible to increase the number of these reports (pers comm: B Graham, DPIPWE, 2021).

As part of the State Policy on Water Quality Management 1997, (SPWQM) the EPA undertook a program to set Protected Environmental Values (PEVs) for Tasmanian rivers. PEVS were based on an evaluation of land use and water quality information for each major catchment, together with a public consultation process. The individual PEV reports – published during the period between 2000 and 2004 provide useful information about river condition and catchment land use at that time.

The SPWQM sets out a process whereby Water Quality Objectives are to be developed for Tasmanian waterways, as a basis for regulation and management. To date, WQOs have been developed on a site-by-site basis, in response to specific development applications, but are not publicly reviewed or reported. In 2020, the EPA published a series of default Water Quality Guideline Values for Aquatic Ecosystems (DGVs) for specific catchments or hydrologic regions across the state. It appears that these are intended for use as interim WQOs, until site-specific WQOs are developed. The DGVs have been derived by the EPA based on both water quality and biological river health data and have been developed for both High Ecological Value (HEV) ecosystems and Slightly to Moderately Disturbed (SMD) ecosystems. Default guideline values are available for inland surface waters by catchment (48), hydrological region (4) and for the State as a whole. An interactive map layer is available via the LIST. While these DGVs may provide a starting point for the development of regulatory targets, they do not necessarily reflect the current water quality condition of individual river systems, as there has been considerable extrapolation across hydrologic regions. Furthermore, the data used may be up to 30 years old in some cases is, and key data sets have not yet been included (e.g. Derwent Estuary Program). These DGVs have not yet been through a public consultation process and it is unclear if or how these will be finalised. See EPA website on Water Quality Guidelines and the Technical Guidance paper for further details (EPA, 2020). In addition to the policy-related work described above, the EPA undertakes river specific monitoring associated with incidents, such as the recent fish kills in the Plenty River and the dairy effluent issues at Woolnorth/Van Dairies.

In addition to the reports mentioned above, some water quality information for specific waterways is available via reports published by the Derwent Estuary Program (DEP) and Tamar Esuary and Esk Rivers (TEER) program, Hydro Tasmania and the University of Tasmania/Institute of Marine and Antarctic Science (IMAS). Catchment or river-specific information can be obtained in the following documents:

- The DEP regularly monitors water quality in the Derwent at New Norfolk and has undertaken a series of catchment monitoring programs and reviews as reported in State of the Derwent Estuary Reports (DEP, 2020; DEP, 2015); Derwent Catchment Review (Eriksen et al, 2011); Derwent Catchment Water Quality Report (DEP, 2018); Derwent catchment nutrient budget (Proemse et al, in review).
- In 2013, the TEER produced a freshwater report card, and associated technical report, for the major catchments that discharge to the Tamar Estuary (North Esk, South Esk, Macquarie, Meander and Brumbys-Lake). Grades were based on a combination of water quality, macroinvertebrates and riparian condition (TEER, 2013, Newall et al, 2012). While recent monitoring has focused largely on pathogens, it is anticipated that this broader assessment will be revisited in the near future (S Jack, TEER, pers comm July 2021).
- Hydro Tasmania Environmental Reviews: the Hydro has completed reviews for the majority of their catchments over the past 15 to 20 years, including the King/Yolande (2019-2021), Pieman (2018), Mersey/Forth (2011), Derwent (2001) and Great Lake/South Esk (1999). These reports contain a wealth of information about specific river systems, but some are now quite dated.
- UTas/IMAS studies (e.g. Little Swanport, Derwent)

In addition, many Landcare and Rivercare projects have collected valuable information about river condition over the past few decades, as a basis for catchment management and prioritising on-ground works. However, there is no central repository these reports, or for those listed above.

Given the lack of recent reporting for the State as a whole, it is difficult to clearly document water quality conditions and trends. Nonetheless, concerns have been raised by many organisations and at numerous sites across the State about the observed decline in water quality with respect to physical condition (water temperature, salinity, pH), water chemistry (sediments, nutrients, metals), pathogens, nuisance algae and toxicants. For example, concerns about water quality were raised in over 25 of the submissions to the recent Rural Water Use Strategy Position Paper (DPIPWE, 2020).

Nuisance and toxic algal blooms pose a serious and growing risk to Tasmanian waterways, with recent and recurring blooms recorded in the lower Derwent River, Craigbourne Dam and Lake Trevallyn. These blooms are usually dominated by cyanobacteria (blue-green algae) and typically form under conditions that combine low flows/still water, elevated nutrients and warm water temperatures. Cyanobacteria blooms can cause a broad range of problems including oxygen depletion and fish kills, harm to livestock, as well as human health impacts related to both physical contact and drinking water (Australian Government, 2021). These can include both short- and long-term health impacts, including links to motor-neuron disease (Violi, 2019). A precautionary strategy is urgently needed to monitor and prevent these outbreaks as – once established – cyanobacteria blooms can be difficult/impossible to eradicate.

3.3 River health

Tasmania's most comprehensive river monitoring program is the River Health Monitoring Program (RHMP) program, established in 1994. The RHMP was initially supported by national and state programs (e.g. National River Health Program, TasTogether), and has been continued by DPIPWE since 2012. While the program was extensive in the early years, its support has declined substantially over the past two decades.

The RHMP uses the Australian River Assessment System (AusRivAS), which focuses on benthic macroinvertebrate ('waterbug') communities along with some aspects of habitat quality to assess river condition. In principle, sites should be monitored twice per year (spring and autumn) for a wide variety or parameters, and river health scores are calculated for each site that reflect its overall condition.

> **O/E vs SIGNAL scores?**
> **O/E**: Ratio of observed number of macroinvertebrate taxa as compared to the expected number of macroinvertebrate taxa. The O/E score is an output of AusRivAS predictive models.
> **SIGNAL**: Stream Invertebrate Grade Number Average Level scoring system that was developed to assess the sensitivity of macroinvertebrate families to common types of pollution. The SIGNAL score is an output of AusRivAS predictive models.

Two important RHMP papers have recently been prepared: one reviewing the overall program and how it could be improved (Hardie et al, 2018) and a second reviewing the collected data in more detail, including temporal and spatial trends, and identifying some of the key factors that influence river health in Tasmania (DPIPWE, 2020). These papers contain essential information to improve future monitoring and to inform management decisions, and it is deeply concerning that their release has been delayed or withheld. The first paper was finally released in 2020, following multiple requests, and the second paper has only recently been released – with redactions – by way of a formal Right to Information filing. Key findings from these two review papers are provided below.

Review of the Tasmanian River Health Monitoring Program (1994-2016): Program Evaluation and Redirection

The 2018 River Health Monitoring Review *(Hardie et al, 2018)* covers the period from 1994-2016, during which time land and water use had changed markedly and river health science had advanced. Information collected during this time was reviewed to document its history, evaluate its effectiveness and recommend improvements, and examine spatio-temporal patterns in river condition.

During the period from 1994 to 2016, 60 core sites were monitored at locations across the state as shown in Figure 3; 31 of these were intended as reference sites (pristine or least disturbed sites) and 29 were test sites (sites likely or known to be impacted by habitat degradation in areas of interest). It should be noted that a number of these original reference sites may no longer qualify as such, due to subsequent decline. The paper also describes the broader use of the RHMP methods and provides a more extensive map of 311 monitoring sites that have been included in the RHMP database (Figure 4).

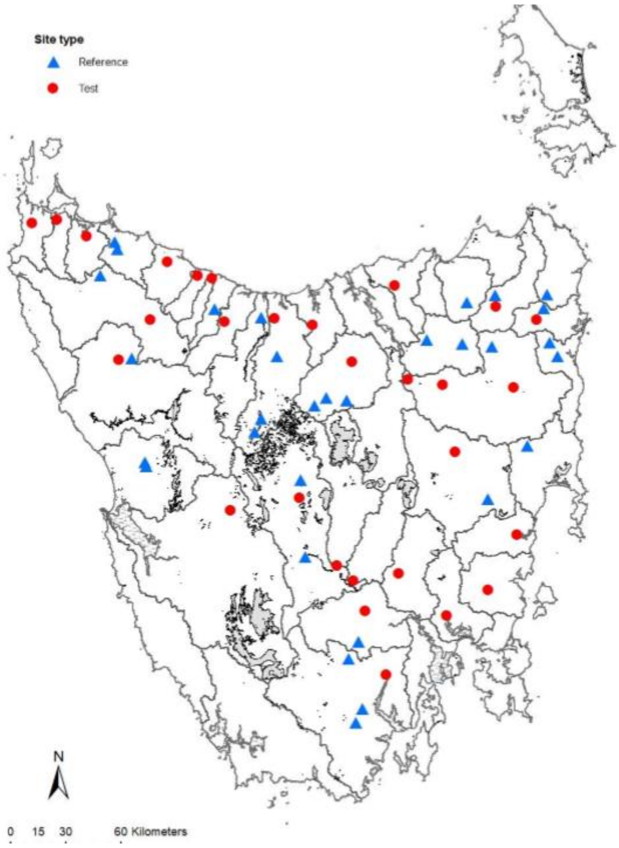


Figure 3: Location of long-term monitoring sites 1994-2016 showing Test and Reference sites (DPIPWE, 2018)

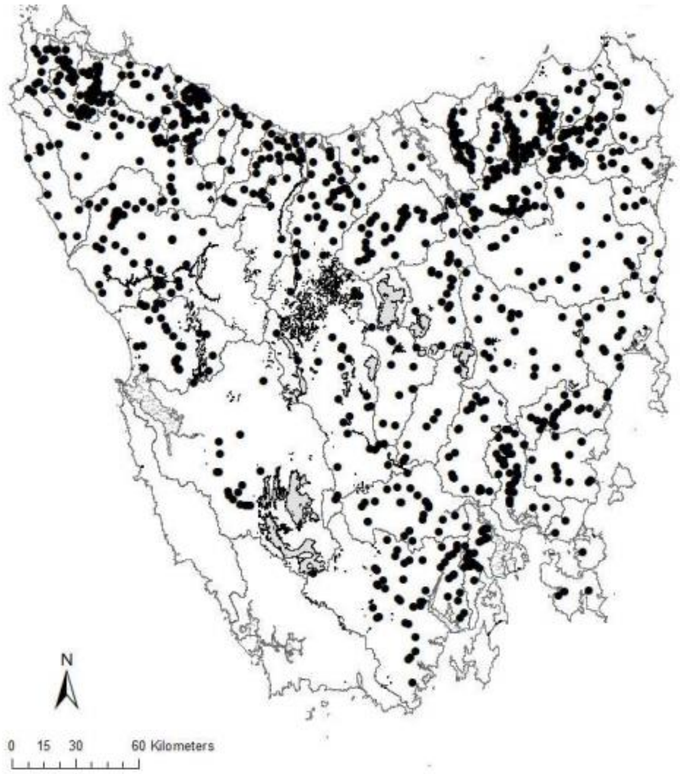


Figure 4: Location of all sites sampled using AusRivas protocols 1994 -2016 according to the RHMP database (DPIPWE 2018

Of the 60 long-term sites monitored, 32% were found to be moderately impaired or significantly impaired, as compared to reference conditions. Of these, the most impaired sites were located on the Welcome and Jordan rivers (Figure 5). Furthermore, the majority of sites showed a decline in river health (mean O/E scores) for the 2013-2016 period, suggesting a decline in river condition during more recent years.

The review confirmed the value of the RHMP methodology, but identified several limitations, which can be addressed by incorporating more targeted parameters, in particular measures of the cover and load of benthic fine sediment and algae. In addition, it recommended that monitoring sites be adjusted to target landscapes where land and water use are reasonably intense. A revised selection of 53 sites (43 test sites and 10 reference sites) were recommended for future monitoring, as compared to the 60 original sites. As a further cost-saving measure, it was suggested that monitoring of river condition could be conducted every two years instead of annually, with additional sampling undertaken if warranted.

According to DPIPWE, the revised program is now being implemented. A small sample of sites were monitored in spring of 2020 to test the changes, and the revised program will be rolled out in the following year. Additional monitoring may be undertaken where Water Management Plans are proposed or reviews are required, or where there are areas of concern, however, this is resource dependant (DPIPWE 2021, pers comm, June 2021).

Temporal and spatial patterns in river health across Tasmania, and the influence of environmental factors

This report was finalised by DPIPWE in 2020 but was only recently accessible via the DPIPWE [Right to Information disclosure log] in July 2021. Temporal trends based on six river health indicators were analysed at 85 long-term monitoring sites that were monitored by DPIPWE and other organisations. This analysis covered a 20-year period (1999-2018), with a minimum of 25 surveys at each site. Results indicate that 35 (41%) of the 85 sites showed declining trends in 1-5 of the river health indicators, while 51 sites (60%) had stable trends in 1-4 of the indicators. Sixteen sites with particularly marked declines in condition are listed in the report (see Table 1); most of these had highly disturbed upstream catchments.

Table 3.1 Summary of temporal sites with declining trends in O/E score based on sampling between spring 1994 and autumn 2018. Only sites with a percent annual change of ≥1% are shown and sites are ordered by descending percent annual change values (i.e. ordered by magnitude of decline in condition). The levels of disturbance in the upstream catchments of sites are indicated (site type: low = minimally disturbed, high = highly disturbed). Approximate AusRivAS impairment bands (A = equivalent to reference condition, B = significantly impaired, C = severely impaired) based on mean O/E scores from recent sampling (2014-2018) are shown. See Figure 3.4 for plots of examples of sites with declining trends and Appendix 3 for further information about the sites.

Site	Site type	O/E score results			No. of indicators with declining trends
		Annual change (%)	Mean O/E score	Band	
Legerwood Rivulet at Warrentina Road	High	-10.2	0.50	C	5
Elizabeth River at Campbell Town	High	-3.6	0.59	B	3
Legerwood Rivulet at Tasman HWY	High	-3.5	0.64	B	4
Cam River off Back Cam Road	High	-3.3	0.71	B	4
Duck River at Trowutta Road d/s Geales Ck	High	-3.2	0.49	C	4
Mersey River at Kellys Bridge	High	-2.7	0.77	B	4
Inglis River at Pages Road	High	-2.3	0.67	B	4
Wilmot River at Alma Reserve	High	-1.7	0.69	B	4
Great Forester River at stream gauging station	High	-1.7	0.66	B	4
Arthur River at Pykes Bridge	Low	-1.7	0.92	A	1
Macquarie River off Honeysuckle Road	Low	-1.7	0.77	B	1
Clyde River at Hamilton	High	-1.6	0.56	C	3
Ringarooma River u/s of Branxholm	High	-1.5	0.77	B	3
Catos Creek at Catos Road	Low	-1.4	0.81	B	2
Emu River at Fern Glade Reserve	High	-1.2	0.81	B	2
George River at St Columba Falls Road	High	-1.1	0.95	A	2

Table 1: Sites with declining river health trends in O/E score based on sampling from 1994 to 2018 (Source: DPIPWE, 2020)

Of particular concern is the analysis of the more recent data (2014 to 2018), indicating a substantial further decline in river condition at most sites. Figure 5 suggests that nearly 70% of sites declined over this 5-year period, with 43% of these now classified as significantly/severely impaired or impoverished. Sites with particularly notable declines include those on the Great Forester, Meander, Emu, Mersey, Forth, Duck, Ringarooma, and Macquarie. While this timeframe included periods of high variability in flows (drought as well as flooding), the authors note that this hydrologic variability was not considered to be the primary cause of the declines.

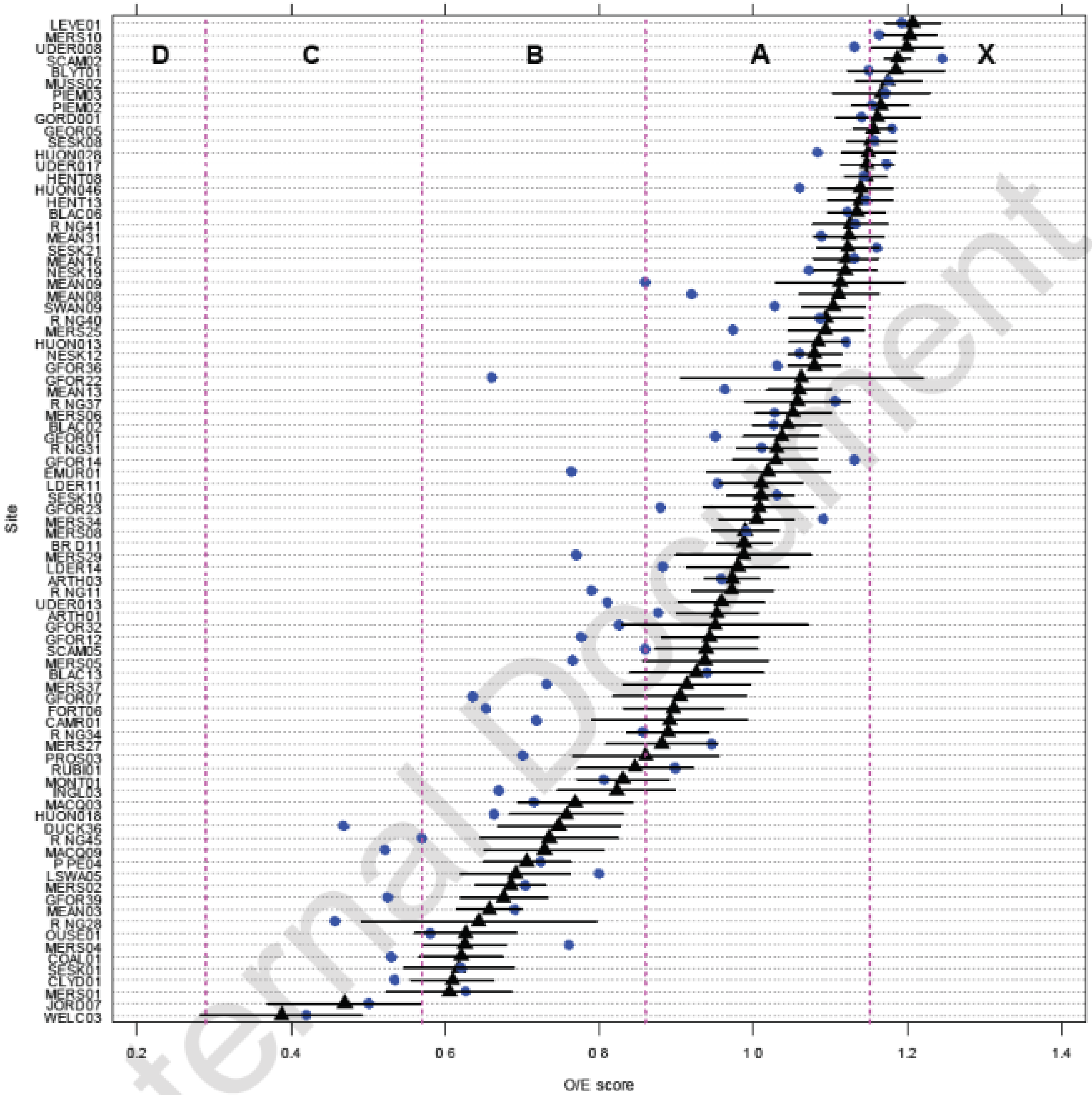


Figure 3.5 Mean (± 95% confidence interval) (closed black triangles and black lines, respectively) of O/E scores from long-term (1994-2018) sampling at temporal sites, and mean O/E scores from recent sampling (2014-2018) at the sites (blue closed circles). Approximate AusRivAS impairment bands are shown (pink dashed vertical lines are band thresholds), and band ratings are: X = above reference condition, A = equivalent to reference condition, B = significantly impaired, C = severely impaired and D = impoverished. Sites are ordered according to their long-term mean O/E scores, with the most impaired sites (i.e. low O/E scores) at the bottom and sites that are in good condition (i.e. high O/E scores) at the top. See Appendix 3 for

Figure 5: Temporal trends in river health for period from 1994 to 2018, as compared to the more recent period 2014-2018 (Source: DPIPWE, 2020)

The second part of the DPIPWE 2020 paper presents a spatial analysis of 298 sites that were monitored over a 10-year period (2007 to 2017), with a minimum of 5 surveys per site. Of these, 41% were found to be impaired or impoverished, while 59% were equivalent to reference conditions or better. See Figure 6 for details.

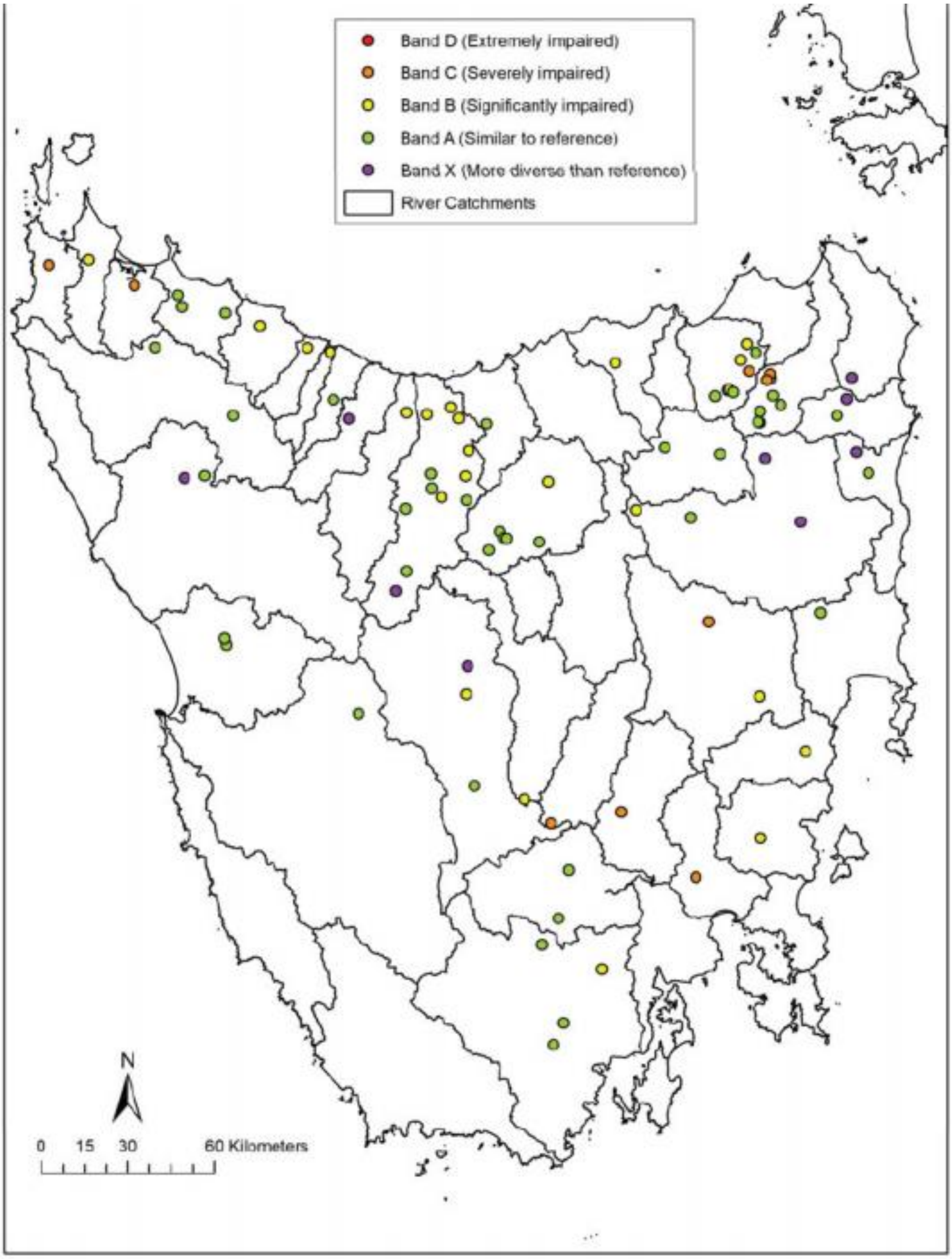


Figure 3.6 Map of approximate AusRivAS impairment bands of temporal sites based on mean O/E scores from recent (2014-2018) sampling.

Figure 6: River health condition at more extensively distributed sites based on monitoring from 2007 to 2017) Source: DPIPWE, 2020 as published on DPIPWE RTI Disclosure Log (# RTI 061)

Finally, the paper analysed a range of factors that could potentially influence river health, using three different statistical methods to determine the most probable stressors. Not surprisingly, factors that were most strongly correlated with poor river health included: the type and intensity of upstream land uses (particularly grazing agriculture); poor water quality (e.g. electrical conductivity); and high levels of upstream water extraction (based on allocation data). The statistical methods used in this paper were reviewed by an independent scientist, and found to be robust (Cawthorn Institute, 2020). In summary, the key findings of this paper are as follows:

1. At a broad scale, in developed catchments in Tasmania the upper reaches of rivers are typically healthy and in stable condition, whereas mid to lower reaches are often degraded to varying degrees and some are experiencing declines in condition.
2. At a broad scale, agricultural land use (particularly stock grazing), water quality (i.e. electrical conductivity) and water use (i.e. capture and extraction of water) are associated with poor river condition, whereas conservation land use is associated with healthy river condition.
3. Declines in river health appear to be associated with several factors including degradation of habitats (in-stream and riparian), poor water quality and changes in flow conditions.
4. There are several information gaps relating to river health in Tasmania, including effects of diffuse pollution on water quality, the status of riparian vegetation, algal and sediment loads on stream beds, the actual volumes of water that are extracted (rather than allocated), and temporal changes in land use.

None of these findings will come as a surprise to most Tasmanian water professionals, or indeed to observant farmers, anglers, walkers or other regular users of Tasmania's waterways. We are travelling the same path as thousands of other rivers around the world, including those in the Murray-Darling Basin and across New Zealand. As such, it is extremely disappointing that a publicly funded report of this nature could only be obtained through a FOI process, and that the few recommendations therein have been redacted from the report.

Furthermore, in considering these reports it is important to keep in mind that the findings may represent a relatively optimistic view of Tasmanian river health for the following reasons:

- The AusRivAs indicators focus on a single, but widely used indicator – macroinvertebrates (waterbugs) – and is therefore likely to underestimate changes in biodiversity and only detect substantial changes in river health (Hardie et al, 2018). As such, the use of the additional proposed indicators such as benthic algae and sediment, should strengthen future assessments.
- It is important not to interpret site-specific results as being fully representative of the condition of entire catchments. Many catchments have only one monitoring site, and the location of this is key. For example, while the results for the Swan and Prosser river sites are indicative of good river health, the monitoring locations are situated relatively high in in the catchment with no sites further downstream, where river conditions are known to be poor. To interpret conditions and trends across a catchment, multiple monitoring sites are needed.
- The papers specifically focus on diffuse, rather than point sources, and as such do not investigate impacts associated with sewage treatment plants, inland fish farms, mines or other industrial sources, nor do they seek to investigate impacts associated with hydropower development.

Other River Health Monitoring Programs

Several other river health monitoring methods and programs have also been undertaken in Tasmania, specifically

- Tasmanian River Condition Index (TRCI): This method was developed by NRM South in 2009 and includes a broader range of variables including aquatic life, hydrology, physical form and riparian vegetation (NRM South, 2009). While it addressed many of the MRH limitations noted above, it has not been extensively adopted in the State as it is more complex and thus more difficult and costly to implement.
- Waterbug Blitz: This Citizen Science project includes identification apps, training and events to support monitoring of river health at sites across Australia, including Tasmania. The on-line data portal provides data for over 1000 Tasmanian sites collected between 1994 and 2020 (these include the MRH data from DPIPWE as described above), along with additional data from Waterbug Blitz events in 2019 and 2020. The portal can be used to examine data for specific sites in more detail, and also includes recent land use data to further

support interpretation. An overview map showing the distribution of sites and river health (based on SignalT scores, red = poor condition) is provided in Figure 7 below. This map – together with the more detailed data on the portal – further confirms that a significant proportion of Tasmanian rivers are in poor health.

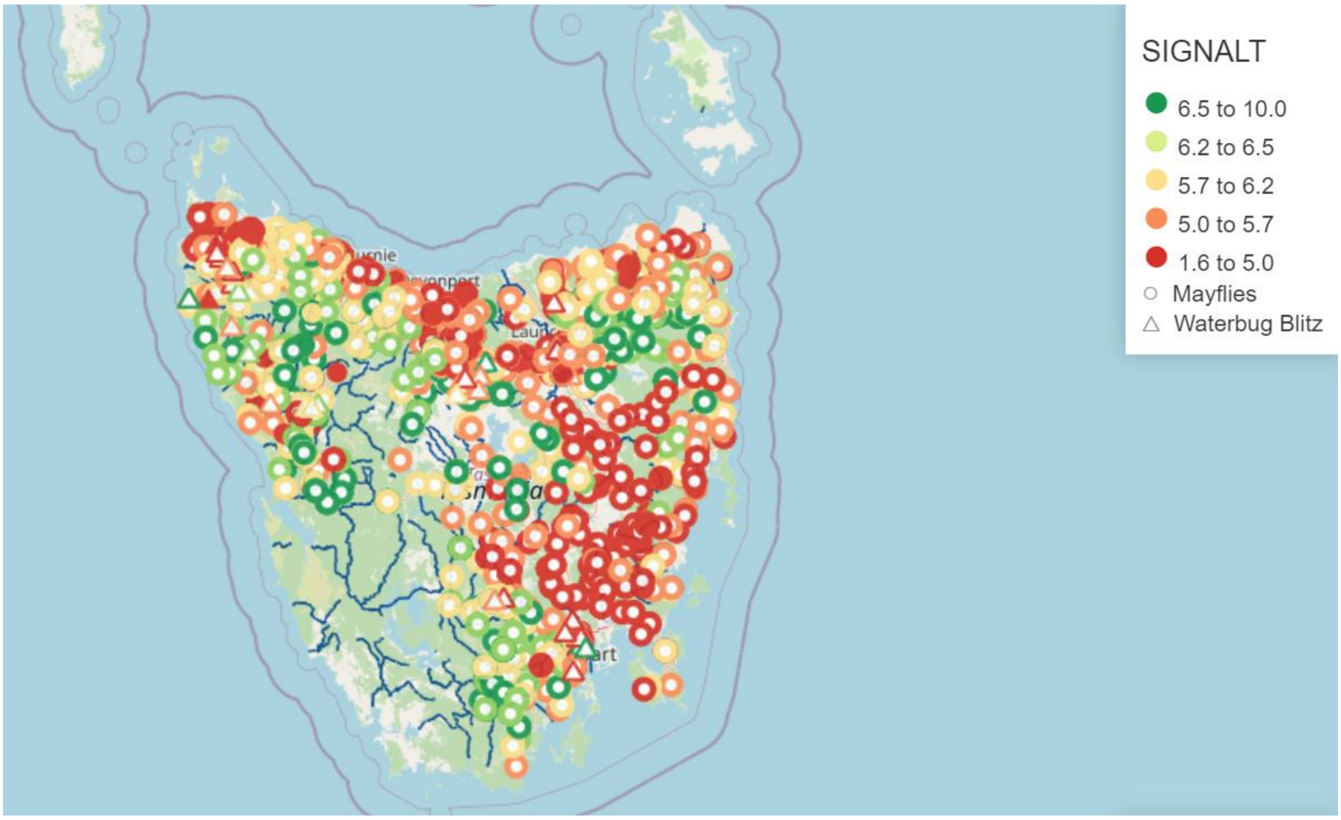


Figure 7: River health based on Signal T scores (Source: Waterbug Blitz website, 2021)

4. FRESHWATER ECOSYSTEMS

In addition to river flow, water quality and river health more broadly, many other aspects of Tasmania's freshwater ecosystems require urgent attention, including the conservation of aquatic habitats and the species that depend on these (including protected species). Risks associated with introduced species, disease and other harmful stressors also need a more coordinated and proactive approach. While these topics are beyond the scope of this paper, and merit much more detailed consideration, several key points are included below.

Conservation of Freshwater Ecosystem Values (CFEV): this statewide audit was undertaken in ~2005 with the objective that priority freshwater values would be considered in the development, management and conservation of the state's water resources**.** The scope included an assessment of rivers (including riparian vegetation), wetlands, lakes, saltmarshes, estuaries, karst systems and groundwater-dependent ecosystem values. The CFEV program included a conservation evaluation of Tasmania's freshwater-dependent ecosystems, which used existing environmental data to identify where aquatic values exist and their overall priority for conservation management. A series of spatial databases were developed that can be accessed on the LIST, along with a comprehensive technical report and other resources. While the CFEV audit was an important and ambitious first step to better understand and conserve our freshwater assets, the underlying data on which it was based was not comprehensive and is now well out of date, and the assessment methods are also in need of review and updating. Nonetheless, this is the best resource currently available.

4.1 Lakes

Hydro Tasmania has previously done some routine monitoring of their lakes and reservoirs, as well as a number of site- and issue-specific investigations (e.g. Lagoon of Islands, Great Lake). However, information about and direct access to these reports and publications is limited.

4.2 Wetlands

Tasmania has ten Ramsar-listed wetlands (out of 65 for Australia). These are: Moulting Lagoon, Logan Lagoon, Lavinia, Pittwater-Orielton Lagoon, Apsley Marshes, East Coast-Cape Barren Island Lagoons, Flood Plain Lower Ringarooma River, Jocks Lagoon, Interlaken, Little Waterhouse Lake. In 2001, a nomination was prepared for Boullanger Bay/Robbins Passage, but was rejected by government after considerable local resistance. Nonetheless, this remains one of the most important area for migratory shorebirds in Tasmania (Parsons, 2011). Each RAMSAR site requires an Ecological Character Description as the basis for management. These were mostly completed in about 2010 and can be accessed on the Australian Government website.

The National Atlas of Important Wetlands (2001) lists 89 wetlands in Tasmania, including some brackish/saline systems, but this is just a fraction of our high value wetlands. There are at least 800 sites listed in the inventory of Tasmanian wetlands (about one quarter of the estimated number in Tasmania), and it remains the case that much of our knowledge of these wetlands is inadequate or outdated. As discussed by Blackhall et al. (1996), about half the State's land area is yet to be investigated for wetlands. An inventory of lentic wetlands of eastern and northern Tasmania and the Bass Strait islands in 1981 (Kirkpatrick and Harwood 1981) showed 51% to be disturbed, with about 12% severely disturbed or destroyed. The Tasmanian Wetland Inventory (Atkinson 1991) has been useful in timely provision of informed advice in response to development proposals, but is desperately in need of information gathering and updating, and the funds to do so. The only recent systematic survey of wetlands has been for tidal saltmarshes. This work predicts some outcomes of climate change, including migration pathways in response to sea level rise (Prahalad and Kirkpatrick, 2019).

Twenty-eight of Tasmania's wetlands are known to host species listed on the Japan—Australia Migratory Bird Agreement (JAMBA) and/or the China—Australia Migratory Bird Agreement (CAMBA).

A draft Tasmanian wetland policy was developed in the early 1990s but has never been finalised or implemented.

4.3 Riparian zones

The riparian zone is the area between rivers and upland areas that is typically colonised by water tolerant vegetation. These areas are of particular importance for river health, as they provide a buffer from land-based activities, reduce flood erosion, provide habitat for aquatic-dependent communities and species (including threatened) and provide direct shade and temperature control to the waterways themselves. Unfortunately, these values are frequently overlooked and there has been (and continues to be) widespread clearing of riparian vegetation to the detriment of river health, particularly in lowland areas. A detailed study of Tasmanian riparian zones was completed in early 2000s, including field surveys at 460 sites and the definition of 21 floristic communities (Daley, 2003; Daley and Kirkpatrick, 2004). This study also found that nearly half of Tasmania's native plant species, including many threatened species, were detected within the 460 survey sites.

There have been a number of programs to protect and restore riparian vegetation including Greening Australia's Reconnecting the Midlands project, the acquisition of high conservation riparian reserves by the Tasmanian Land Conservancy, the Cows our of Creeks program and other site-specific projects undertaken by landholders – many with support from Landcare Tasmania, regional NRM bodies or other NGOs. While these are excellent initiatives, they cannot take the place of good policy and legislation at a state-wide scale. The Rivers of Carbon website provides excellent resources and case studies for riparian protection and restoration, including a strategic 7-step program to better focus resources.

4.4 Estuaries

Estuaries – where fresh and saltwater mix – are highly dependent on the quantity, timing and quality of freshwater discharged by their headwater streams. This plays a major role in all aspects of estuarine health, including water circulation, water quality, ecosystem health and fisheries. There has been no state-wide audit of estuarine condition in Tasmania, with on-going monitoring and reporting limited to specific systems such as the Derwent (DEP, 2020) and Tamar (TEER, 2020). There has also been extensive monitoring and investigations of Macquarie Harbour associated with mining and aquaculture impacts, studies of the Huon estuary associated with aquaculture, and a series of studies carried out in Little Swanport and its catchment by IMAS. Murphy et al (2003) monitored water quality in 22 Tasmanian estuaries back in the early 2000s, however this work has not been continued or repeated.

5. AQUATIC FAUNA INCLUDING INVASIVE SPECIES

A wide range of aquatic mammals, birds, fish, reptiles, amphibians, crustaceans, insects, etc. depend on Tasmania's freshwater systems. These include protected/endangered species such as the giant freshwater crayfish, several species of galaxids, the grayling, Australasian bittern, green and gold frog, as well as species, such as the platypus, that are under increasing pressure.

Tasmania supports 11 frog species; three of which – the Tasmanian Tree Frog, the Tasmanian Froglet and the Moss Froglet – are endemic. In addition, two other frog species, the Green and Golden Frog and the Striped Marsh Frog, are already threatened in Tasmania. Chytrid infection, which is present in Tasmania, has the potential to devastate these, and other frog populations.

5.1 Fish passage

Migratory fish such as whitebait, eels and lamprey require physical connectivity between rivers and the sea to complete their breeding cycles. Tasmania has hundreds of large and small dams, weirs and associated infrastructure that block this passage, resulting in a decline in these fish populations. While there are several projects to address this (e.g. eel traps/ladders at Trevallyn and Meadowbank), there is no systematic program to map, prioritise or mitigate these blockages. On the other hand, some blockages, natural or otherwise, are critical in protecting remaining populations of threatened aquatic organisms, such as the Swan Galaxiid.

5.2 Invasive species and disease

Introduced aquatic species are relatively widespread in Tasmania and include fish (brown, rainbow and brook trout, tench, carp (Lakes Crescent/Sorell), eastern gambusia (Tamar Island Wetland and spreading through estuary). The management/near-eradication of European carp from Lakes Crescent and Sorell by the Inland Fisheries Service after over 20 years of sustained effort has been a very positive outcome (Yick et al, 2021). Other potential invasive species that have been identified by DPIPWE as a high risk to Tasmanian waterways include: New Zealand didymo ('rock snot'), several species of freshwater turtles from mainland Australia and several species of freshwater snails.

Weeds of particular concern for Tasmanian waterways include riparian species such as the crack willow (widely distributed) and New Zealand karamu (lower Derwent system). Gorse also often competes with rare native riparian species.

Chytrid disease poses a severe risk to frog populations around the world and was first detected in Tasmania in 2004. It appears to be relatively widespread in areas of the state with high levels of human disturbance but was still relatively rare in southwest wilderness areas as of 2008, except in the vicinity of gravel roads (Pauza and Dreissen, 2008).

6. SUMMARY AND RECOMMENDATIONS

Tasmania's freshwater resources can no longer be considered clean, green and abundant. The recent Monitoring River Health reviews (2018, 2020) indicated that up to 43% of sites were classified as impaired, and that nearly 70% of sites had declined – often significantly – during the final five years of the program. Furthermore, this may well be an optimistic view, as the methods used and the sites monitored do not necessarily reflect worst case conditions. River flows have declined in many rivers across the state, and accurate climate change impacts are difficult to predict other than increasing levels of variability both temporally and spatially. In short, we may already be at or beyond a tipping point, with serious concerns about the consequences of the next dry summer.

This decline in river condition is playing out within the context of poor information about existing water use (due to limited metering), together with ambitious growth targets for agriculture (x5), salmon farming (x2), renewable energy (x2), mining and tourism. All of these are dependent on clean, green and abundant freshwater supplies. Where will it come from, and will it be at the expense of our priceless river systems?

At the same time, there has been a major reduction in the resources needed for informed water management and planning, with major cuts in funding for monitoring, assessment, compliance and reporting. DPIPWE's Water Resources division is now one of the worst-funded sections in the Department (just ahead of Racing Compliance) and is hard-pressed to undertake the work needed for current levels of water use, much less the ambitious new programs. Similarly, the EPA has only a few dedicated water quality officers.

Monitoring programs and the resources to support these have declined significantly over the past 20 years, during a time of unparalleled growth in water extraction. In particular, the RHMP program is a shadow of its previous self. The reduced two-yearly monitoring at 50 sites is not adequate to understand and respond to changes in river health. While additional monitoring carried out by sectoral and regional bodies, much of this work lacks coordination, rigour and/or transparency.

The reduction in monitoring has been matched by a lack of synthesis and regular, transparent reporting. Tasmania's statutory five-yearly State of Environment Report is now two cycles overdue. The Monitoring River Health review is an excellent initiative, but the release of these reports was unnecessarily delayed or prevented. The recent development of State of River Reports for six catchments is a positive step and should be expanded to include water quality and eflow aspects, and extended to all major/stressed river systems.

Eflows have not been set for most rivers, and many of previous assessments are now 20 years old. This area needs support for major review and progress, including monitoring & enforcement. Eflows should be managed by an independent entity, as in Victoria, to ensure the long-term ecological health of Tasmanian waterways

For many Tasmanian rivers, wetlands, estuaries and groundwater systems we simply have no – or very limited – information. Until this is available, a highly precautionary approach is needed to prevent long-term, irreversible decline.

An ambitious program is urgently needed to look after our river systems, as a prerequisite to further water development programs. This should include the following key elements:

- A major increase in funding and other support for freshwater monitoring, assessment, compliance and reporting.
- Production of Tasmania's long-overdue State of Environment Report, including a detailed Freshwater Systems technical report.
- An audit of existing monitoring programs currently being undertaken by government, industries, NGOs, etc to provide the basis for a comprehensive and cost-effective state-wide program
- A major investment in improved and better integrated monitoring of river flows, water quality and river health. This could build on the strong foundations of the RHMP.
- A review and reassessment of the environmental flows needed to sustain Tasmanian rivers both now and into the future.
- Improved protection and management of riparian zones and wetlands
- Improved management for migratory fish, eels and lamprey, including protection of fish habitat and key migration pathways
- More targeted management of aquatic flora and fauna, including threatened and invasive species

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