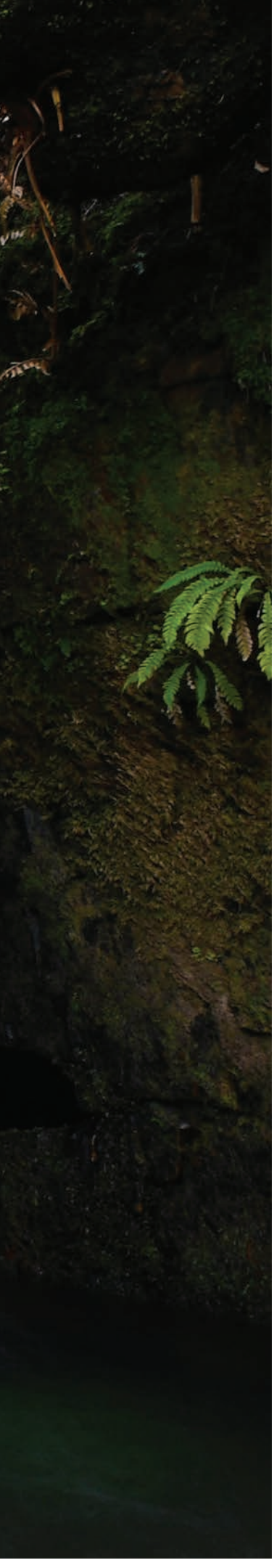
STATE OF OUR RIVULETS

A REPORT INTO THE ENVIRONMENTAL HEALTH OF HOBART'S WATERWAYS

City *of* HOBART



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Cover photo: Hobart Rivulet.
Report written by John Gooderham, National Waterbug Blitz.
Published May 2023.

INTRODUCTION

Hobart is surrounded by natural beauty. The mountain, kunanyi/Mt Wellington, sits high above us and is slightly removed by its elevation, but its rivulets are braver, plunging down the slope and cutting through Hobart bringing wildlife and greenery into the urban landscape.

This study uses the presence and diversity of waterbugs to provide a benchmark for the ecological health of Hobart's four major rivulets: New Town Rivulet, Hobart Rivulet, Sandy Bay Rivulet and Lambert Rivulet (from north to south).

Waterbugs provide insight into the longer-term effects of water quality on the health of a freshwater ecosystem. Waterbugs break down and feed on organic matter and each other. They are important food for larger animals in the food chain, such as native freshwater fish and the much-loved platypus, which inhabit Hobart's rivulets.

The diversity of waterbugs at particular points along a waterway can tell us much about that waterway's long-term exposure to impacts such as pollution and sediment. The presence of more sensitive waterbugs indicates lesser impacts, whereas sites populated only by "tolerant" organisms suggest impacts of pollution, sedimentation and erosion. Tolerant waterbugs are those that have resilience to these impacts.

The upper reaches of Hobart's rivulets are excellent reference sites for what healthy local waterways should look like in terms of stream biodiversity and water quality when pollution is low to non-existent. These upper reaches also act as a "biodiversity bank" by allowing sensitive waterbugs such as stoneflies and mayflies to breed and migrate downstream when conditions allow.

By measuring the ecological health of Hobart's four main rivulets over time through the presence of waterbug diversity, the City of Hobart can determine which areas most need closer monitoring and remediation.

Waterbug sampling for this report was carried out in early spring 2022 using the methodologies developed for the National Waterbug Blitz. This technique samples waterbugs from instream habitats, then identifies them in the field using The Waterbug

App. These lists of identified invertebrates are then converted into an assessment of ecological health, allowing different sites to be compared numerically using known relationships between the waterbugs sampled and their tolerance (or otherwise) of riverine pollution. Data can be viewed at the National Waterbug Blitz website – **waterbugblitz.org.au** – where it is mapped alongside other assessments from Tasmania. Sampling also included a suite of water quality measures and descriptions of streamside vegetation (riparian) condition.

As well as providing a benchmark against which future work can be compared, this survey aimed to address the following key questions:

1. Are there observable impacts downstream of the following known point source outfalls: Girrabong Avenue – NTR04 (large stormwater inflow with known sewer leaks), Pottery Creek – NTR06 (known sewer leaks). The Cascade Brewery and adjacent infrastructure – HOB04, McRobies Gully Waste Management Centre – HOB06.
2. Are sites with willow infestation noticeably impacted (GYF02, NTR07, SAN03) and how do they differ from sites without willows?
3. How does the 2022 spring survey compare to historic samples from the same rivulets?
4. How does the ecological health data compare with water quality data collected at the same time?
5. Is there a longitudinal trend in condition along each rivulet?

SITE SELECTION

Sites were selected along the length of each rivulet to best answer the key survey questions.

Figure 1 (pages 6-7) shows the location of these sites within the City of Hobart municipal area.

Table 1 (pages 8-9) lists these sites with further information including whether they can be considered urban rivulets or upstream of urban influences. It also lists if the sites are downstream of known point sources of pollution or amid willow infestation.

At least one site in each rivulet was located above where the waterway reached areas of urban influence (site codes ending in 01). These higher elevation sites provide reference points for the biodiversity and abundance of waterbugs that naturally occur in each rivulet without the influence of urban runoff.

The only exception is Lambert Rivulet, as the headwaters of this stream are urbanised along the Mt Nelson ridge.

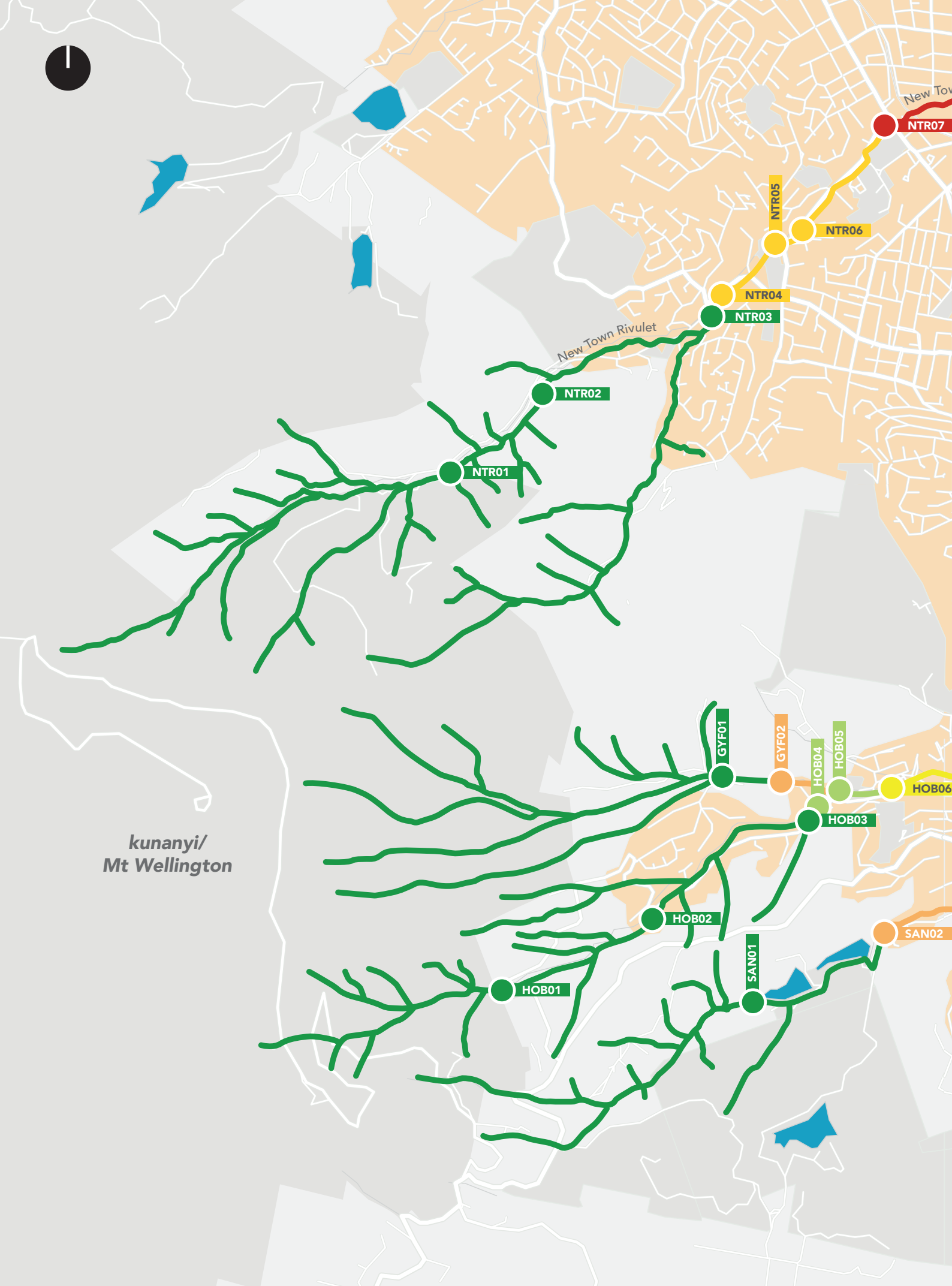
SPRING SURVEYS

Each of Hobart's four major rivulets were sampled at a number of sites along their length in spring 2022 to provide information on their ecological health and water quality. Ecological health was assessed using SIGNALT scores, which are calculated based on the types of freshwater macroinvertebrates (waterbugs) collected in each sample. Ecologically healthy sites tend to have a rich diversity of waterbugs that includes sensitive animals such as mayfly nymphs, stonefly nymphs and caddisfly larvae alongside pollution tolerant animals such as worms, introduced water snails and blood worms. Ecologically healthy sites tend to have SIGNALT scores above 5.8. Urban rivulet sites tend to only have the pollution tolerant animals such as worms, introduced water snails and blood worms. These sites have lower SIGNALT scores.

Hobart Rivulet and New Town Rivulet have both been assessed previously by the Department of Natural Resources and Environment Tasmania as well as the National Waterbug Blitz.

The spring 2022 samples for Hobart Rivulet showed improved ecological health compared to samples from 2021, 2019 and 2012. New Town Rivulet scored better than when previously sampled in 2005. Sandy Bay Rivulet and Lambert Rivulet had no prior data for comparison.

All four rivulets were healthier upstream than downstream. Hobart Rivulet and New Town Rivulet degrade gradually from the naturally forested headwaters to their urbanised mouths, where they enter the River Derwent. Sandy Bay Rivulet and Lambert Rivulet undergo a more abrupt change once the catchment becomes urbanised.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NTR07
NTR05
NTR06
NTR04
NTR03
New Town Rivulet
NTR02
NTR01
GYF01
GYF02
HOB04
HOB05
HOB06
HOB03
HOB02
SAN02
SAN01
HOB01
kunanyi/
Mt Wellington

RIVULET SURVEY POINTS

SITE SCORING

- 0 – 4.7
- 4.7 – 5.3
- 5.3 – 5.8
- 5.8 – 6.1
- 6.1 – 10

URBAN AREAS

RESERVES & PARKS

Figure 1 Sites sampled for State of Our Rivulets report.

RIVULET SAMPLE SITES

Site name	Date	Latitude	Longitude	Urban	Willows	Point Sources
New Town Rivulet NTR01	2/09/2022	-42.8746	147.2555			
New Town Rivulet NTR02	2/09/2022	-42.8654	147.2775	X		
New Town Rivulet NTR03	2/09/2022	-42.8644	147.2816	X		
New Town Rivulet NTR04	2/09/2022	-42.8629	147.2829	X		X
New Town Rivulet NTR05	2/09/2022	-42.8593	147.2878	X		
New Town Rivulet NTR06	2/09/2022	-42.8591	147.2888	X		X
New Town Rivulet NTR07	2/09/2022	-42.8534	147.2957	X	X	
New Town Rivulet NTR08	2/09/2022	-42.8497	147.3106	X		
Hobart Rivulet HOB01	5/09/2022	-42.9081	147.2631			
Hobart Rivulet HOB02	5/09/2022	-42.9034	147.2767	X		
Hobart Rivulet HOB03	5/09/2022	-42.8971	147.2904	X		
Hobart Rivulet HOB04	5/09/2022	-42.896	147.2916	X		X
Hobart Rivulet HOB05	11/09/2022	-42.895	147.294	X		
Hobart Rivulet HOB06	5/09/2022	-42.8949	147.2979	X		X
Hobart Rivulet HOB07	5/09/2022	-42.8937	147.3078	X		
Hobart Rivulet HOB08	5/09/2022	-42.8862	147.3229	X		

Table 1 Sites sampled for this report in 2022.

Site name	Date	Latitude	Longitude	Urban	Willows	Point Sources
Guy Fawkes Rivulet GYF01	5/09/2022	-42.8945	147.2854			
Guy Fawkes Rivulet GYF02	5/09/2022	-42.8944	147.29		X	
Sandy Bay Rivulet SAN01	6/09/2022	-42.9091	147.2859			
Sandy Bay Rivulet SAN02	6/09/2022	-42.904	147.2975	X		
Sandy Bay Rivulet SAN03	6/09/2022	-42.9019	147.3078	X	X	
Sandy Bay Rivulet SAN04	6/09/2022	-42.8997	147.3141	X		
Sandy Bay Rivulet SAN05	6/09/2022	-42.8946	147.3197	X		
Sandy Bay Rivulet SAN06	6/09/2022	-42.8934	147.3253	X		
Lambert Rivulet LAM01	6/09/2022	-42.9142	147.33			
Lambert Rivulet LAM02	6/09/2022	-42.9089	147.3307	X		
Lambert Rivulet LAM03	6/09/2022	-42.905	147.3333	X		

WHAT DOES A HEALTHY RIVULET LOOK LIKE?

Hobart's rivulets are steep, rocky, freshwater ecosystems with pools and riffles, where fast flowing water moves over and around shallower, rocky areas. The steep terrain has resulted in many small waterfalls and the shape of the landscape gives each rivulet just a short run before it enters the timtumili minanya/ River Derwent. In natural areas forest, including wet temperate rainforest, provides plenty of shading for the rivulets. The abundance of surrounding forest results in plenty of leaf litter and woody debris, which creates an abundance of different habitats for the organisms that live in Hobart's rivulets.

Typically, leaf litter and sticks washed down from surrounding forest would provide food and habitat for aquatic life in Hobart's rivulets. There would be relatively few plants and algae living within the rivulet system due to low light levels and the relatively fast flowing nature of these waterways.

A wide variety of animals make their home in Hobart's rivulets, including:

- platypus
- rakali (water rats)
- several species of jollytail (*Galaxias* spp.)
- wide diversity of waterbugs (also known as freshwater macroinvertebrates).

WHAT DO URBAN RIVULETS LOOK LIKE?

In an urban waterway, everything from habitat to water quality tends to be modified.

In areas with lots of infrastructure, waterways tend to be managed to minimise the risk of flood damage on nearby structures – roads, houses, buildings. These modifications change and limit the habitats available in a waterway and usually reduce the diversity of aquatic wildlife, including native fish and waterbugs.

Urban waterways are characterised by much faster flowing water systems. Concrete and tarmac shed rainwater swiftly, and stormwater systems are designed to remove standing water as quickly as possible. Faster moving water often makes urban rivulets highly erosive places – channels are forced to move larger amounts of faster water than if the water was allowed to percolate into the soil across a catchment. This additional hydraulic stress often damages aquatic habitat by scouring, smothering or eroding sediment as water moves swiftly through the rivulet.

One archaic way of minimising damage caused by faster flowing urban waterways was to plant introduced willow trees in an attempt to hold down sediment and prevent erosion. Unfortunately, willow species are often environmental weeds in Australia and come with their own problems. They smother native riparian and aquatic vegetation and reduce waterways to root-lined ponds and chutes. Invasive willows are also bad for Hobart's rivulets because they deliver leaf litter in a single, large dose in autumn. Willow leaves then smother and blanket many of the places in which aquatic fauna would survive. They also decompose very quickly compared to eucalypts and most other native vegetation, a process that can crash levels of dissolved oxygen available in the water. Willows also change stream dynamics, increasing flood risk and accentuating erosion by altering stream geomorphology and pushing water away from its natural course. The over use of lawn fertilisers can also have detrimental impacts on the health of our waterways. The same nutrients in fertilisers that encourage grass to grow can also lead to increased algae in our waterways.

Pollutants are another threat to the water quality and ecological health of Hobart's urban rivulets. The long list of pollutants that can find their way into urban rivulets can be simplified by looking at where the pollutants come from. Nutrients and organic pollution often come from ineffective septic systems and sewer system overflows. Animal faecal material, typically from dogs and birds such as pigeons or waterfowl, can also have an impact on rivulet health. Oil, petrol and other hydrocarbons wash off road surfaces and into stormwater systems and then urban rivulets. Herbicides, pesticides, petrol, oil, cleaning products, paint, concrete wash and sediment from new housing sites and road construction can all find their way into waterways through the stormwater system, further deteriorating the health of Hobart's rivulets.

A platypus searching for food in the Hobart Rivulet. Photo: @hobartrivuletplatypus

As waterways pass through urban areas, water quality degrades and fewer types of waterbug can survive. Those waterbugs that do survive in the poorer urban rivulet environment create a subset of more tolerant waterbugs. Fish are also sensitive to water quality and may be impacted by poorer water quality. Larger animals such as rakali and platypus can persist if there is enough food and suitable streamside habitat. Brown trout (*Salmo trutta*) is an invasive species that occurs throughout urban rivulets. It can also impact waterbug diversity and smaller fish species as it is an efficient predator.

WATERBUG WONDERLAND

The world of waterbugs is completely alien to most people, but for those willing to explore this miniature aquatic kingdom it is full of mystery, wonder and some of the strangest creatures on the planet.

Mountain shrimp

Mountain shrimp live in the pools of the Hobart Rivulet just above Strickland Falls. They are more common in rivulets higher up the slopes of kunanyi/Mt Wellington. These animals have barely changed their form since the Carboniferous period, 300 million years ago. They were described from fossils before the first living examples were discovered in Hobart in 1893.

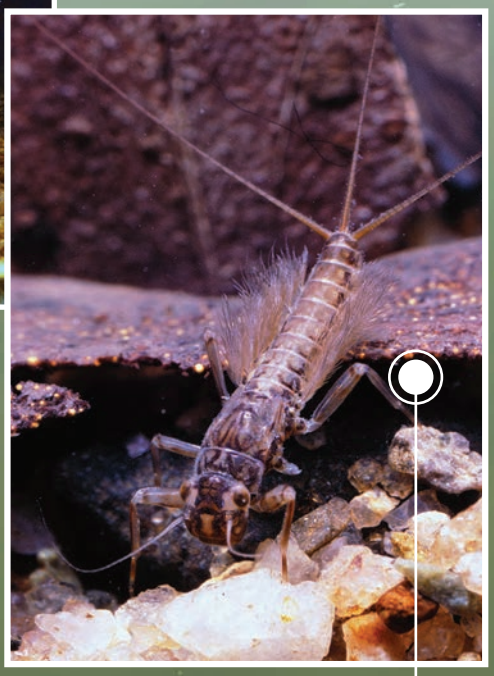
U-sthenid stonefly

As a nymph, these insects terrorise the rest of the waterbug world in Hobart's rivulets. They hunt at dawn and dusk, moving around and under rocks and woody debris, running down sideswimmers and mayflies just as they are turning in for the night. This waterbug lives as a nymph for a couple of years before emerging as a fully-fledged stonefly to look for a mate. They are quite common along walking tracks of our rivulets between November and June. When startled or threatened the adult stonefly flares up, showing its red hind wing.

Photo: Daniel Rhodes

Cow shrimp

Cow shrimp are the stars of Lambert Rivulet, where for some reason they are more common than in other rivulets. They live in the leaf litter that accumulates behind cobbles in the rivulet. They are slow-moving, but well armoured, like miniature armadillos.



Sideswimmers

Sideswimmers can grow to the size of a 5 cent piece. Their body is flat, allowing them to slot between cobbles and leaves, which they shred to bits while feeding. These are the most numerous waterbugs in the upper parts of Hobart Rivulet and are likely an important food source for platypus.

Tinsel-gilled mayfly

There are many mayfly species in Hobart's rivulets. The tinsel-gilled mayfly has distinctively fluffy gills along its abdomen. Absence of mayflies indicates pollution in our waterways, which is why they are the mascot for the National Waterbug Blitz.

Log cabin caddis

Many caddis are master builders, the larvae create protective structures from materials at hand – sand grains, silk, or in the case of the log cabin caddis, freshly-cut water weed lumber.

The structures are completely mobile, allowing the caddis to move around underwater in their own mobile mini-home.

NATIONAL WATERBUG BLITZ & SIGNALT SCORES

The National Waterbug Blitz is a citizen science program that uses the waterbugs in a river, creek or rivulet to assess the ecological health of that waterway. The program collects data with The Waterbug App (freely available for Android and iOS/ Apple mobile devices). This data is then mapped, analysed and published on the National Waterbug Blitz website – **waterbugblitz.org.au**. The program uses SIGNALT to assess sites. This is a variant of the SIGNAL 2 scoring system (Chessman, 2003). The program allows for a rapid assessment of the ecological health of a waterway that contributes to a broader knowledge of freshwater ecosystems.

SIGNALT is calculated using known associations between waterbugs and the levels of impact they can withstand. Each waterbug has a SIGNALT grade, those that are sensitive to pollution are given grades closer to 10, while those that can tolerate pollution get lower grades (Figure 2). A site assessment score is calculated by averaging the grades of all the waterbugs found at that site. This average can be weighted by the abundances of the waterbugs to produce a weighted SIGNALT score. When SIGNALT is used in the National Waterbug Blitz the default measure is weighted SIGNALT as it is more stable. Weighted and unweighted scores are displayed in this report because sometimes their reasons for differing are informative.

The water quality parameters displayed in the results for each rivulet were measured using a Hanna H929829 multiprobe. Of the parameters measured electrical conductivity and temperature have been shown in the results as they have a clear correlation with downstream ecological health trends.

RESULTS

Results are presented separately for each of the four rivulets. Questions that span multiple rivulets are addressed in the Discussion.

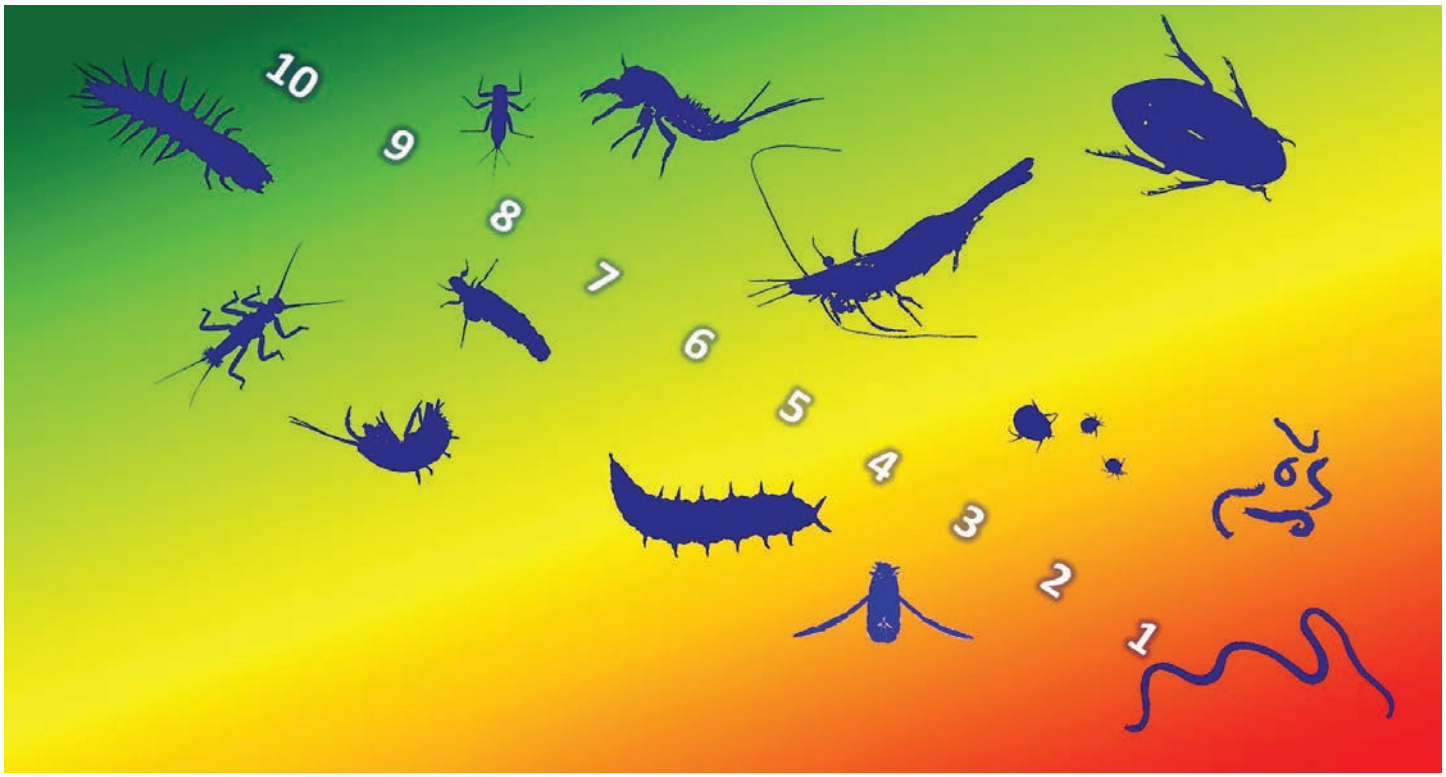


Figure 2 A graphic representation of different waterbugs and how tolerant they are of pollution. Waterbugs in the lower right of the figure are tolerant and therefore have lower SIGNALT scores than the sensitive waterbugs in the top left.

Volunteers learn how to identify waterbug species. Photo: Rebecca Johnson

NEW TOWN RIVULET

Sampling of the New Town Rivulet headwaters (reference site NTR01) revealed very healthy diversity and abundance of sensitive waterbugs. Further downstream, as the rivulet is increasingly impacted by urbanised areas within the catchment, the trend in ecological health declines steadily. By the lowest sample site the rivulet is impacted (Figure 3 and Figure 4). There is a marked decline in ecological health between NTR03 and NTR04, then a further drop between NTR06 and NTR07.

Almost one quarter of the waterbug diversity in the rivulet is lost between NTR02 and NTR03 (Figure 5). By NTR07 just over half of waterbug types remain.

The tree cover reduces abruptly at NTR03, possibly causing a related spike in algal cover at this site.

Electrical conductivity increases consistently downstream in New Town Rivulet. This is likely to reflect the wide array of soluble pollutants entering the rivulet (Figure 6). In contrast, temperature increases to NTR04, then starts to decrease downstream. This may reflect the canopy cover in the lower sections of the rivulet, which is mostly greater than 50 per cent despite the urban surrounds.

NTR04 is downstream of Girrabong Avenue, a stormwater junction associated with known sewer leaks (Figure 7). NTR03 was chosen to be close but upstream so it is likely that the drop in ecological health observed between these two sites can be attributed to the Girrabong Avenue point source. Electrical conductivity spikes, then remains constant after NTR04 until NTR06, the next known point source for pollution along the rivulet.

NTR06 is downstream of the Pottery Creek junction, a small catchment with multiple known sewer leaks. There is no discernible difference between the ecological health measured at NTR05 (upstream of the confluence with Pottery Creek) and NTR06 (downstream). Electrical conductivity is higher at the lower site, however, and continues to rise downstream.

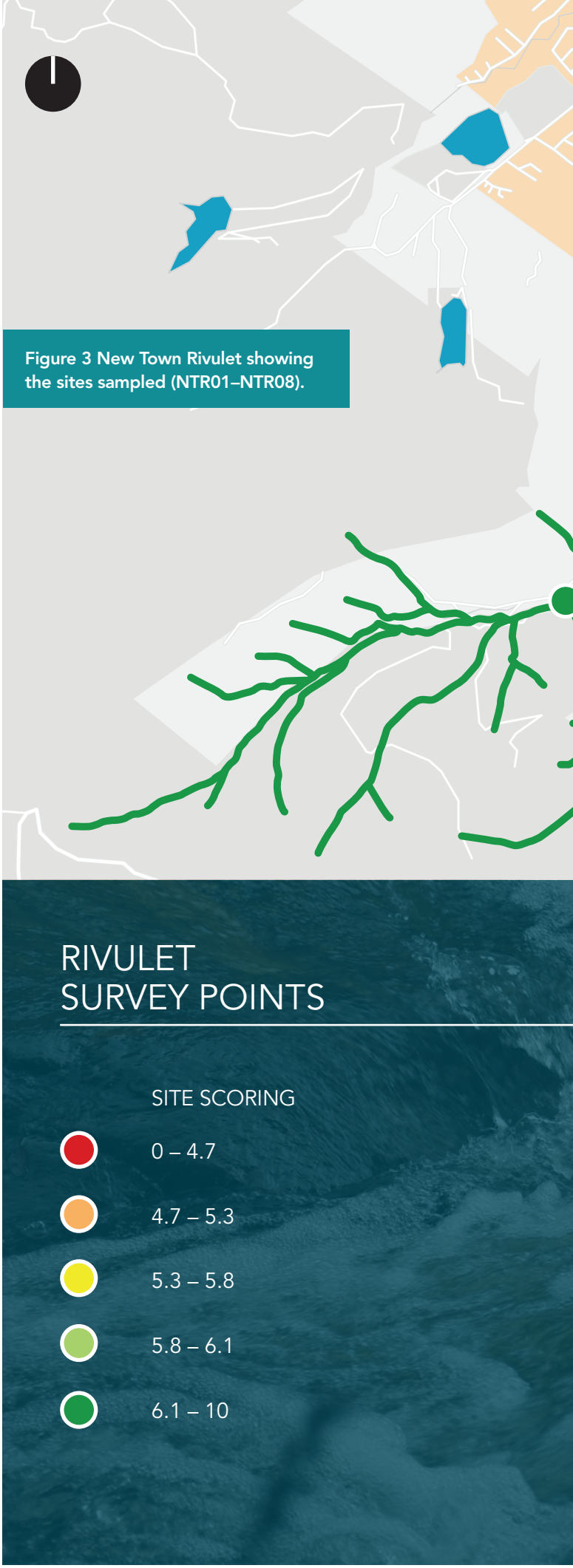


Figure 3 New Town Rivulet showing the sites sampled (NTR01–NTR08).

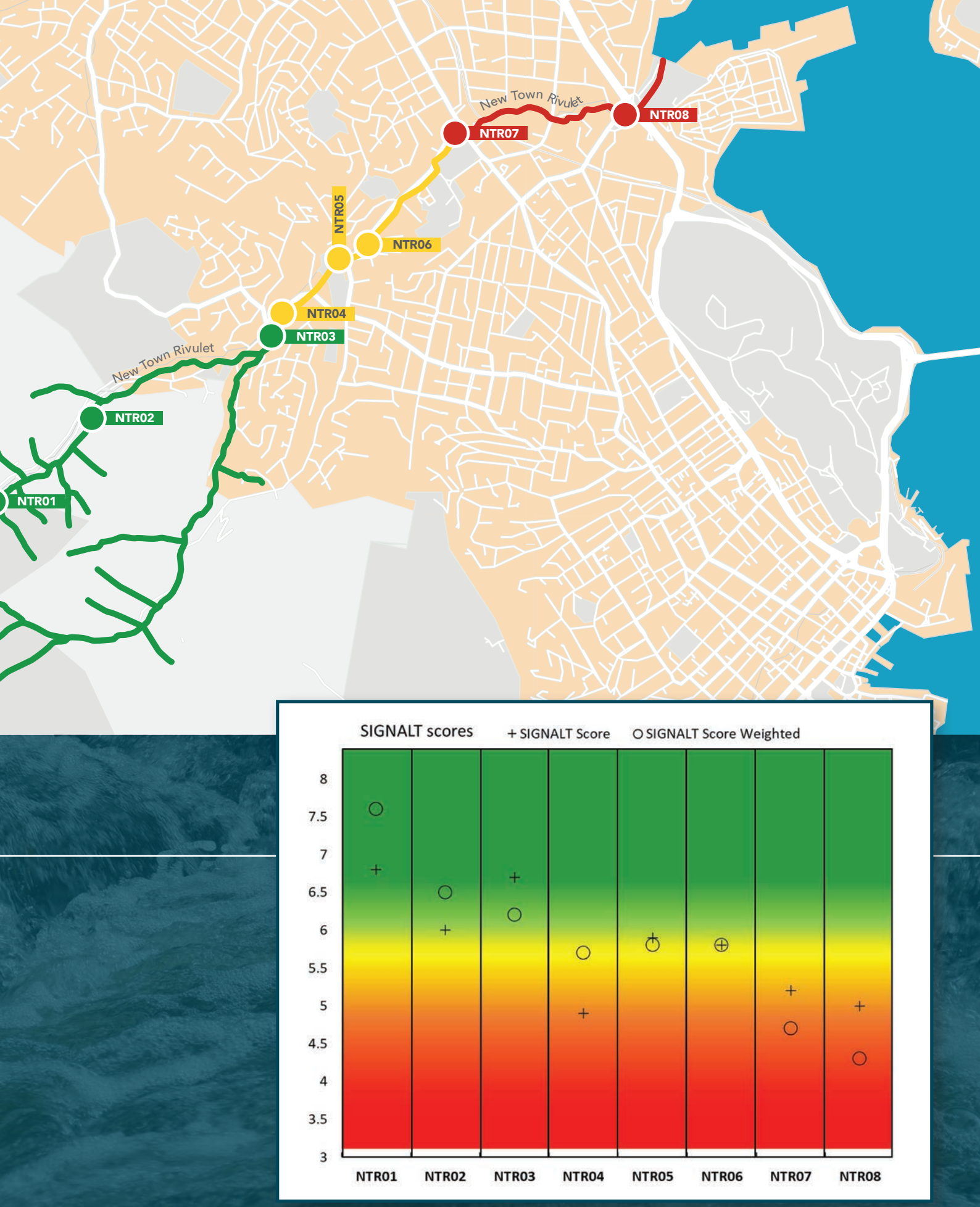
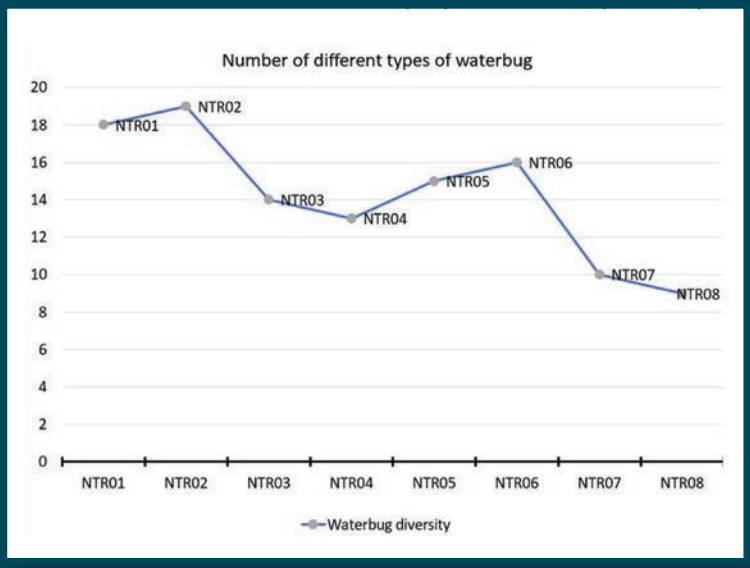


Figure 4 SIGNALT scores for sites in the New Town Rivulet. NTR01 is an upstream healthy site, site numbers increase downstream. Circles are for weighted SIGNALT scores, crosses show unweighted scores. The background colours approximate the level of impact at each site, red being heavily impacted, and green relatively natural/healthy.

NEW TOWN RIVULET



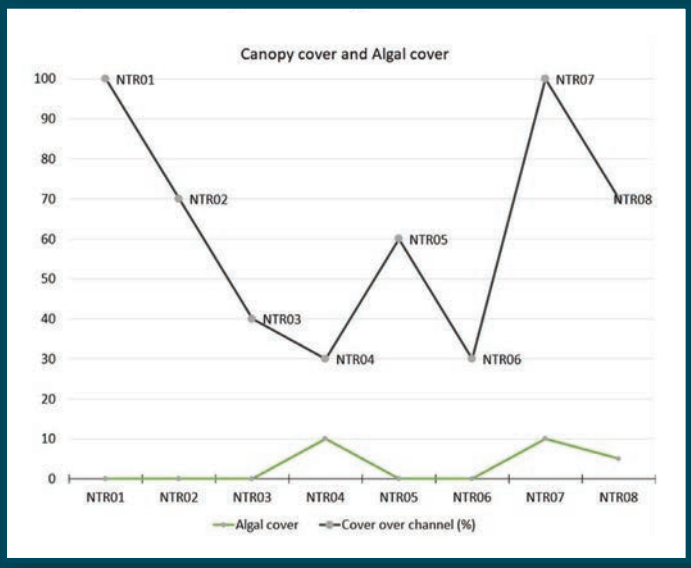


Figure 5 Number of different types of waterbug (left) and percentage of canopy cover over the channel coupled with percentage of algal cover over the river bed (right). Sites are arranged with downstream to the right of the figure.

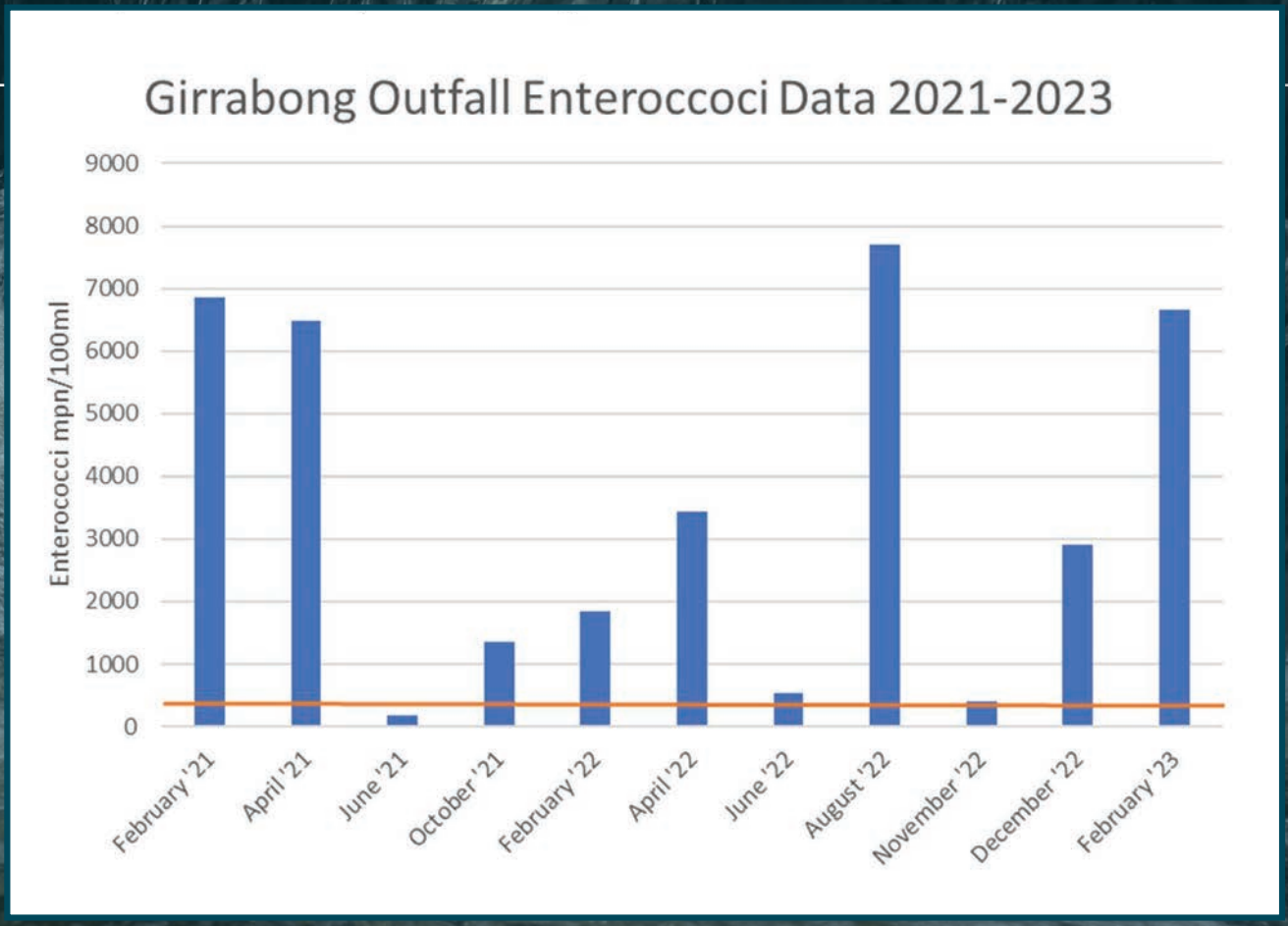
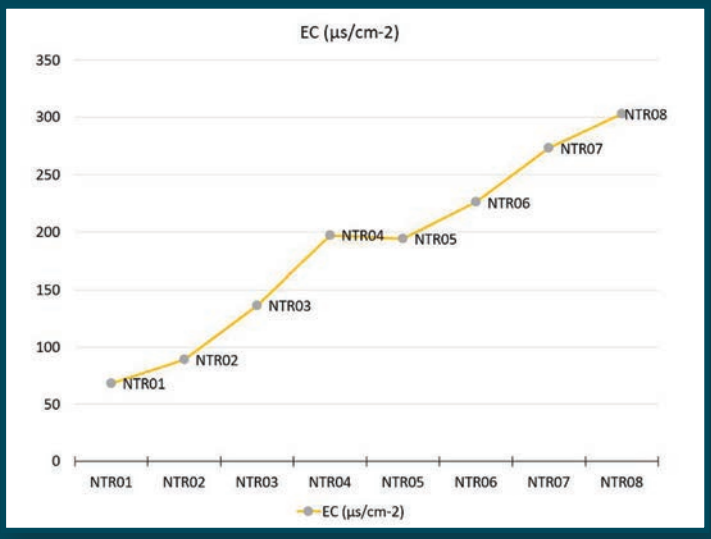


Figure 7 Showing enterococci from the previous two years of sampling at Girrabong outfall. The orange line represents poor water quality and deemed not safe for swimming in. Enterococci is indicative, but does not confirm sewage infiltration, however it is likely.



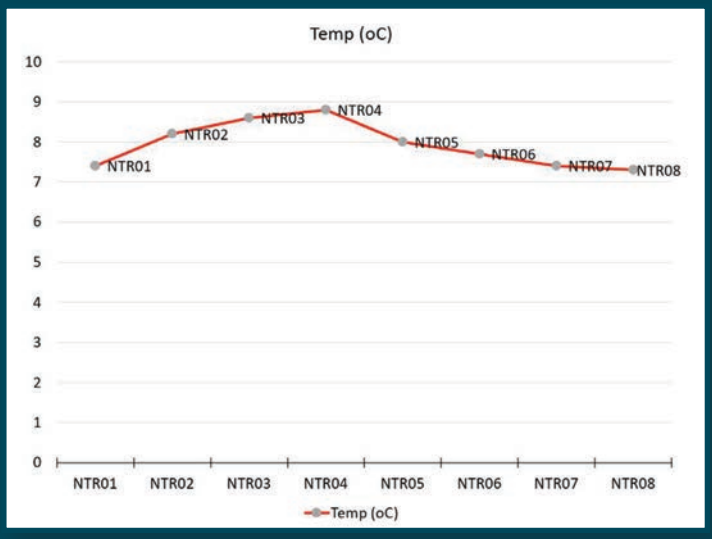


Figure 6 Two water quality measures, Electrical Conductivity (EC), left, and Temperature (Temp), right. Sites are arranged with downstream to the right of the figure.

HOBART RIVULET

SIGNALT scores decrease downstream along Hobart Rivulet (Figure 8 and Figure 9). HOB06 and GYF02 both register as impacted compared to the next site upstream. HOB07 is noticeably more impacted than HOB06 when looking at SIGNALT weighted. Interestingly, unweighted scores are very similar for these two sites, suggesting the difference between them is a drastic change in the abundance of a sensitive animal (such as a mayfly or stonefly).

The two point source impacts identified for this rivulet were immediately upstream of HOB04 and HOB06. Unlike New Town Rivulet, these impacts don't stand out by themselves in the change of Weighted SIGNALT downstream. HOB04 (infrastructure including a sewer junction near Old Farm Road), HOB05, and HOB06 (outflow from the Hobart tip) simply continue the downstream degradation trend. The first step in this trend (Figure 9) is between HOB06 and HOB07, and this is likely due to the distance between the two sites being greater than the gaps between sites upstream, thus allowing the trend to be further advanced at the downstream sample site.

GYF02 is noticeably different to the upstream reference site GYF01 (Figure 9). This site placement was intended to see if the willow infestation at the lower site would result in a drop in ecological health. These sites are ideal for this comparison – both sites share very similar and low levels of urbanisation and are upstream of most stormwater pollution. The only possible impact other than willows at GYF02 could be leaky septics upstream, but this scenario is just as likely for GYF01 upstream.

The largest change in waterbug diversity is between sites HOB07 and HOB08 (Figure 10) compared with New Town Rivulet. The diversity changes very little otherwise, so the drop in ecological health downstream from HOB03 is driven mainly by a change in assemblage. Waterbugs with high SIGNALT grades are replaced by lower scoring ones, but the overall number of different types of waterbug remaining is similar (14–19), right down to HOB07.

The tree canopy cover drops markedly at HOB03 (to 30 per cent) and an algal response can be seen in Figure 10. Lower canopy cover at sites HOB07 and HOB08 don't show the same response in algal cover, but this reduction in algal cover may be due to scouring impacts at lower elevations, where flows are larger.

Electrical conductivity increases downstream (Figure 11), but remains relatively constant between HOB03

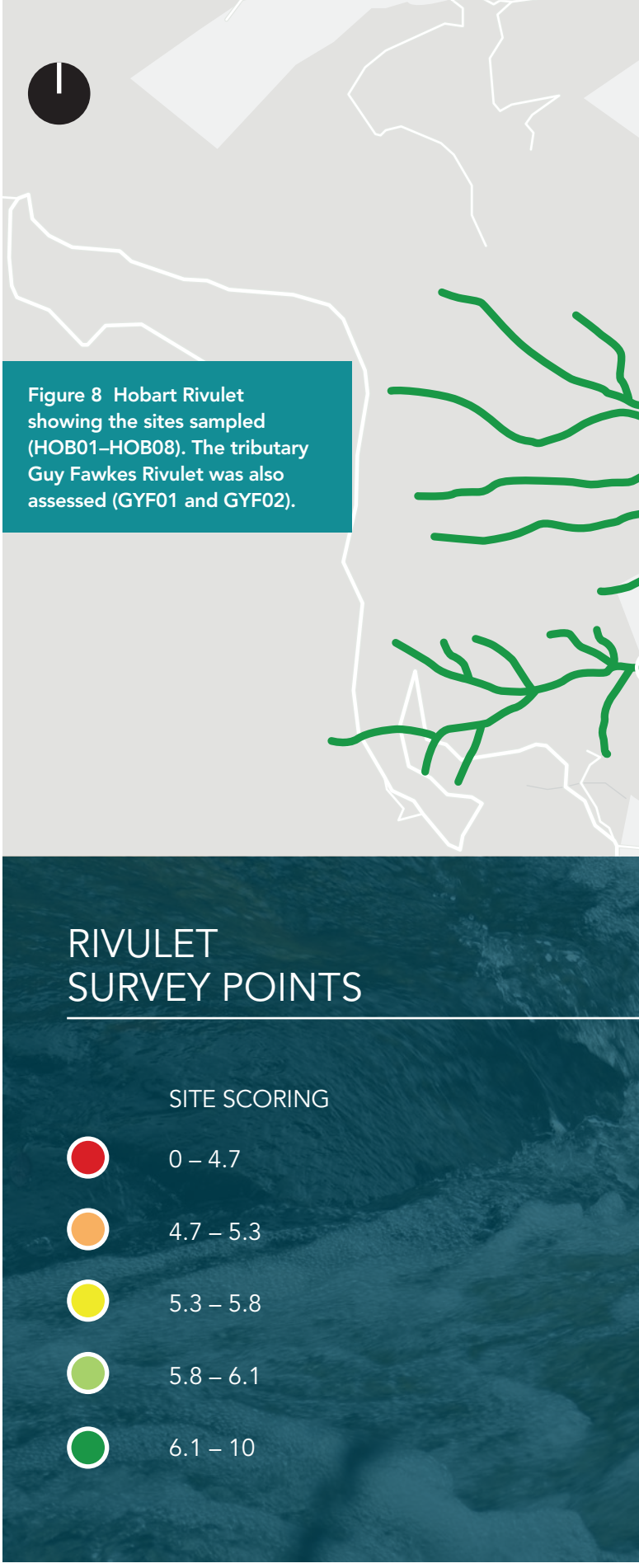


Figure 8 Hobart Rivulet showing the sites sampled (HOB01–HOB08). The tributary Guy Fawkes Rivulet was also assessed (GYF01 and GYF02).

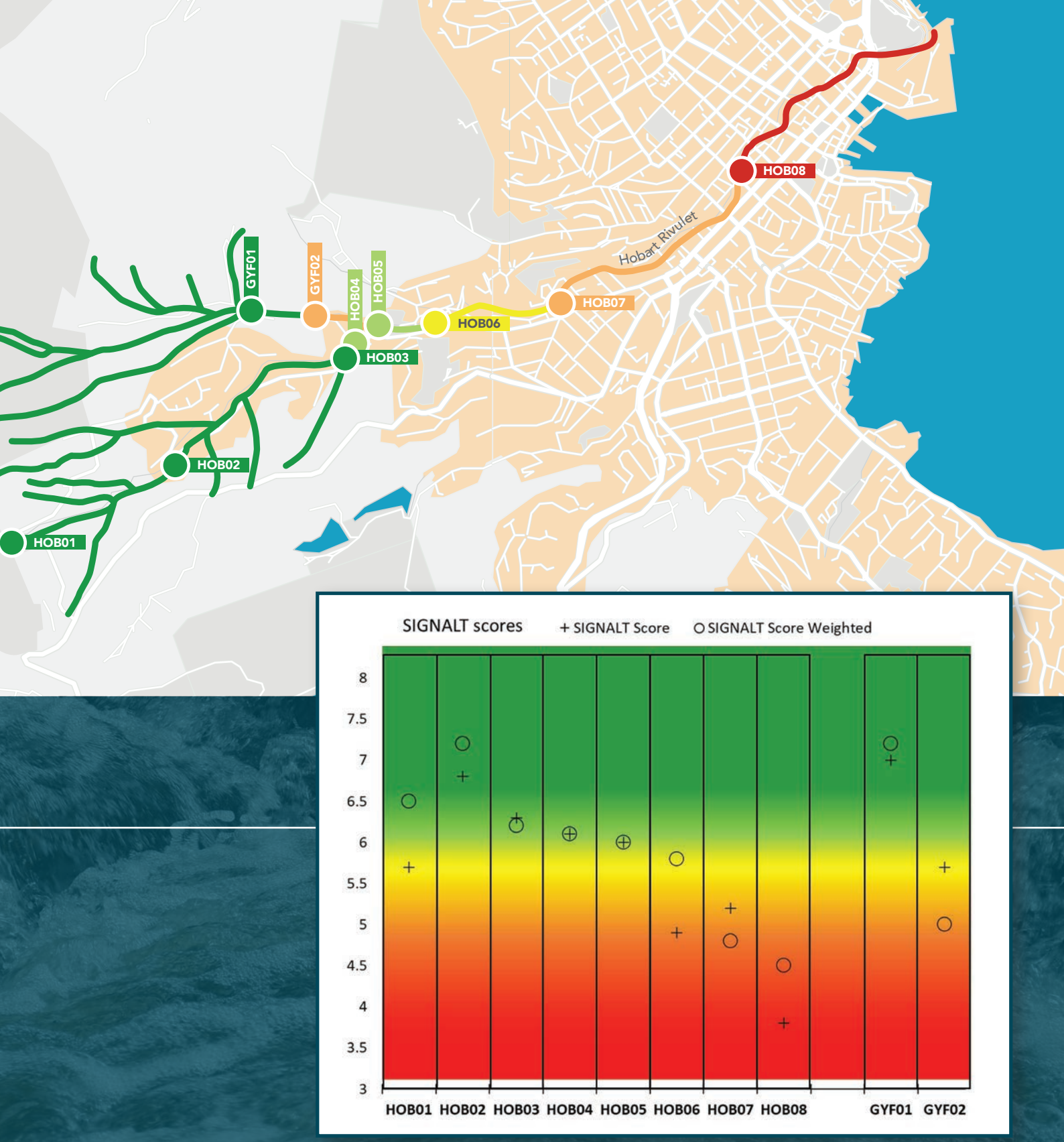
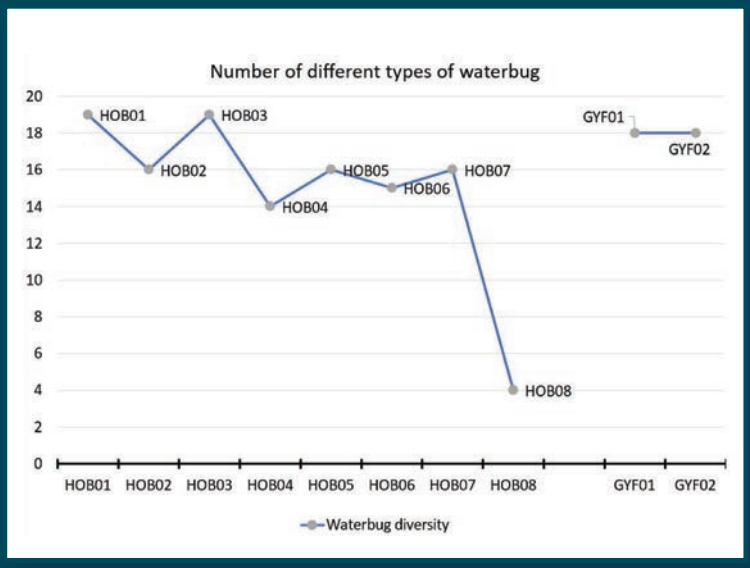


Figure 9 SIGNALT scores for sites on the Hobart Rivulet. HOB01 is an upstream, healthy site, site numbers increase downstream. Circles are for weighted SIGNALT scores, crosses show unweighted scores. The background colours approximate the level of impact at each site, red being heavily impacted, and green relatively natural/healthy. Guy Fawkes Rivulet (a tributary of the Hobart Rivulet) sites have the code GYF01 and GYF02.

and HOB06. This is possibly a reflection of how geographically close these sites are.

Temperature increases downstream from HOB01 to HOB05, then seems to be reset at HOB06. This pattern does not fit with any of the other variables recorded during the survey and remains an interesting anomaly. One piece of information missing that could possibly explain it is diurnal variability in temperature (and all the water quality variables). This is considered more in the Discussion.

HOBART RIVULET



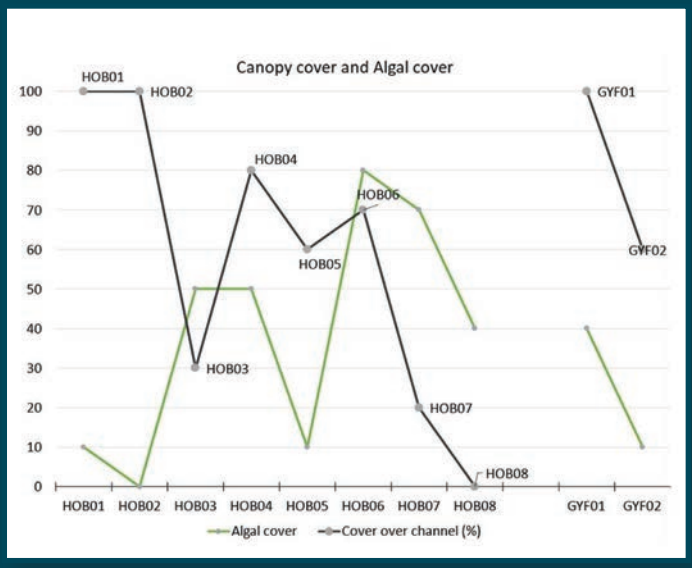
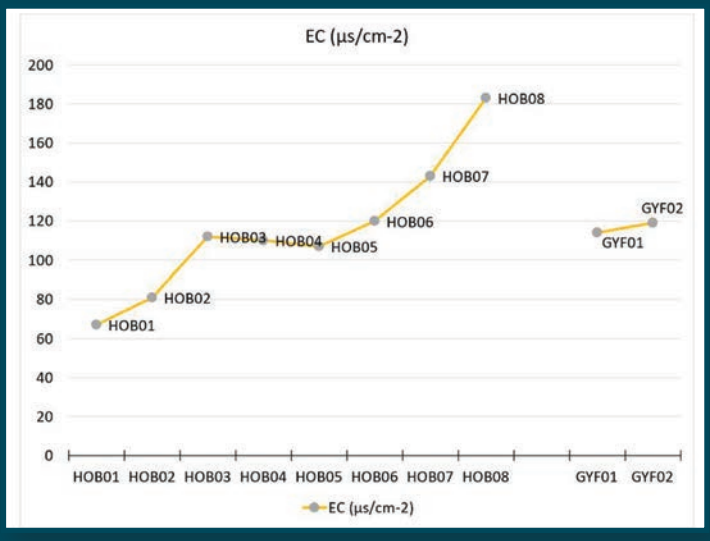


Figure 10 Number of different types of waterbug (left) and percentage canopy cover over the channel coupled with percentage of algal cover over the river bed (right). Sites are arranged with downstream to the right of the figure.



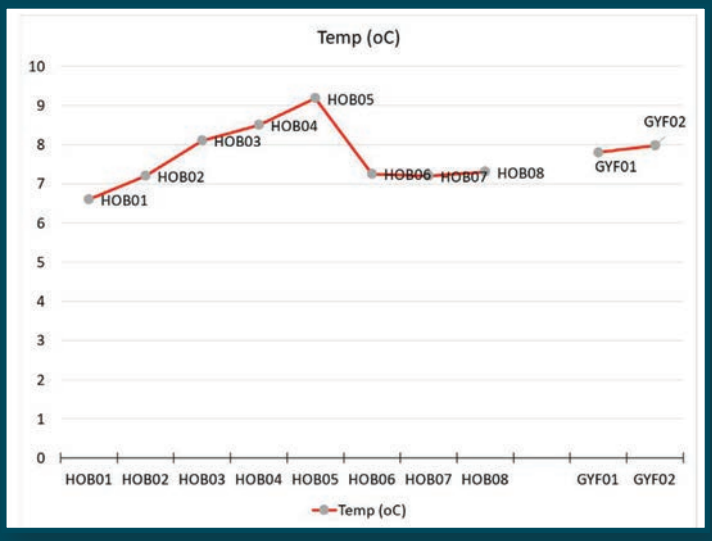


Figure 11 Two water quality measures, Electrical Conductivity (EC), left, and Temperature (Temp), right. Sites are arranged with down-stream to the right of the figure.

SANDY BAY RIVULET

Sandy Bay Rivulet is in good condition upstream of Waterworks Reserve, but drops markedly almost immediately downstream (Figure 12 and Figure 13). The ecological health as measured by weighted SIGNALT of the system continues to decline downstream.

The number of waterbug types sampled (diversity – Figure 14) doesn't drop off to less than 10 until SAN05, the weighted SIGNALT scores drop well before this (SAN02). This pattern reflects changes in assemblage, sensitive animals being swapped for tolerant ones as the sampling moves downstream, while the overall diversity doesn't change much. Until SAN05.

Algal cover increases at SAN03 at the same time as the percentage canopy cover decreases (Figure 14).

Electrical conductivity increases consistently with sampling downstream (Figure 15). The trough at SAN02 might be the discontinuity of the rivulet at this point after passing along the rock channel alongside the reservoir. The temperature shows a similar spike at SAN02, the channel doesn't have tree cover and would likely heat up more than if it was covered with vegetation. SAN03 had high algal cover and an unpleasant smell prompting concerns over the source of nutrient load in this part of the catchment. Further investigation is required to understand why Sandy Bay Rivulet drops so dramatically in health from above the reservoirs to below and beyond, while maintaining a good diversity of waterbugs, albeit the assemblage is dominated by more tolerant macroinvertebrates.

Sandy Bay Rivulet provides an instance where there is an observable drop in SIGNALT (SAN03, see Figure 13) around a likely point source that wasn't identified prior to sampling. The low dissolved oxygen and slightly elevated turbidity (Figure 16) at this site suggest an impact such as sewer overflow. This would be worth further investigation.

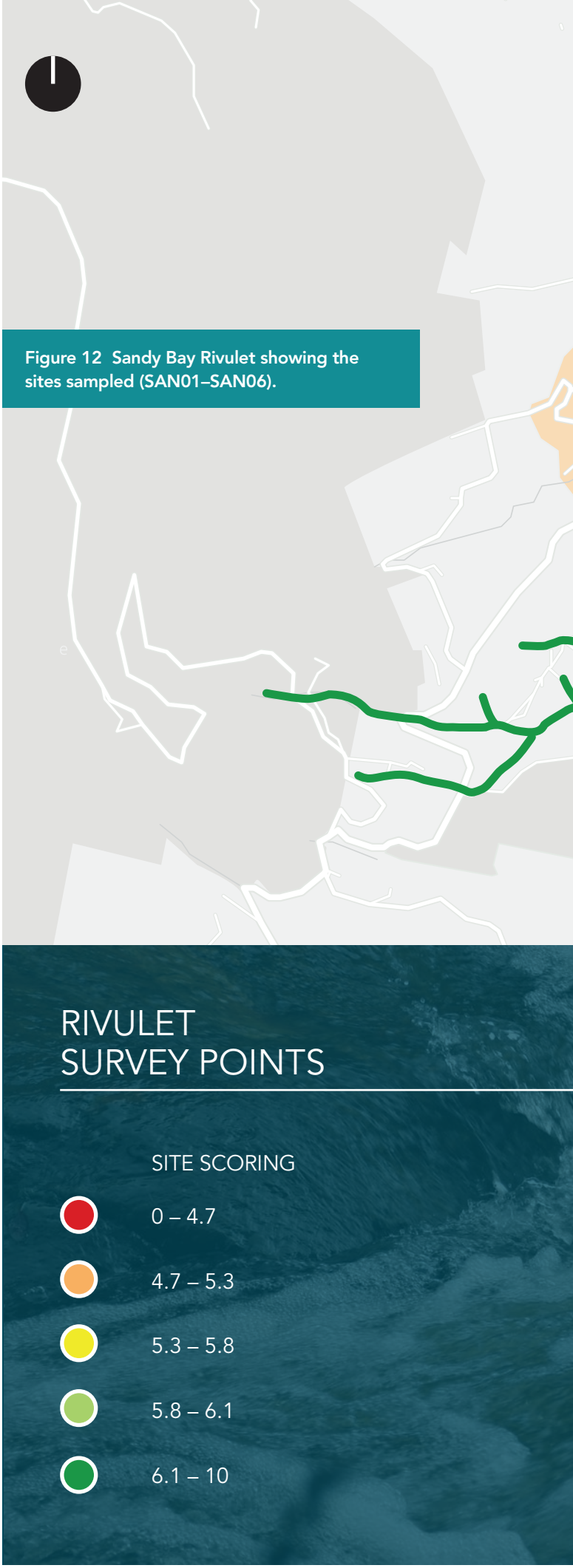
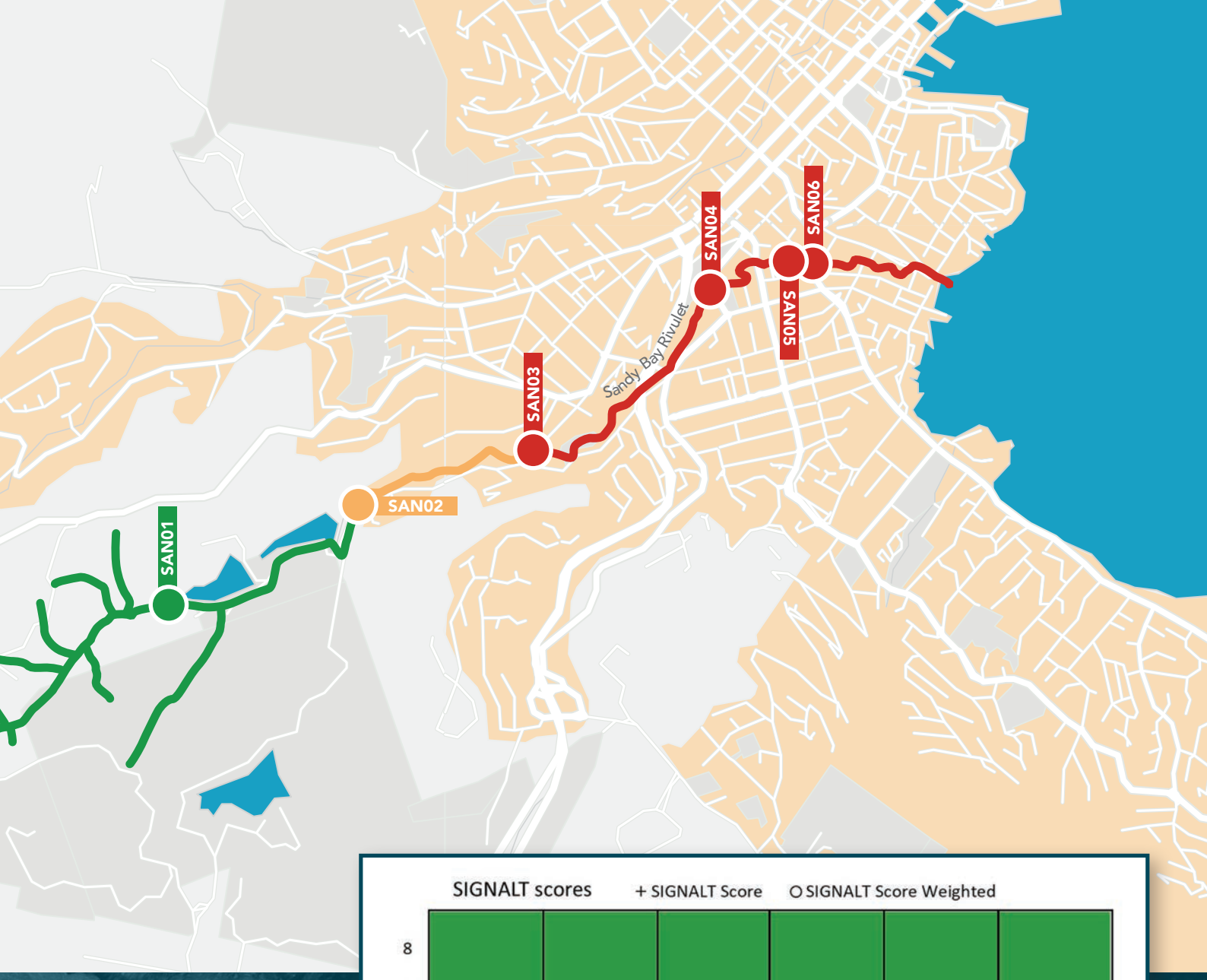


Figure 12 Sandy Bay Rivulet showing the sites sampled (SAN01–SAN06).



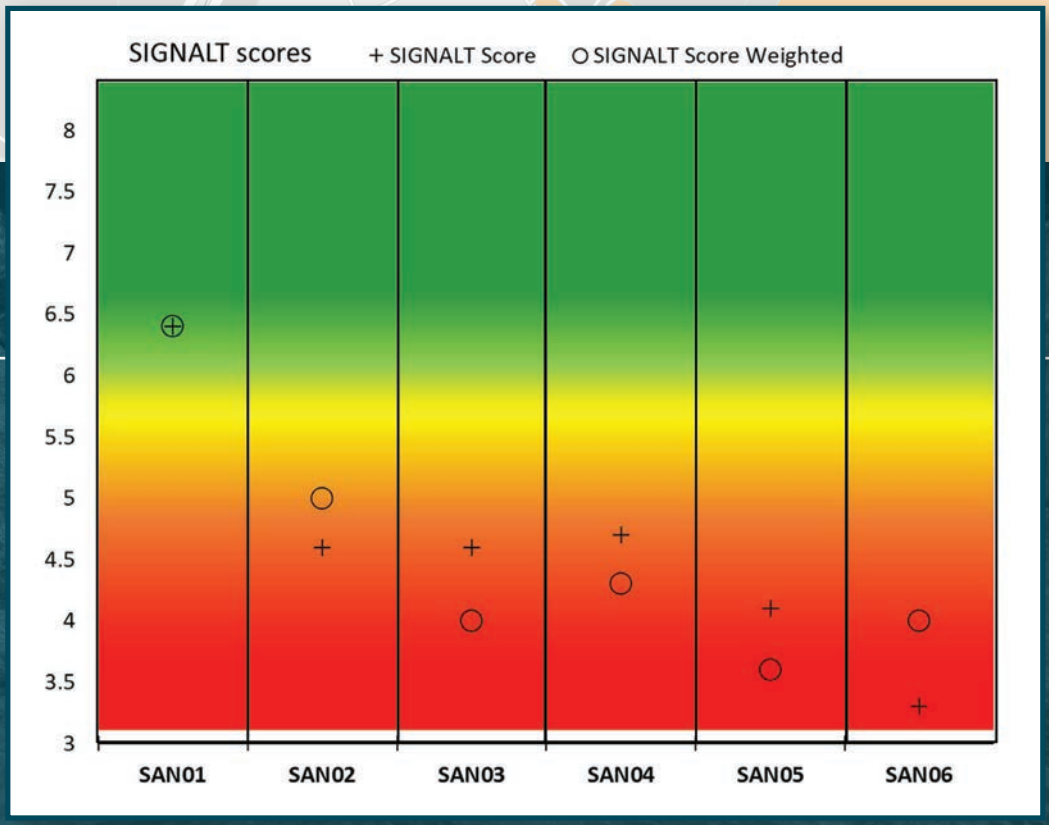
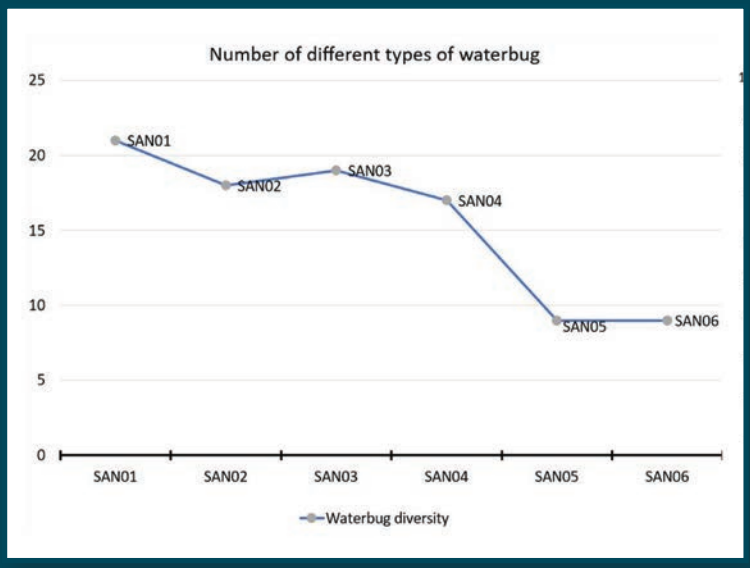


Figure 13 SIGNALT scores for sites in the Sandy Bay Rivulet. SAN01 is an upstream healthy site, site numbers increase downstream. Circles are for weighted SIGNALT scores, crosses show unweighted scores. The background colours approximate the level of impact at each site, red being heavily impacted, and green relatively natural/healthy.

SANDY BAY RIVULET



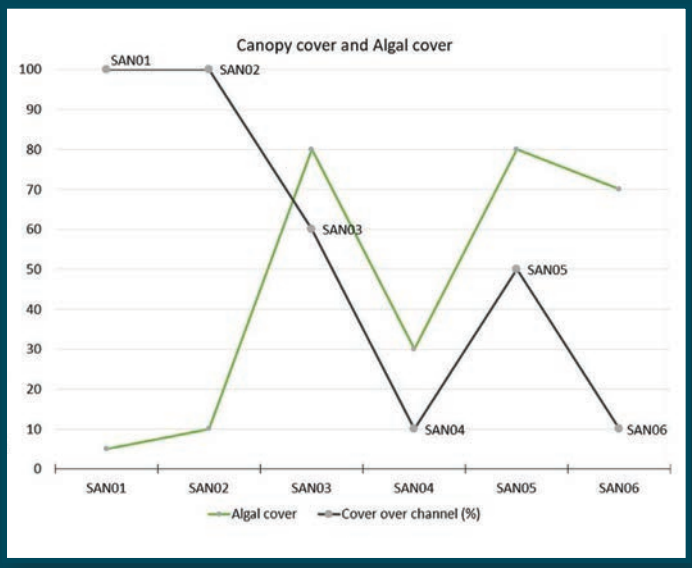
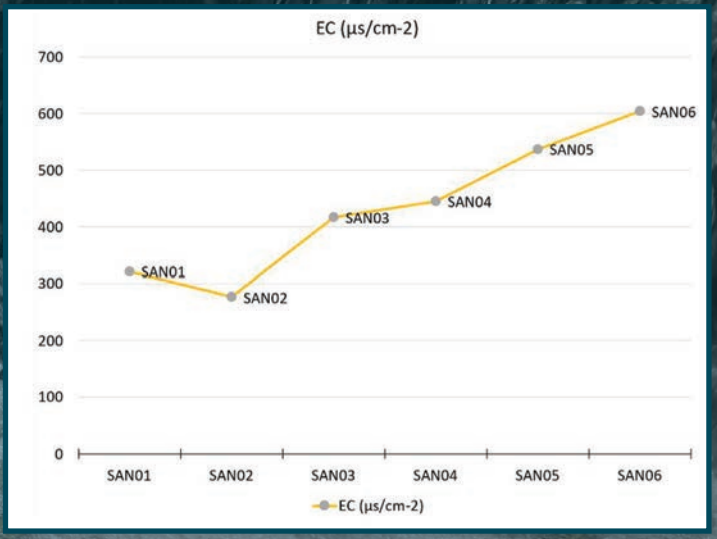


Figure 14 Number of different types of waterbug (left) and percentage of canopy cover over the channel coupled with percentage of algal cover over the river bed (right). Sites are arranged with downstream to the right of the figure.



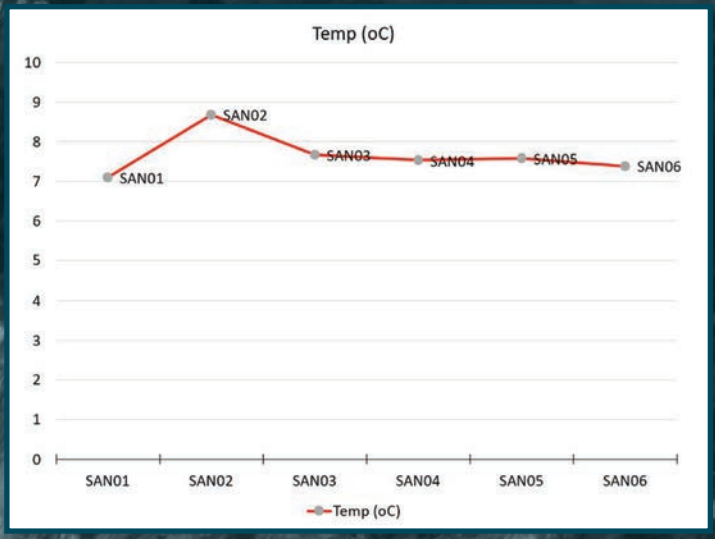
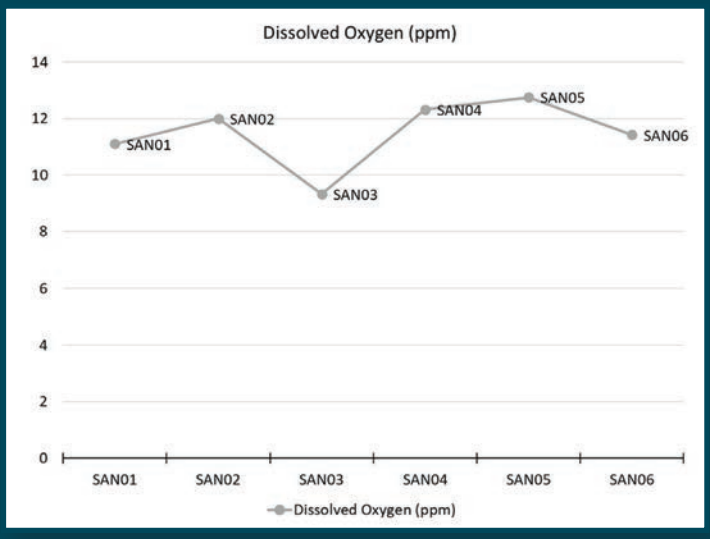


Figure 15 Two water quality measures, Electrical Conductivity (EC), left, and Temperature (Temp), right. Sites are arranged with down-stream to the right of the figure.



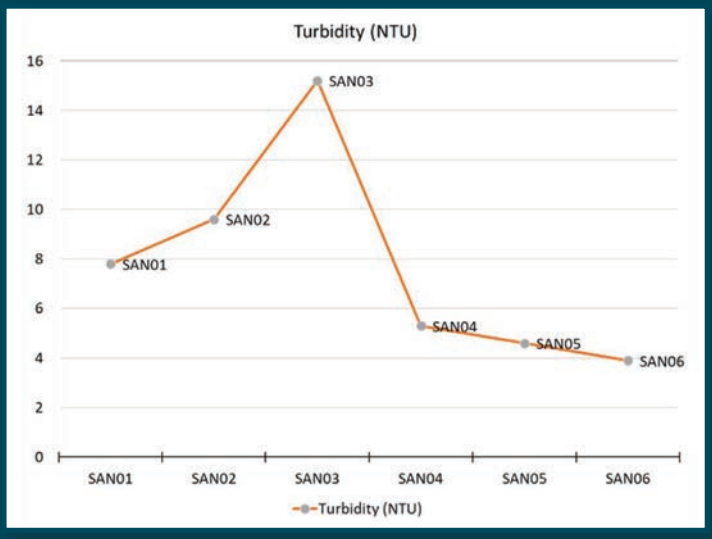


Figure 16 Two water quality measures, Dissolved Oxygen (ppm), left and Turbidity (NTU), right. Sites are arranged with downstream to the right of the figure.

LAMBERT RIVULET

Lambert Rivulet is the smallest of the rivulets sampled. It differs from the other three in having some urbanisation along the entirety of its length (Figure 17). The other three rivulets all contain upstream catchments that are predominantly native bushland. The upstream site in this rivulet (LAM01) starts as impacted, and the two sites downstream are worse but similar to one another (Figure 18).

All the diversity scores in Lambert Rivulet (Figure 19) are low (<15 types of waterbug) compared to the upstream sites in other rivulets (SAN01 had 21 different types). Lambert Rivulet has good riparian cover along its length, maintained along with adjacent linear parks. The canopy cover at LAM02 was slightly less than at the other sites and corresponds with a rise in algal cover.

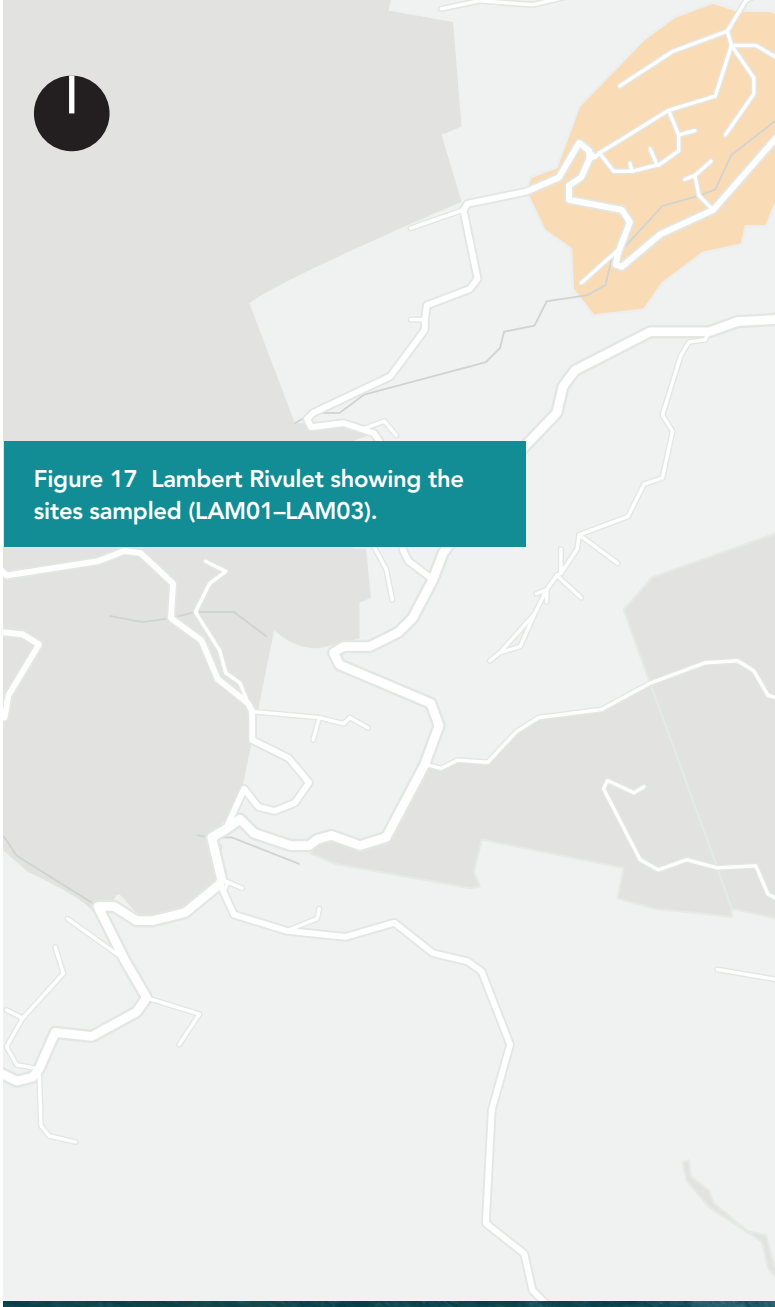
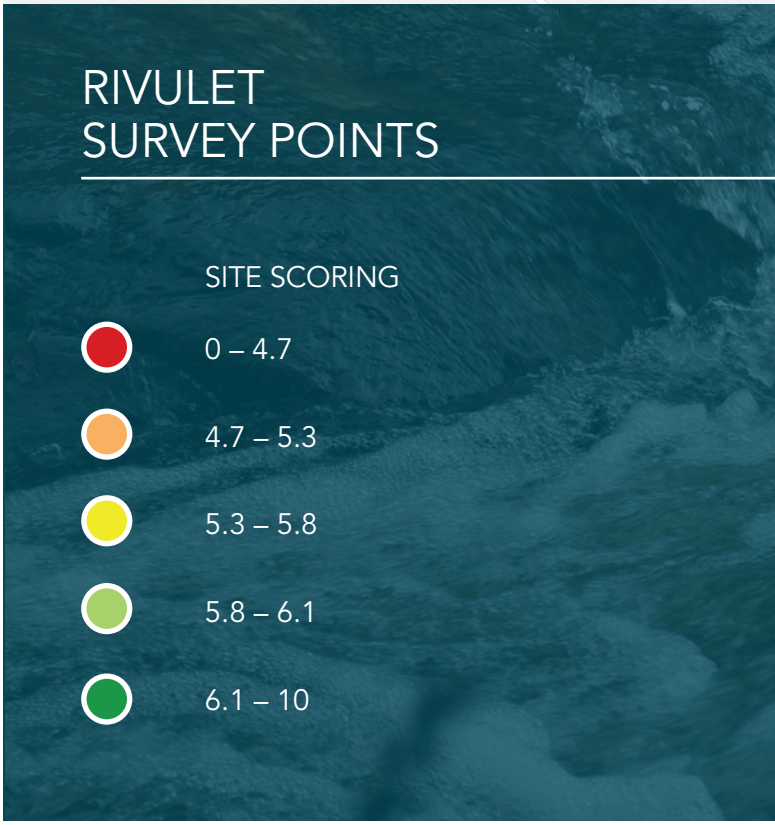


Figure 17 Lambert Rivulet showing the sites sampled (LAM01–LAM03).



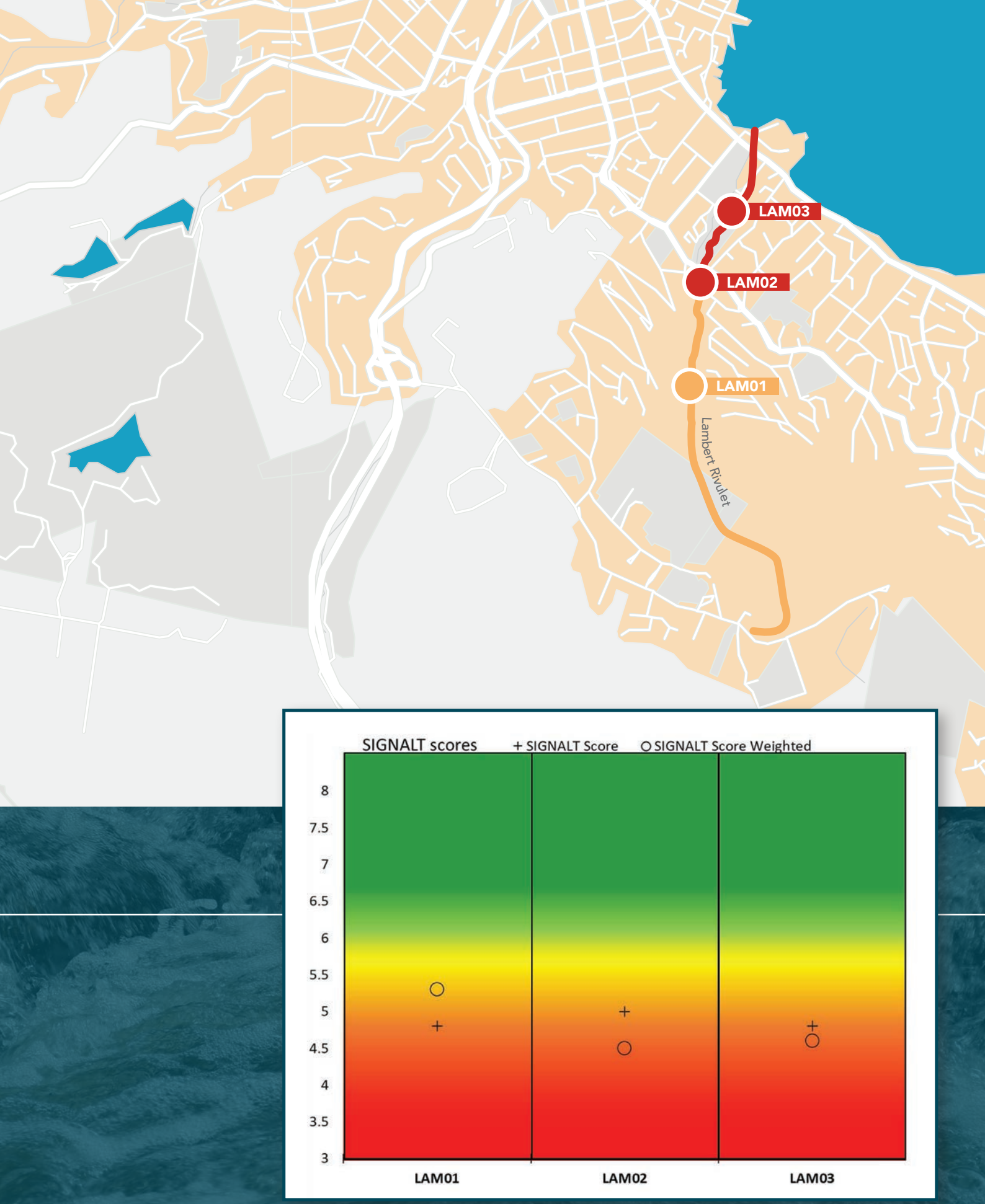
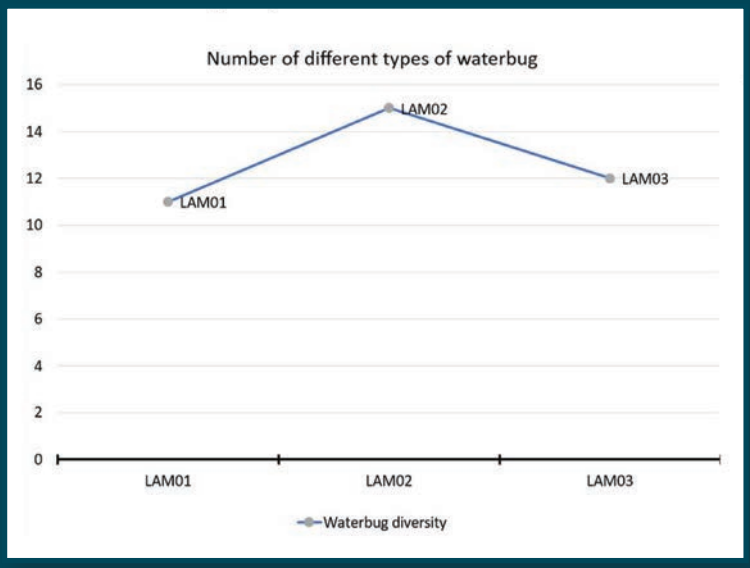


Figure 18 SIGNALT scores for sites in Lambert Rivulet. Site numbers increase downstream. Circles are for weighted SIGNALT scores, crosses show unweighted scores. The background colours approximate the level of impact at each site, red being heavily impacted, orange moderately impacted and green relatively natural/healthy.

LAMBERT RIVULET



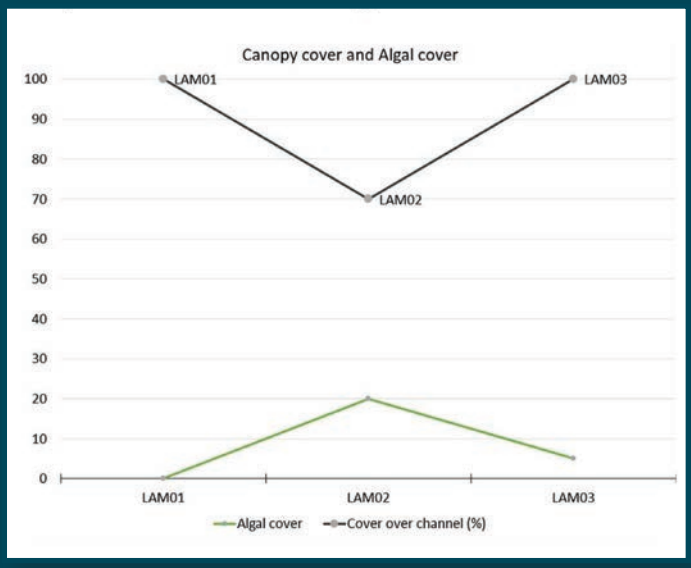
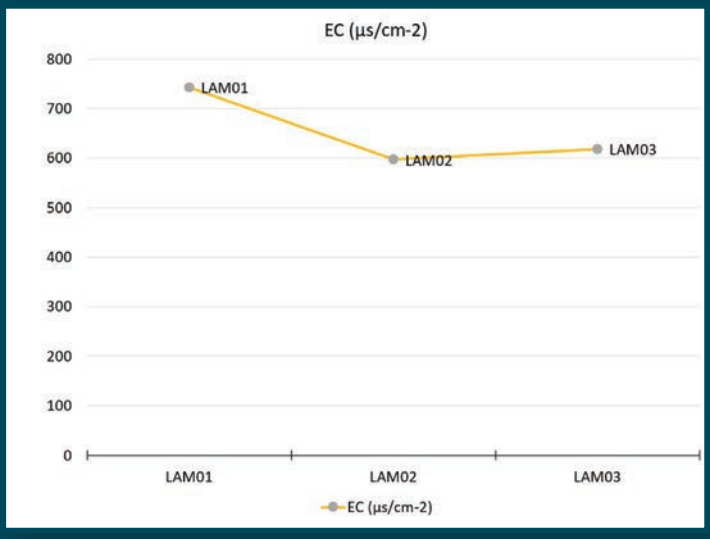


Figure 19 Number of different types of waterbug (left) and percentage of canopy cover over the channel coupled with percentage of algal cover over the river bed (right). Sites are arranged with downstream to the right of the figure.



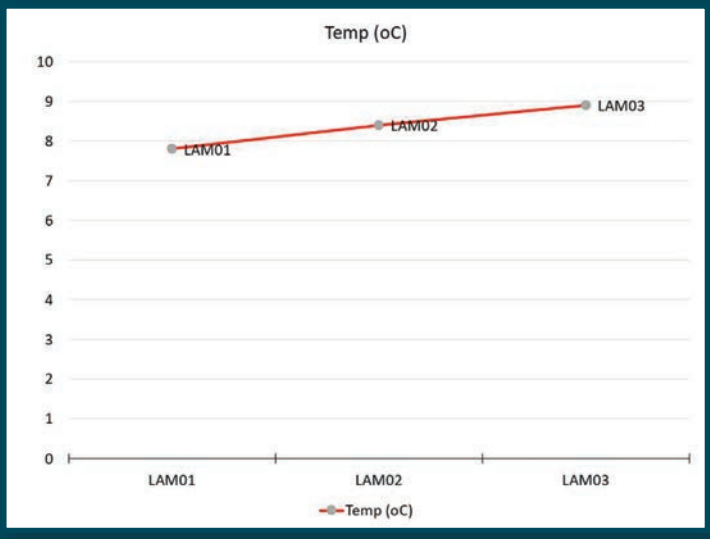


Figure 20 Two water quality measures, Electrical Conductivity (EC) figured left and Temperature (Temp) figured right. Sites are arranged with downstream to the right of the figure. Note the y axis on the temperature plot has been truncated.

DISCUSSION

Downstream urbanisation

All of the rivulets sampled in this report demonstrated a decline in ecological health as they passed downstream into urban areas. These declines were more gradual in New Town Rivulet and Hobart Rivulet than in Sandy Bay Rivulet. This result is an expected trend as diffuse sources of pollutants, such as hydrocarbons, and concentrated pollutants, such as concrete wash, enter the rivulets from a range of sources that occur more frequently as the catchment area is urbanised.

Known point source impacts

Of the three point source impacts identified for investigation only the Girrabong stormwater outflow on New Town Rivulet was associated with a drop in ecological health. The other two point source impacts singled out for upstream/downstream sampling failed to demonstrate obvious changes in ecological health. This could be due to the impacts being masked by other point sources that were not identified, or because once the system has been degraded and loses the sensitive waterbugs, that same level of pollution or impact will not be identifiable downstream. For the downstream impact to register it needs to be larger than all the impacts that have already happened upstream.

Historic data

The National Waterbug Blitz sampled Hobart Rivulet previously, and also incorporates historic data collected by the Tasmanian Government's Department of Natural Resources and Environment; samples which included Hobart Rivulet and New Town Rivulet. Spring 2022 samples for Hobart Rivulet showed improved ecological health compared to samples from 2021, 2019 and 2012. New Town Rivulet scored better than when it was previously sampled in 2005. This could be due to the time of year and recent rainfall patterns "flushing" the system and providing more favourable conditions for sensitive waterbugs further downstream or perhaps is an indication that the ecological health of the waterway has improved.

Willows

A response to willows was observed in the ecological health assessments at the upstream sites such as Guy Fawkes Rivulet. When the willow infestations are further downstream (as in NTR07 and SAN03), sensitive waterbugs have already been removed from the system and so the response is negligible alongside the overall downstream trend in degradation of ecological health. Willow impacts are variable – habitat diversity can be reduced by root matting and willows can induce changes in stream dynamics (i.e. pooling), which can have benefits for some parts of the ecosystem. For example, currently the pools provide good foraging areas for platypus. These benefits don't seem to extend to the waterbugs, as evident from the observations in Guy Fawkes Rivulet. The SIGNALT score at GYF02, a site with significant willow infestation, shows a clear drop in ecological health from the reference site at GYF01. As there are very few differences in terms of urbanisation and water quality between these two sites, willows are suspected as the main reason for the impacts at the lower site GYF02.

Other weed species

Two invasive species occurred throughout the rivulets. Both are gastropod molluscs: New Zealand mud snail (*Potamopyrgus antipodarum*) and Physa (*Physa acuta*). These two species have no demonstrated negative impacts on ecosystems where they are found, but interestingly do seem to prosper in polluted or urbanised systems, and can be considered a strong indicator of impact. New Zealand mud snail occurred at all sites except NTR01, HOB01 and HOB02. Physa occurred at most of the lower sites, but was not consistently found throughout.

Variability & water quality

Some water quality variables vary naturally (i.e. without impacts) over time. An example is rivulet temperature heating up over the course of a day. Water at the same site might be 7° Celsius at 10 am, but 8° Celsius at 4 pm, for example. These changes have the potential to look like a downstream trend if sampling starts upstream and works down the catchment through the day. To prevent this, sampling for these rivulets was conducted working up the system from the lower sites. If the resulting samples still increase down the catchment when sampled from bottom to top, that suggests the downstream rise in temperature is greater than the diurnal

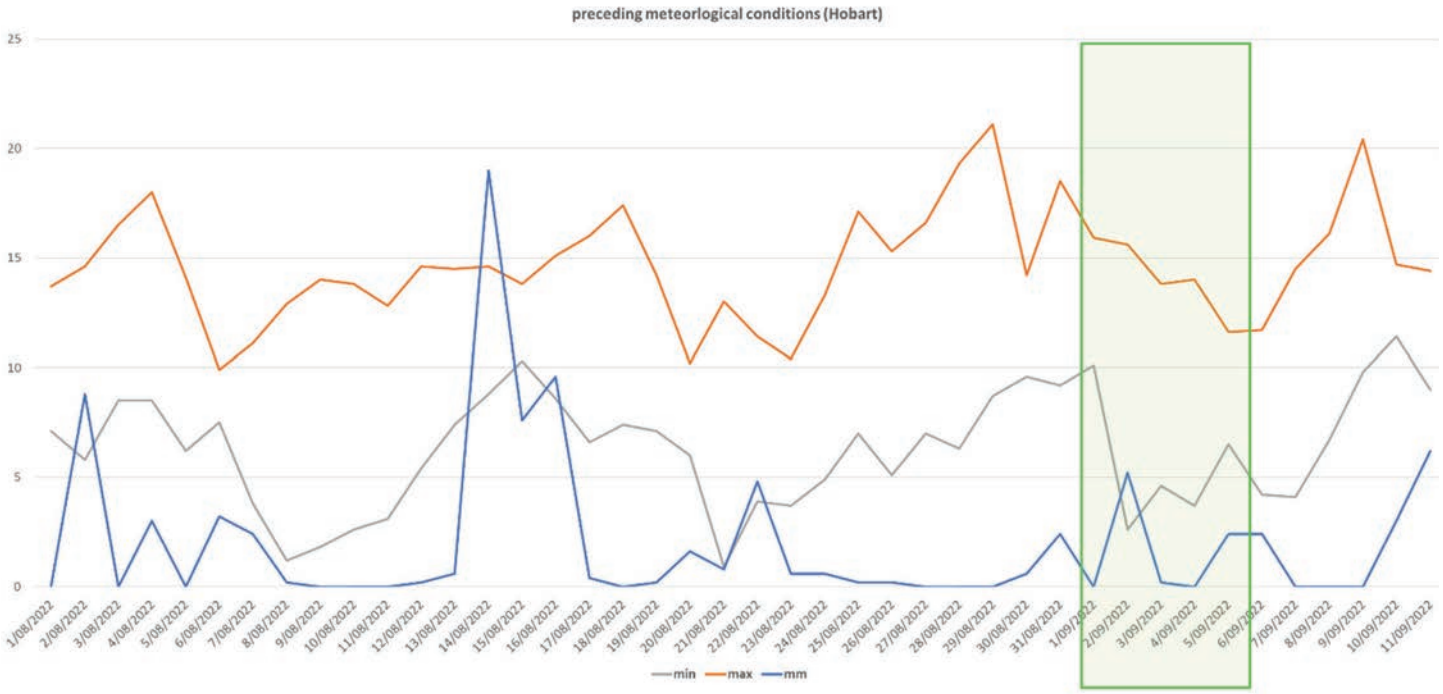


Figure 21 Meteorological conditions prior to sampling. Downloaded from the Bureau of Meteorology. Station located in Battery Point. The green rectangle encloses the sampling dates.

variability. If sampled from the rivulet's headwaters downstream, the daily rise and the downstream rise would have been combined and no information about their relative magnitude would be gained.

Electrical conductivity is less likely to behave in such a manner, but it will respond to dilution if a catchment receives extra rain or if the waterway is drying. For these reasons, only large differences in these variables have been commented on in the results. Rainfall in the Hobart region across the sampling days – and the weeks prior – was low (Figure 21).

Rainfall prior to sampling was not especially high, but there was a wetter than average August, with several high flow events (Bureau of Meteorology 2022).

Outcomes

The results of the 2022 freshwater ecological health surveys of Hobart's rivulets provide the first ever comprehensive report into the condition of the city's major rivulets. They also provide an important scientific baseline for future surveys.

The results identify areas of concern along each rivulet where nearby point sources of impact and/or diffuse pollution may require action. They also identify impacts associated with willow infestation, water quality, pollution and general urbanisation.

Identifying where assemblages of sensitive waterbugs are replaced with more tolerant ones (an indication of a change in water quality and health) creates a clear visual map for action. It highlights which areas along each rivulet need further investigation and possibly remediation to improve water quality in that part of the rivulet.

Over the coming years the City of Hobart will build on this report by producing an annual snapshot of Hobart's rivulets. These snapshots will be created by sampling Hobart's four main rivulets every spring, and publishing the results on the City's website. These annual rivulet snapshots will reveal stronger trends in improved health or declines of the City's rivulets, aid water management decisions and help improve the health of Hobart's precious waterways.

An unexpected outcome of this project was community interest in citizen science when sampling Hobart's rivulets. It identified a curiosity from residents in the building blocks of Hobart's waterway ecology.

RECOMMENDATIONS

This study has identified several areas of waterways management for Hobart's rivulet system worthy of further investigation. The upper Sandy Bay Rivulet becomes degraded much more quickly than either New Town Rivulet or Hobart Rivulet. This could be because there is less forest in its upper catchment, or it could be due to impacts on the waterway immediately downstream of Waterworks Reserve. A denser distribution of sampling sites in this reach would pinpoint where (and possibly why) the rivulet degrades so quickly. The presence of dense willows and high algal coverage at SAN03 requires further investigation into nutrient inputs directly upstream of this site.

Systematically removing willows from Hobart's rivulets will improve ecological indicators over time. To be successful this must be met with a commitment to revegetate these areas with native vegetation that provides canopy cover over the waterway and stream edge plants, creating habitat for waterbugs and other wildlife.

An autumn sampling would be of interest, as many pollution-based impacts are diluted in a spring sampling by preceding wet conditions over winter.

Repeating these surveys annually would provide ongoing information on how stable the ecological health is at all of the sites sampled in this report and provide information on the rivulets' response to any land use changes that might occur between sampling events. The location of sampling sites may be adjusted, or additional sites may be required, to answer slightly different questions in future surveys, but it is important to keep a subset of the sites ongoing to allow comparisons over time.

Photo: Michael Roberts

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