Great Barrier Reef Catchment Loads Monitoring Program

Condition Report 2021-2022

Story Map text-only version

Queensland Government

Prepared by: Water Quality and Investigations, Department of Environment, Science and Innovation

The Department of Environment, Science and Innovation acknowledges Aboriginal peoples and Torres Strait Islander peoples as the Traditional Owners and custodians of the land. We recognise their connection to land, sea and community, and pay our respects to Elders past, present and emerging.

The department is committed to respecting, protecting and promoting human rights, and our obligations under the Human Rights Act 2019.

Disclaimer

If you need to access this document in a language other than English, please call the Translating and Interpreting Service (TIS National) on 131 450 and ask them to telephone Library Services at +61 7 3170 5470.

This publication can be made available in an alternative format (e.g. large print or audiotape) on request for people with vision impairment; phone +61 7 3170 5470 or email <library@des.qld.gov.au>.

Citation

Water Quality & Investigations, 2024, *Great Barrier Reef Catchment Loads Monitoring Program: Loads and yields for sediment and nutrients, and Pesticide Risk Metric results (2021–2022) for rivers that discharge to the Great Barrier Reef*, Department of Environment, Science and Innovation, Brisbane, Australia.

January 2024

CONTENTS

THE PROGRAM

Condition Report 2021-2022

The Great Barrier Reef Catchment Loads Monitoring Program (GBRCLMP) is a large-scale water quality monitoring program that helps track long-term trends in water quality entering the Great Barrier Reef lagoon from adjacent catchments along the east coast of Queensland. The monitoring data reported by the GBRCLMP are used to validate and calibrate the catchment water quality models that track progress towards the Reef 2050 Water Quality Improvement Plan (Reef 2050 WQIP) 2025 water quality targets. The five priority pollutants identified as impacting the Reef in the WQIP are sediment (especially fine sediments), dissolved inorganic nitrogen, particulate nitrogen, particulate phosphorus, and pesticides.

In the 2021-2022 monitoring year, the GBRCLMP measured water quality at 68 sites within 24 basins*. Total suspended solids and nutrients were monitored at 26 end-of-catchment sites, 22 sub-catchment sites and 8 fine-scale monitoring sites. Pesticides were monitored at 27 end-of-catchment sites, 9 sub-catchment sites and 8 fine-scale monitoring sites.

The GBRCLMP is part of the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (Paddock to Reef program). The Paddock to Reef program provides the framework for evaluating and reporting progress towards the Reef 2050 WQIP targets and objectives through the Reef Water Quality Report Card.

* The term 'basin' is used in this Story Map to refer to 'drainage basin' as defined by the Australian Water Resources Management Committee 1997 via Geoscience Australia (1997).

Background

The 2017 Scientific Consensus Statement for the Great Barrier Reef supports the continued need to focus efforts on reducing water pollution to improve the resilience of coastal and marine ecosystems of the Great Barrier Reef.

The Consensus Statement concludes that the greatest water quality risks to the Reef are from:

- fine sediments, which can smother corals and reduce the amount of light reaching aquatic plants such as seagrass, affecting their growth and survival as well as the survival of the marine animals that depend on them for food and shelter.
- nutrients (nitrogen and phosphorus), which are additional stressors for many coastal coral species and may promote macroalgal growth and coral-eating crown-of-thorns starfish population outbreaks with destructive effects on mid-shelf and off-shore coral reefs.
- pesticides, which pose a toxicity risk to freshwater ecosystems and some inshore and coastal habitats.

The Great Barrier Reef Catchment Loads Monitoring Program (GBRCLMP) is a long-term, large-scale water quality monitoring program conducted along the east coast of Queensland. It monitors the concentrations of total suspended solids, nutrients (different forms of nitrogen and phosphorus) and pesticides for multiple sites within priority basins that discharge to the Great Barrier Reef lagoon.

From the monitoring data, the GBRCLMP calculates annual and daily loads (mass) of sediment (measured as total suspended solids) and nutrients and a pesticide risk metric based on 22 reference pesticides (for more details and definitions of terms see *Program Design* in the **Downloads** tab, and *What We Monitor* below). This program delivers the primary monitoring data set used to validate and calibrate Source Catchments water quality models that measure progress towards the 2025 water quality targets.

The loads presented in this Story Map are the mass of each analyte transported past the monitoring sites and do not necessarily represent the load discharged to the Great Barrier Reef lagoon. Due to logistical constraints, most sites are not located at the mouth of the waterway and therefore an unmonitored portion of the catchment or sub-catchment may contribute, transform or degrade the loads before they discharge to the Great Barrier Reef lagoon. Where higher loads are reported for upstream sub-catchments compared to end-of-catchment sites, this may be indicative of deposition or transformation within water storages or lower catchment areas where water velocities may be reduced.

Care is needed when interpreting monitoring results as these will vary from year-to-year. Monitored pollutant loads in catchments vary markedly from year-to-year, mainly due to differences in annual rainfall and catchment conditions. Due to this variability (climate), catchment modelling is used to estimate the long-term annual pollutant load target reductions as the result of improved land management practices. Research suggests time lags to monitor the improvements from land management practice change could range from years for pesticides up to decades for nutrients and sediments. Loads are rounded to two significant figures for reporting.

Yields are the average rate of pollutant delivery across a monitored catchment area (i.e. load divided by area) and provide a useful means of comparing the rate of pollutant delivery between catchments of varying sizes. The yields discussed in this Condition Report refer to end-of-catchment sites only, except where there is an explicit reference to sub-catchment sites. Yields are rounded to two significant figures for reporting. A more comprehensive discussion of Loads and Yields is provided in the Program Design Document available in the Downloads Tab.

Queensland Government's Water Quality and Investigations unit is responsible for the delivery of two key water quality monitoring programs: the Great Barrier Reef Catchment Loads Monitoring Program (GBRCLMP) and the South East Queensland Catchment Loads Monitoring Program. Both programs support the monitoring and reporting roles of the Queensland Government as part of Reef 2050 WQIP and South East Queensland Resilient Rivers Initiative. In addition to these programs, Water Quality and Investigations is actively involved in environmental investigations, assessments and analyses relating to pollution events, ecotoxicology, water quality and aquatic ecosystem health.

The GBRCLMP commenced in 2005 and is now considered a long-term monitoring program for Queensland and Australia. It has been continuously improving and the scope has expanded substantially since commencement.

Data from the GBRCLMP are used by our partner organisations and support the regional report cards. These data are also used to inform marine monitoring and modelling results found in the Reef Water Quality Report Card 2021 and 2022.

The data produced by the GBRCLMP help inform management decisions and investments that can ultimately reduce land-based run-off to the Great Barrier Reef lagoon. By working towards improved water quality for the Great Barrier Reef we can help build the resilience of the Reef to emerging threats.

For more details and definitions of terms, please see *Program Design* in the **Downloads** tab.

Program objectives

The objectives of the GBRCLMP are:

- to monitor event and ambient concentrations of sediment (total suspended solids), nutrients (nitrogen and phosphorus analytes) and pesticides in key catchments.
- to calculate sediment and nutrient loads (annual and daily) and the Pesticide Risk Metric.
- to provide concentrations and loads data to calibrate and validate the Source Catchment models that are used to assess progress towards the Reef 2050 WQIP water quality targets.
- where suitable long-term data sets are available, to investigate methods to track long-term trends in water quality entering the Great Barrier Reef lagoon.

What we monitor

Sediment

Sediments are the total suspended solids in water that include clay, silt and sand. Sediments are characterised by different particle sizes and these different fractions are measured as a single value in the water sample. Not all sediment or particle size fractions present the same risk to the Great Barrier Reef, with fine (<20 µm) sediment moving farthest into the marine environment and settling more slowly, leading to increased turbidity and reduced light, and therefore posing the greatest risk. Total suspended solids are measured in the water sample and presented in the Story Map as loads and yields.

Nutrients

Nutrients are the natural chemical elements and compounds that plants and animals need to grow. Nitrogen and phosphorus are transported in run-off as tiny particles (particulates) and as dissolved constituents in water. The dissolved inorganic (and a proportion of the organic) nutrient forms are immediately available for biological uptake, and particulate nutrients may also become biologically available via mineralisation/desorption or via ingestion of particulates by biota. Particulate and dissolved inorganic forms of nitrogen and particulate phosphorus are measured in the water sample and presented in this Story Map as loads and yields.

Pesticides

Pesticides, including herbicides, insecticides and fungicides, are used for protecting agriculture and other land uses against pest organisms (e.g. weeds and insects). Pesticides have been detected in the waters and benthic sediments of rivers, creeks, wetlands, estuaries, and the inshore parts of the Great Barrier Reef catchments and lagoon. The types and concentrations of pesticides in the fresh, estuarine and marine ecosystems vary between catchments and regions, reflecting the main land use in each area. Chlorpyrifos, fipronil, imidacloprid, haloxyfop, imazapic, metsulfuron-methyl, pendimethalin, metolachlor, ametryn, atrazine, terbuthylazine, tebuthiuron, simazine, diuron, terbutryn, hexazinone, metribuzin, 2,4-D, MCPA, fluroxypyr, triclopyr and isoxaflutole are measured in the water sample and represented in this Story Map as the **Pesticide Risk Metric**.

For more details and definitions of terms, please see *Program Design* in the **Downloads** tab.

Quality assurance and quality control

The GBRCLMP operates under the Water Quality and Investigations Quality Management System that ensures consistency and transparency across all aspects of the Program. The continuous improvement of the GBRCLMP is necessary to produce the data required to calculate high-quality annual pollutant load estimates and the Pesticide Risk Metric.

Water samples were collected by over 30 regionally based and partner organisations including Indigenous partners, agricultural industries, natural resource management bodies, landholders and regional councils. Each program site was sampled by trained personnel in accordance with the Quality Management System. Sample collection, storage and transport were conducted in alignment with the Environmental Protection (Water and Wetland Biodiversity) Policy: Monitoring and Sampling Manual.

Prior to the onset of the 2021-2022 wet season, WQI staff conducted trips to deliver face to face training to 28 individual samplers or sampling organisations, covering 96% of GBRCLMP monitoring sites.

MONITORING SITES

The Great Barrier Reef receives run-off from six Natural Resource Management (NRM) Regions along the east coast of Queensland. Within these natural resource management regions, 35 basins drain into the Great Barrier Reef lagoon.

Between 1 July 2021 and 30 June 2022, 68* sites were monitored within 24 basins. Total suspended solids and nutrients were monitored at 26 end-of-catchment** sites, 22 sub-catchment sites and 8 fine-scale monitoring sites. Pesticides were monitored at 27 end-of-catchment sites, 9 sub-catchment sites and 8 fine-scale monitoring sites***.

**The number of sites and locations varies slightly from year-to-year.*

***End-of-catchment sites are defined as sites located at the lowest point in a river or creek where the volume of water passing that point can be accurately measured.*

****Fine-scale monitoring sites typically occur off the main channel of a waterway and may experience lower or intermittent flows compared to the dominant river system. Fine-scale monitoring sites may also have a relatively small upstream catchment that is dominated by a land use of interest or may be undergoing periods of land use change. Owing to their typically low discharge in most years, the reported loads, yields and pesticide risk may not represent risk to the inshore Reef.*

Loads Monitoring Sites

Between 1 July 2021 and 30 June 2022, 56* sites were monitored across 23 basins for total suspended solids and nutrients. This includes 26 end-of-catchment sites, 22 sub-catchment sites and 8 fine-scale monitoring sites.

**Loads were not calculated for Pascoe River at Wattle Hills Station or Burdekin River at Hydro Site due to an insufficient number of samples to calculate reliable loads. Bonnie Doon Creek at Strathalbyn loads were only calculated for total suspended sediment, total nitrogen and total phosphorus. Speciated nutrients loads were not calculated for Bonnie Doon at Strathalbyn, due to delayed site access following events.*

Pesticide Monitoring Sites

Between 1 July 2021 and 30 June 2022, 44 sites were monitored across 23 basins for pesticides. This includes 27 end-of-catchment sites, 9 sub-catchment sites and 8 fine-scale monitoring sites.

LAND USE

The Great Barrier Reef receives run-off from 35 basins within six natural resource management regions that drain 424,000 km^2 of coastal Queensland. The Great Barrier Reef catchments are largely rural and dominated by summer monsoonal rains and occasional cyclones delivering sediments, nutrients, and pesticides to the inshore and sometimes offshore portions of the reef in pulsed flows, which can be affected by water reservoirs and dams.

Grazing (77 per cent) is the dominant agricultural land use, particularly in the Burdekin and Fitzroy regions. Sugarcane (1.4 per cent) and horticulture crops (0.2 per cent) are more prevalent on the coastal floodplain with high rainfall and irrigation. Grain crops and irrigated cotton are prevalent in the inland areas of the Fitzroy region.

Urban and industrial land uses can have important local impacts, although they provide a relatively small contribution to water pollution overall. Land use types discussed in this Story Map are agglomerated into twelve categories that align with the Reef Categories of the Source Catchment models (i.e. banana, conservation, dryland cropping, dairy, forestry, grazing, horticulture, irrigated cropping, sugar, urban, water and other*).

*Banana and dairy were mapped for the Wet Tropics region only.

For more details and definitions of terms, please see *Program Design* in the **Downloads** tab.

The majority of the Cape York region is reserved for nature conservation purposes with large areas also used for grazing. Isolated tracts of intensive agriculture including bananas, irrigated and dryland cropping are also present in the Normanby basin.

A considerable proportion of the Wet Tropics region is dedicated to nature conservation, including the Wet Tropics World Heritage Area. The dominant land uses include grazing to the west, sugarcane on the narrow coastal floodplain and some horticulture across the region. The upper reaches of the Barron River and Johnstone River catchments contain some intensive agriculture; however, most intensive agriculture areas are located in the lowland coastal areas.

Grazing is the dominant agricultural land use in the Burdekin region, with areas dedicated to sugarcane, horticulture and other cropping closer to the coast. Within the Burdekin region, the Haughton basin contains the largest proportion of sugarcane, comprising the dominant land use on the lower floodplain.

Grazing is the single largest land use in the Mackay Whitsunday region, followed by conservation and sugarcane. Within the region, the Plane basin contains the highest proportion of sugarcane production, followed by the Pioneer, O'Connell and Proserpine basins.

The dominant land use in the Fitzroy region is grazing with smaller areas used for forestry, dryland cropping, cotton production and mining. Relatively small areas of horticulture are also present in the Fitzroy region.

Land use in the Burnett Mary region is dominated by grazing, forestry, and conservation, with areas of horticulture, sugarcane and other cropping along the coastal floodplains of the Burnett and Mary rivers, and in smaller coastal catchments including the Burrum, Kolan, and Baffle basins.

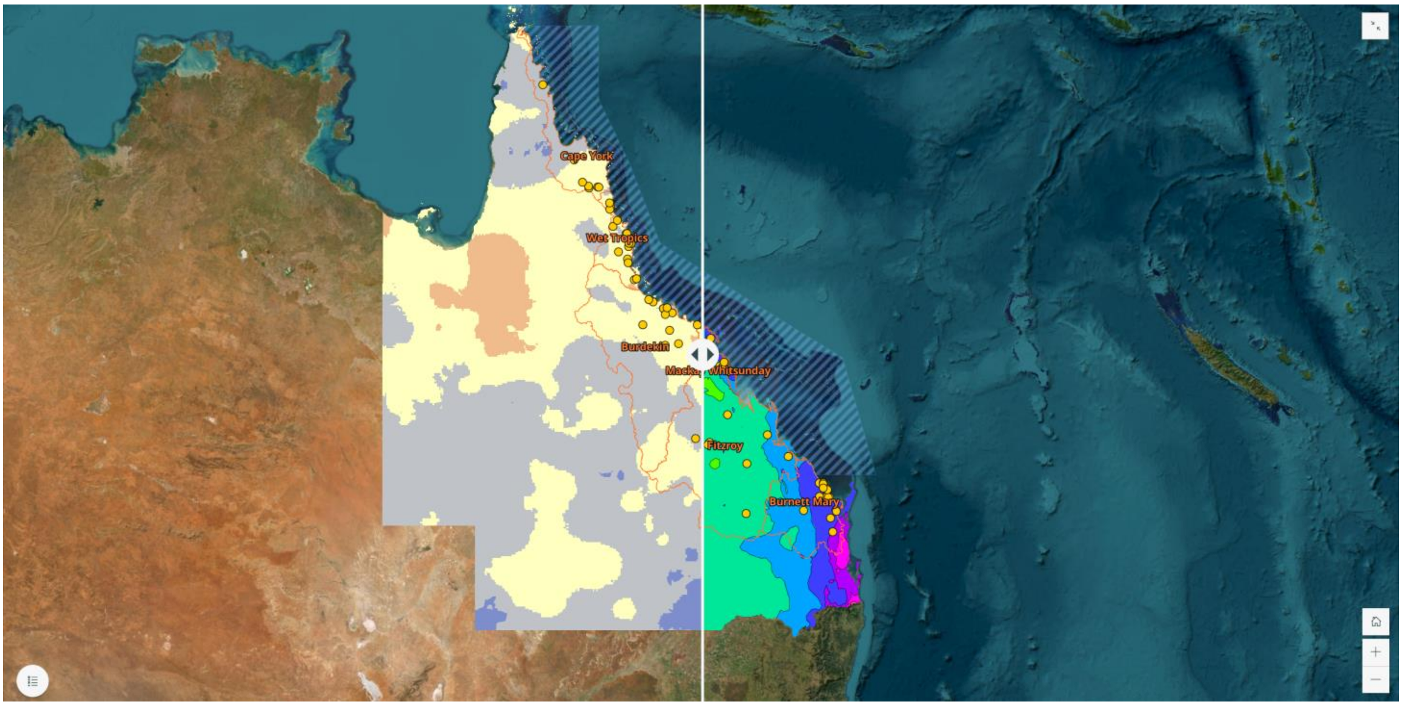
Land use data were obtained from the Queensland Land Use Mapping Program and are freely available from the Queensland Spatial Catalogue – Qspatial.

For a complete overview of land use upstream of the monitoring sites, please download the land use spreadsheet in the **Downloads** *tab.*

CLIMATE

Rainfall

Rainfall during the 2021-2022 monitoring year was variable across the Great Barrier Reef catchment area, ranging from areas of below average rainfall in the Wet Tropics, Burdekin, Mackay Whitsunday and Fitzroy regions, to very much above average in large parts of the Burnett Mary. Annual rainfall across the state is displayed as rainfall deciles to make a comparison with the long-term mean.

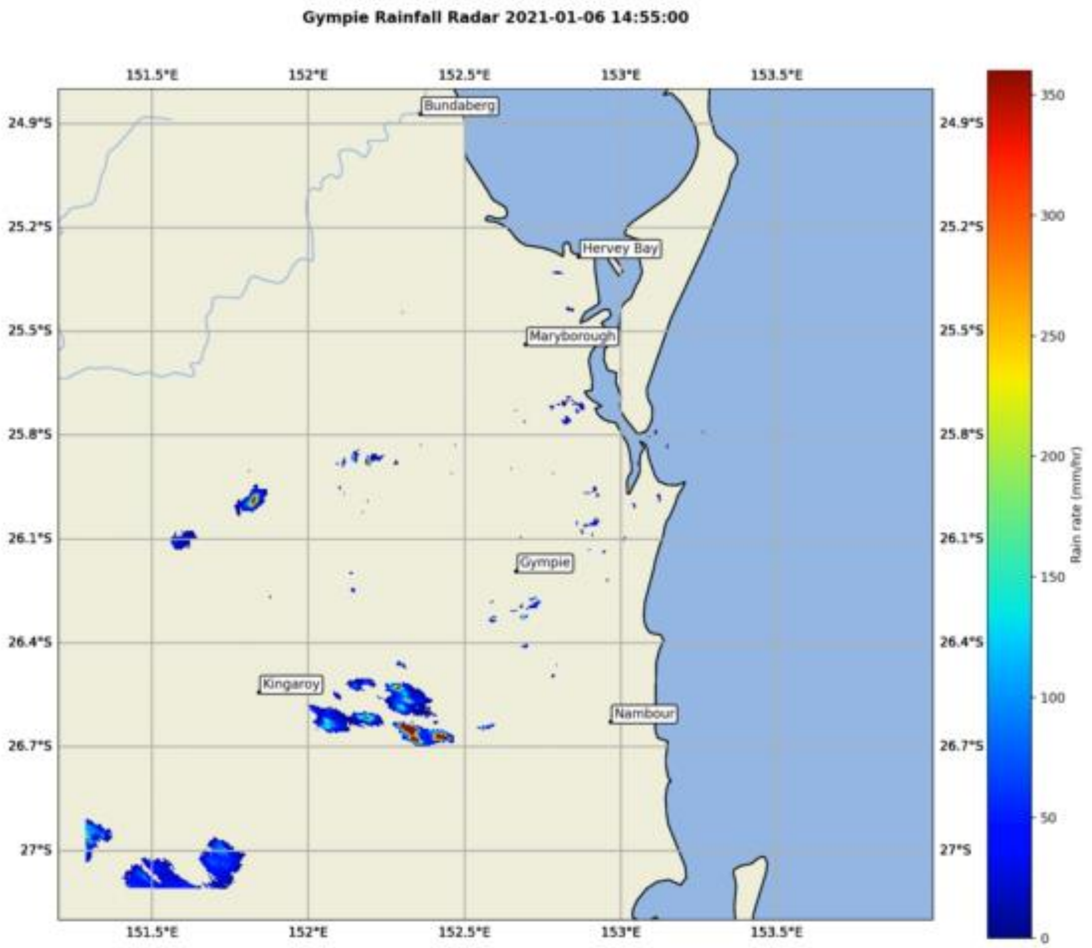


Slide to compare: Rainfall deciles on the left-hand side, and 2021-2022 total annual rainfall on the right-hand side. Click on the menu on the bottom left of the map to view the legend.

In late May and June 2021, leading into the 2021-2022 monitoring year, the weekly Indian Ocean Dipole (IOD) index was persistently below the negative IOD threshold. A number of rainfall events resulted in Queensland experiencing the wettest June since 2016. The negative IOD continued in August and September with above average rainfall in the north and central coast, and below average rainfall in the south-east. A La Niña watch was activated by mid-September. Above average rainfall continued through October for parts of northern Queensland, while south-eastern areas of Queensland experienced below average rainfall.

In 2021, Queensland experienced its wettest November since 2010 and the 7th wettest November on record with above average rainfall across virtually the entire state. Many areas in the Fitzroy and Burnett Mary regions received their highest November rainfall totals on record leading to widespread flooding. Monthly totals above 100mm were common along the east coast. In the Pacific Ocean in late November La Niña became established.

Eastern parts of Queensland mostly received average to above average rainfall in December, with small areas of below average rainfall in the Fitzroy and Burnett Mary regions. On the 23rd December a slow moving tropical low formed before moving south-east into the Gulf of Carpentaria on the 28th December. It continued to track east across Cape York before entering the Coral Sea on 30th December. On December 31st Tropical Cyclone Seth reached cyclone intensity before peaking as a category 2 system near Frederick Reef that evening. The system was reclassified as a sub-tropical low on January 2nd before tracking south then west towards the Queensland coast. Ex-Tropical Cyclone Seth crossed the Queensland coast near Hervey Bay on January 7th delivering extreme rainfall with daily totals of over 400mm recorded north-west of Gympie, before weakening overland. The Mary River suffered intense flooding, with more widespread flooding occurring across the south-east of the state. The Burnett River reached moderate flood levels as Saltwater Creek overflowed flooding parts of Bundaberg South on January 9th.



Historical rain radar at 5 minute intervals of Ex-Tropical Cyclone Seth on the 6th and 7th of January 2021.

The extreme wet conditions in the south of Queensland continued into February, with more than 30 sites recording 6-day rainfall totals of over 1000mm (1 metre of rain). An already saturated Mary River reached its highest levels since 1893. However, the rest of the state was predominantly drier than average.

In March much of the east coast of Queensland was drier than average, stretching from south of Mackay to north of Cairns.

April saw a return to wetter conditions, with most of the Great Barrier Reef catchment area experiencing above average, or very much above average monthly rainfall. The southern Fitzroy region and the Burnett Mary received average to below average rainfall in April.

Queensland experienced its wettest May since 1989, and 5th wettest since 1900 with almost the entire Great Barrier Reef catchment area experiencing very much above average monthly rainfall. Some regions received record falls in May, including large parts of the Burdekin, and areas around Bundaberg and Gympie in the Burnett Mary.

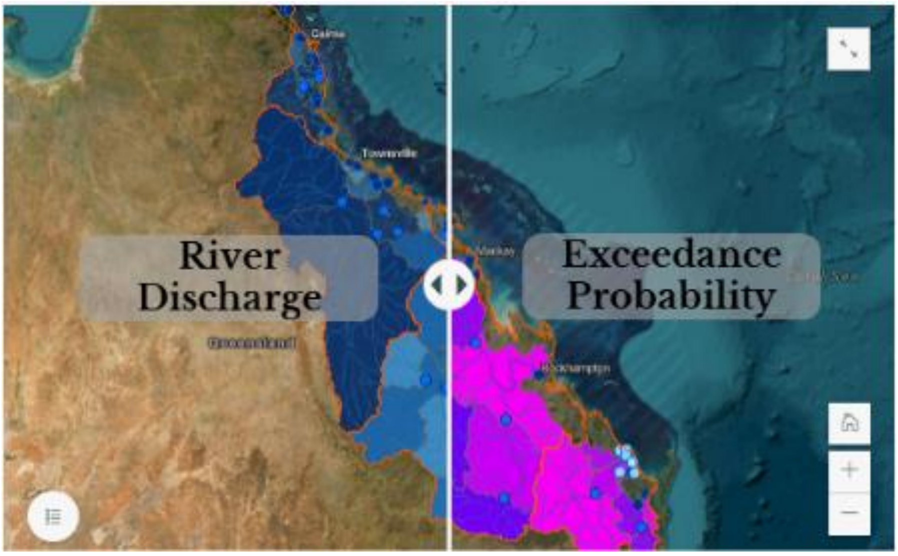
June 2022 saw wet conditions confined to Cape York and the northern Wet Tropics, with the Burdekin, Mackay Whitsunday, Fitzroy and Burnett Mary regions recording average to very much below average June rainfall totals.

Queensland monthly climate summaries

River Discharge and Annual Exceedance Probability

River discharges are essential for the environment and are used alongside sampling concentrations to calculate loads of sediment and nutrients. Discharge data were sourced from measured discharge from existing Department of Regional Development, Manufacturing and Water (DRDMW) gauging stations, time and flow factored measured discharge from existing DRDMW gauging stations, Department of Environment, Science and Innovation (DESI) modelled flows generated in the eWater Source catchments modelling program, or calculated by DESI using Empirical Dynamic Modelling.

Annual exceedance probability is the likelihood that a certain discharge (the volume of water passing a site in a given year) will occur again in the future, based on historical flow records. An annual discharge with an exceedance probability of 25 per cent has a 25 in a hundred chance of being exceeded in any year.



Swipe to compare: River Discharge on the left and Exceedance Probability on the right for the 2021-2022 monitoring year.

The total volume of water discharged to the Great Barrier Reef from monitored catchments in 2021-2022 (40,000 GL) was approximately nine per cent larger than in 2020-2021 (35,000 GL).

River flows in the northern Cape York and Wet Tropics regions were fairly typical, with end-of-catchment sites experiencing between 69 per cent (Normanby River, 59% exceedance probability) and 126 per cent (Daintree River, 26% exceedance probability) of their long term mean annual discharge. Laura River at Carroll's Crossing sub-catchment discharged 43 GL (70% exceedance probability) which is just 53 per cent of the long-term annual average for the site – the lowest across the northern regions.

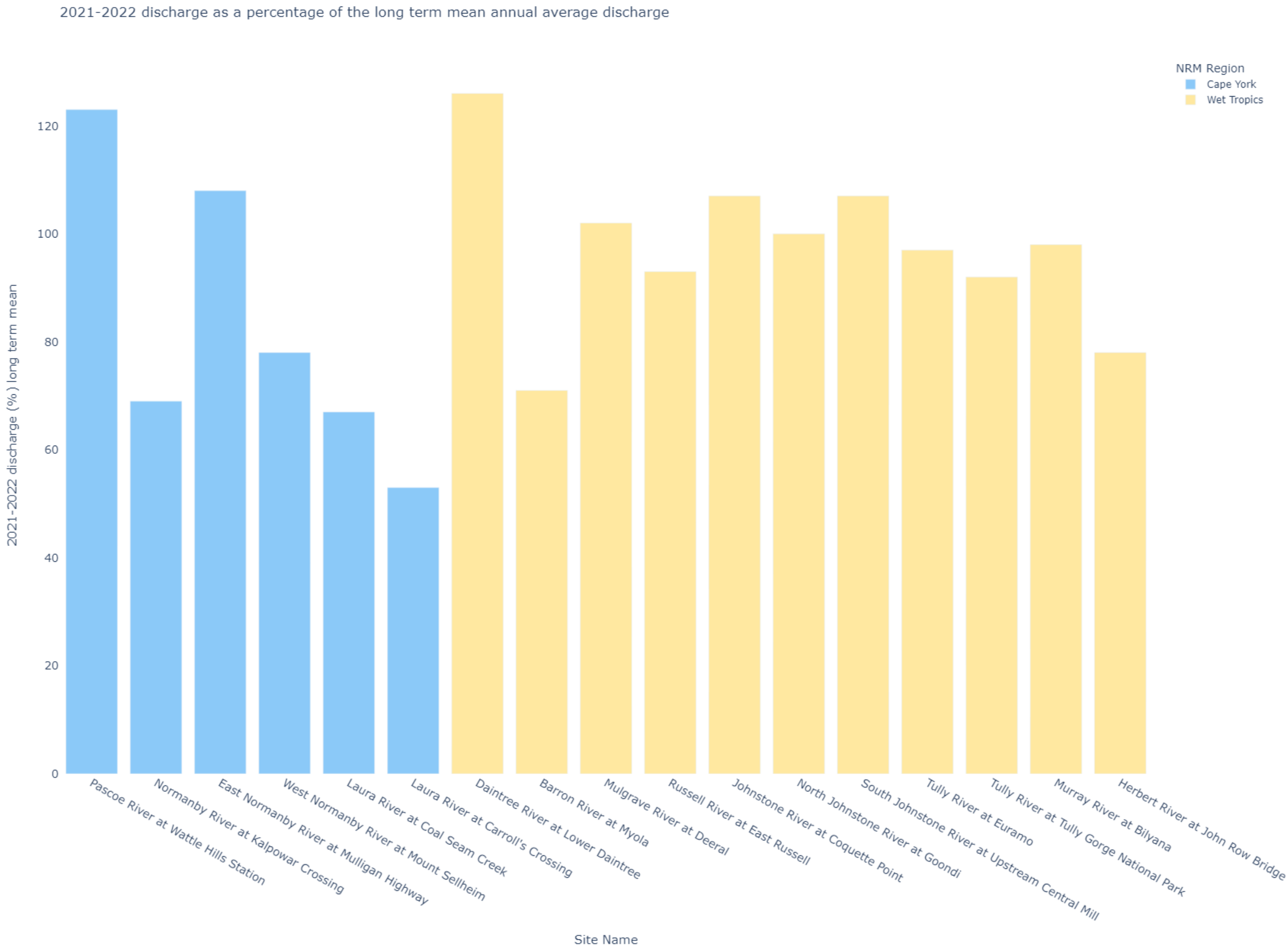


Figure 1. 2021-2022 Cape York and Wet Tropics discharge as a percentage of the long term mean annual average discharge.

The Burdekin and Mackay Whitsunday regions were predominantly drier than usual, with all sites experiencing 80 per cent or less of their long-term annual average. Only Baratta Creek at Northcote (130 GL, 43% exceedance probability) had an exceedance probability of less than 50%, indicating it received more than the median annual discharge. The Ross River (6.2 GL, 97% exceedance probability) had the lowest total discharge as a percentage (2.9%) of the long-term annual averages across the program. This is the lowest discharge as a percentage of the long-term annual average in the Burdekin region since the program began monitoring.

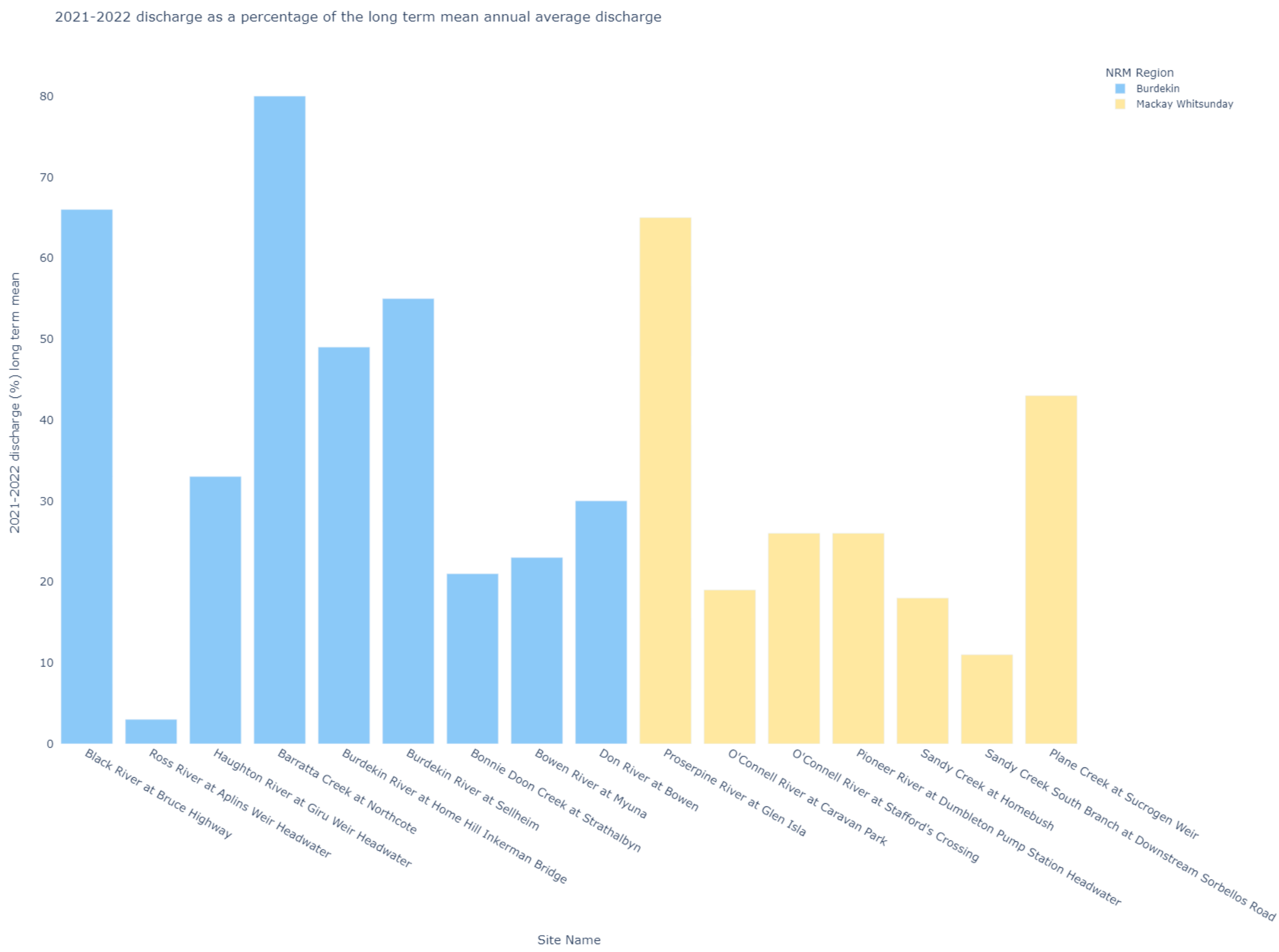


Figure 2. 2021-2022 Burdekin and Mackay Whitsunday discharge as a percentage of the long term mean annual average discharge.

The northern Isaac River (370 GL, 63% exceedance probability) sub-catchment site was the only site in the Fitzroy with an exceedance probability above 50 per cent. Theresa Creek (440 GL, 19% exceedance probability) and the Dawson River at Taroom (1100 GL, 7.9% exceedance probability) received 77 per cent and 173% more flow than the long-term annual averages respectively.

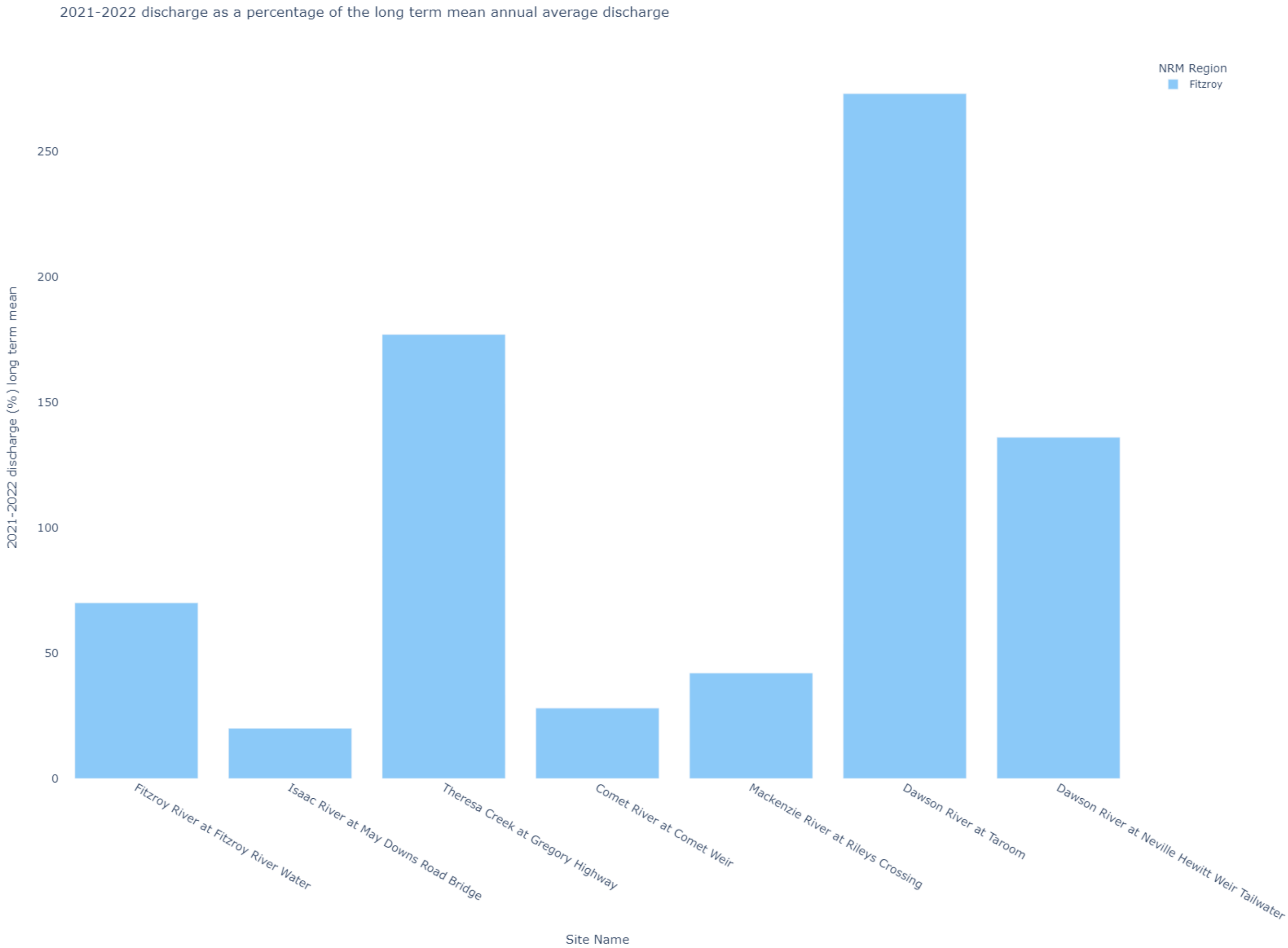


Figure 3. 2021-2022 Fitzroy discharge as a percentage of the long term mean annual average discharge.

In the Burnett Mary, the only monitoring sites with reportable discharge that received less than their long-term annual averages were the fine-scale monitoring sites of Moore Park Drainage at Moore Park Road (5.9 GL, 57% exceedance probability), receiving 35 per cent and 39 per cent of their long term mean annual averages respectively. The rest of the Burnett Mary region was much wetter than usual, with all other sites experiencing discharges more than double their long-term mean annual averages. The largest discharge in the Burnett Mary region was 6700 GL recorded in the Mary River at Home Park (2.4% exceedance probability), 4.6 times the long-term average. The Mary River at Home Park suffered three major flooding events in January, late February to early March, and May 2022. The Mary River at Fishermans Pocket exceeded the major flood level in late February 2022.

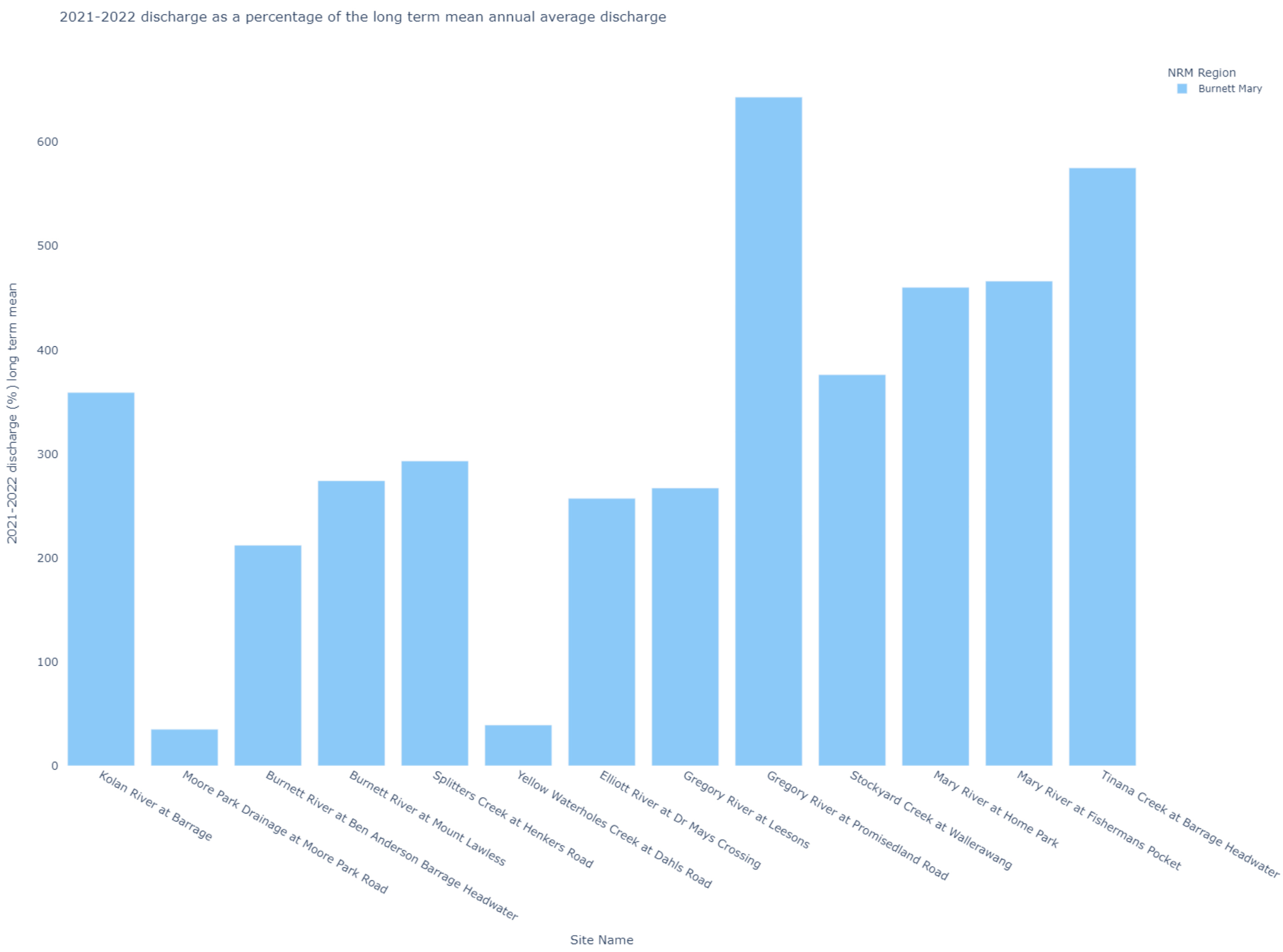


Figure 4. 2021-2022 Burnett Mary discharge as a percentage of the long term mean annual average discharge.

OUR SAMPLERS

Who does the monitoring?

Throughout the 2021-2022 monitoring year, Water Quality and Investigations contracted over 30 individuals and stakeholder organisations to conduct water quality sampling across 24 basins for the Great Barrier Reef Catchment Loads Monitoring Program. These samplers represent a broad spectrum of society including individuals, landowners, industry bodies, natural resources management groups, environmental organisations, Landcare organisations, councils, traditional owner groups and more. They receive rigorous in-person training, to ensure high-quality samples were collected using a standardised methodology aligned with the Queensland Water Monitoring and Sampling Manual (2018). As recommended by this Manual, all samples are analysed by laboratories holding accreditation with the National Association of Testing Authorities (NATA).

Water Quality and Investigations strive to provide face-to-face retraining to our sampling stakeholders annually, to maximise sample quality and ensure consistency throughout the programs. Stakeholders are also presented with the program data tailored to their region in a clear and concise way, to build on their understanding of local water quality issues and how their input is assisting in understanding spatial and temporal changes. Similarly, these interactions build rapport and allow the local samplers to provide us with their insights and knowledge, providing context to the data we generate. Our program would not be able to provide the amount of quality data that it does without the sampling stakeholders. Here are few of their stories, written largely in their own words.

Laura Rangers (South Cape York Catchments)

The Laura Land and Sea Rangers (Laura Rangers) are a local group consisting of a Coordinator and Traditional Owners, undertaking the management of natural and cultural resources on Country. This work includes waterway monitoring, fire management, weed control, sawfish monitoring, biosecurity and biodiversity projects. They are also responsive to community project requests from Elders in Laura and its surrounds. The Laura Rangers cultural heritage work systematically records, manages and preserves approximately 10,000 Natural Heritage listed Quinkan cultural and art sites –most of which are still to be recorded with the Cultural Heritage Unit of the Department of Treaty, Aboriginal and Torres Strait Islander Partnerships, Communities and the Arts for permanent documentation. Preservation works include construction of animal exclusion fencing, weed removal and installation of dust suppression matting which all have potential secondary benefits to water quality in the Normanby River and Laura River catchments.

As custodians of Country, the Laura Rangers view maintaining good environmental water quality as an obligation. The rivers provide food, places for recreation, connection to family and culture, provide places to ease mental stress, and provide nurseries for culturally significant species such as the freshwater sawfish (*Pristis pristis*). The Rangers feel these traditional values are being put at risk by local development, and feel environmental outcomes aren't being attributed appropriate value.

Springvale Station in the upper Normanby River was identified as a major sediment producing property, with gullies on the property accounting for approximately 40 per cent of gully erosion within the Normanby River catchment. This led to the purchase of the property by the Queensland Government in 2015, with the intent to improve biodiversity and conservation values of the Cape York bioregion, and reducing erosion and sediment yields from the highly degraded property that was disproportionately contributing very high sediment loads downstream and to the Great Barrier Reef ecosystem. Laura Rangers began monitoring water quality for the Department of Environment and Science in the 2016-2017 monitoring year and continue to do so.

Sediments mobilised in the upper Normanby River and Laura River are transported downstream during high flow periods. The Laura Rangers have reported sedimentation of waterholes around the Laura township, and the likelihood that sediments will eventually move further downstream impacting Rinyirru (Lakefield National Park) and the seagrass beds of Princess Charlotte Bay. The proposed expansion of the Lakeland Irrigation Area is viewed by the Rangers as having the potential to impact base flow conditions in the Normanby and Laura Rivers, accelerating the localised sedimentation.

The combined sediment loads exported past the East Normanby River at Mulligan Highway (39 kt) and West Normanby River at Mount Sellhiem (63 kt) exceed the downstream sediment load at the end of catchment Normanby River at Kalpowar River (61 kt). This has been the case for every year since monitoring began apart from the 2017-2018 monitoring year in which the combined load of 99 kt was less than the downstream load of 110 kt. Of the two, the West Normanby River has produced the greatest sediment load each monitored year, averaging 155 per cent more than the East Normanby River. However, the 2017-2018 monitoring year was the only year in which the West Normanby River produced a higher yield of sediment than the East Normanby River, 92 t/km^2 compared to 71 t/km^2 respectively.

In the Laura River sub-catchment, sediment loads generated above Laura River at Beefwoods Station (6.7 kt) and Lara River at Carroll's Crossing (4.4 kt) are approximately ten per cent of the monitored load downstream at Laura River at Coal Seam Creek (56 kt), indicating significant sediment generation just upstream of Coal Seam Creek in the 2021-2022 monitoring year. In 2020-2021 the load of total suspended sediments exporting past Lara River at Carroll's Crossing (290 kt) were 241 per cent larger than the monitored Laura River at Coal Seam Creek load (85 kt).

The largest generation of sediment and nutrient yields was the East Normanby River, producing 130 t/km^2 of sediment, 210 kg/km^2 of particulate nitrogen, 47 kg/km^2 of dissolved inorganic nitrogen and 68 kg/km^2 particulate phosphorus in 2021-2022.

Mulgrave Landcare & Catchment Group Inc.

Mulgrave Landcare have been partnered with the Great Barrier Reef Catchment Loads Monitoring Program (GBRCLMP) since 2014, monitoring the Mulgrave River, Russell River and Johnstone River catchments. They are a community driven environmental organisation focusing on riparian and wetland restoration, sustainable and profitable agriculture, water quality monitoring and improvements, and community engagement and partnerships.

Mulgrave Landcare, in partnership with Greening Australia, Madjandji Aboriginal Corporation (Madjandji), and local landholders undertook a project to revegetate and rehabilitate cane drains and wetlands in the Mulgrave River catchment under Reef Assist 2.0 funding. The project had a strong focus on First Nations employment and training, combined with positive on-ground Reef water quality outcomes. Subsequent flow on benefits for Mulgrave Landcare came in the form of education from the Madjandji people around traditional conservation management, seed collection and propagation, and nursery services.

The Department of Environment, Science & Innovation (DESI) has, through the alliance between Mulgrave Landcare and the Madjandji, embarked on a journey of building capacity within the Madjandji community, upskilling in environmental monitoring and facilitating the understanding of scientific data to complement their cultural knowledge. This has helped the Traditional Owners with their forthcoming Madjandji Healing Waters Report card and allows for succession planning for the Madjandji to potentially monitor their local waters for the GBRCLMP in future years.

The Madjandji people maintain a deep connection to the Bana (watercourses), recognising the threats posed by erosion, tourism, and invasive species. Despite these challenges, the Madjandji are committed to preserving their cultural knowledge and actively monitor nine significant Bana sites in the Mulgrave River catchment, monitoring changes in water quality and ecosystems.

The Madjaybana Rangers (Madjandji community rangers), engage in various projects, including reforestation and riverbank restoration supported by Mulgrave Landcare staff. These efforts have resulted in stabilisation of riverbanks, increased native flora and fauna, and reduced localised pollutant run-off in the Mulgrave River catchment.

Through collaborations with Cairns Regional Council, Tangaroa Blue Foundation, and environmental organisations including Mulgrave Landcare, the Madjandji people extend their conservation efforts to creek and marine debris cleanup, as well as mangrove monitoring. They emphasise the cultural value of water and advocate for involvement in decision-making processes related to their catchments, highlighting the need for ongoing collaboration, funding, and government support.

The enduring partnership between Mulgrave Landcare, the Madjandji community, and relevant stakeholders, including DESI, serves as a model for community-driven conservation. The Madjandji's dedication to preserving their cultural heritage and environment underscores the importance of continued collaboration and support for the mutual benefit of Mulgrave Landcare, the community and the Reef catchments.

The loads of total suspended sediment (35 and 39 kt), particulate nitrogen (210 and 190 t), dissolved inorganic nitrogen (190 and 220 t) and particulate phosphorus (49 and 61 t) were similar between the Mulgrave River and Russell River catchments, respectively for the 2021-2022 monitoring year. However, the Russell River produced a higher yield for the four priority pollutants, generating 66 per cent more sediment, 33 per cent more particulate nitrogen, 75 per cent more dissolved inorganic nitrogen and 94 per cent more particulate phosphorus on a per area basis than the Mulgrave River.

The end of catchment Johnstone River at Coquette Point monitoring site often records smaller total suspended sediment and particulate nutrients pollutant loads, than the combined sum of the contributing North Johnstone and South Johnstone River catchments. This was again the case in the 2021-2022 monitoring year, with instream processes downstream of the confluence from the North and South Johnstone Rivers resulting in significantly lower loads being monitored at Coquette Point. The dissolved inorganic nitrogen load at Coquette Point (690 t) was the only priority pollutant monitored which resulted in a higher downstream load than the combined sum of the North Johnstone (320 t) and South Johnstone (110 t) Rivers. The North Johnstone River and South Johnstone River sub-catchments generated 330 t/km^2 of dissolved inorganic nitrogen respectively, with an increased yield of 430 t/km^2 monitored at Coquette Point.

Burdekin Bowen Integrated Floodplain Management Advisory Committee Inc. (BBIFMAC)

Burdekin Bowen Integrated Floodplain Management Advisory Committee Inc. (BBIFMAC) were engaged to collect samples at eight locations in the Burdekin NRM region for the GBRCLMP in 2021-2022, covering the Burdekin River, Haughton River and Don River basins. BBIFMAC has maintained a robust and enduring 19-year collaboration with the Department of Environment, Science and Innovation (DESI) for local catchment water quality monitoring. This partnership provides the skills and training required for BBIFMAC to contribute to the broader Great Barrier Reef catchment monitoring efforts. The regular up-skilling and quality assurance training provided by DESI has been instrumental, fostering a positive working relationship and expanding BBIFMAC's engagement with local stakeholders in the region.

The team at BBIFMAC believe that good environmental water quality, for the collective community of organisations, individuals, and farmers, signifies responsible custodianship of the local environment. A commitment to good water quality ensures that future generations can enjoy the same quality of life as we currently do.

The primary systems of the Burdekin River, Haughton River, and Barratta Creek hold pivotal importance to the local communities. These waterways support extensive freshwater and estuarine wetland areas, playing a crucial role in fisheries, serving as habitats for migratory birds, and ultimately discharging into the Great Barrier Reef lagoon. Farmers also rely on these systems for irrigation water. Many crops rely on good water quality, particularly in the early crop phases to ensure good germination and establishment.

Over the years, numerous projects have addressed declining water quality in the Lower Burdekin area. These initiatives have not only enhanced community and farmer understanding of water quality but also led to changes in fertiliser and pesticide use and application. Ongoing recent projects have recently focused on enhancing irrigation efficiency, showcasing positive impacts on both farm productivity and downstream water quality.

The near future poses challenges that may impact water quality, including climate change-induced severe weather events. These events not only affect local weather conditions but also impact primary industries. Population growth is another local concern, leading to changes in land use and increased pressure on natural resources, with farming land being converted to housing and more marginal areas being opened for farming.
The link between local water quality and the health, resilience, and sustainability of the Great Barrier Reef is well-established by scientific evidence. Also, the local importance of water quality is evident in its impact on fisheries, recreation, tourism, and the coastal wetlands and estuaries of the Burdekin region.

The pursuit of improvements in water quality is a long-term goal. Recognising the potential lag effect in observing improvements downstream, particularly from upstream land use changes, underscores the importance of sustained and long-term monitoring. This extended monitoring period enables a nuanced understanding of natural fluctuations over time and facilitates the understanding of trends spanning a 10 to 20 year timeframe. The commitment to this monitoring approach is crucial for informed decision-making and the advancement of sustainable water management practices.

The collaborative efforts of the community, organisations, and growers, in conjunction with government initiatives, are pivotal in preserving and enhancing water quality in the Burdekin region. Recognising the intricate linkages between local water quality and broader environmental health remains imperative for sustainable agriculture, regional development and the safeguarding of precious natural resources for generations to come.

The Burdekin River at Sellheim sub-catchment generated the largest total suspended sediment (1600 kt), particulate nitrogen (2700 t) and particulate phosphorus (1400 t) loads in the Burdekin region. The largest contributor towards the dissolved inorganic nitrogen load in the Burdekin was downstream at Burdekin River at Home Hill with a reported load of 620 t. The 2019-2020 and 2020-2021 monitoring years also saw the largest total suspended solids and particulate nutrient loads coming from the grazing dominated Burdekin River at Sellheim sub-catchment, with the end of catchment site at Home Hill downstream of sugar land use areas, producing the greatest dissolved inorganic nitrogen load.

Burdekin River at Sellheim generated the largest yield of sediment (45 t/km^2) and particulate nutrients (75 kg/km^2 particulate nitrogen, 40 kg/km^2 particulate phosphorus) of BBIFMAC sampled sites, with Barratta Creek producing the largest dissolved inorganic nitrogen yield (160 kg/km^2). The next largest generator of dissolved inorganic nitrogen among the BBIFMAC monitored sites was the Don River (18 kg/km^2), 89 per cent lower than Barratta Creek.

Reef Catchments

Reef Catchments have been monitoring water quality in the Mackay Whitsunday region for Great Barrier Reef Catchment Loads Monitoring Program (GBRCLMP) for many years. They understand that, maintaining good water quality ensures the health of the local environments, habitats, and water resources. The water catchments within the region encompass a rich tapestry of values, including recreational, agricultural, environmental, cultural, and both economic and intrinsic benefits. The preservation of good water quality in the local creeks and rivers is essential to sustaining the functionality and value of these benefits both in the present and for generations to come.

The Proserpine River is a significant source for urban water supplied by Lake Proserpine, freshwater for irrigation and livestock in the Mackay Whitsunday Region. It is a favoured location for recreational activities, including boating, fishing, and birdwatching. The river also plays a pivotal role in supporting the local tourism industry through crocodile tours. Ecologically diverse and teeming with marine, estuarine, and freshwater species, the Proserpine River and its associated wetlands provide essential habitat for iconic species such as barramundi and crocodiles.

The Great Barrier Reef and Whitsunday Islands hold immense importance for the local community. Not only do they serve as major economic drivers through tourism and fisheries, creating jobs and supporting the regional economy, but they also bear high cultural significance for Indigenous communities. Additionally, they are hubs for local recreational activities.

For some individuals, such as Reef Catchments employee Emma Jones, the waterways such as the O'Connell River hold personal and professional significance. The river serves as a venue for waterway restoration professionals to work on projects aimed at enhancing river stability and ecological health. Outside of work, it offers recreation and exploration opportunities for her, contributing to the overall appeal of the region.

The region, however, faces an elevated risk of extreme weather events, including cyclones and flooding, which can significantly impact waterways and water quality. These events can amplify erosion, pollutant run-off, and reduce the resilience of riparian areas. Drought periods and El Niño years can bring reduced rainfall and elevated temperatures, potentially jeopardising water quality. They may decrease riverine flows leading to the accumulation of land-based pollutants, which can be released in high concentrations during subsequent rainfall events.

Reef Catchments has actively participated in various Australian Government Reef Trust funded programs, including Reef Trust VII and Reef Trust 4, with the overarching goal of improving water quality within the Great Barrier Reef lagoon. These programs emphasise increasing awareness and adoption of land management practices that enhance and safeguard soil, biodiversity, and vegetation. The projects encompass multiple components addressing issues such as streambank erosion, grazing land condition, sugarcane farming practices, irrigation, and best practice adoption.

Reef Catchments is also engaged in several agricultural projects aiming to improve water quality, such as the Mackay Whitsunday Water Quality Program, funded by a partnership between the Australian Government's Reef Trust and the Great Barrier Reef Foundation. These initiatives work in collaboration with cane industry landholders to enhance nutrient management, pesticide control, and irrigation practices on farms, while preserving or improving productivity and profitability. The project's success has led to its expansion into the Proserpine River and O'Connell River catchments after initially being focussed on the Plane River and Pioneer River catchments.

Reef Catchments and the Water Quality and Investigations team share a commitment to improving the understanding of changes in water quality and the implications on the surrounding environment. Collaboration with the Water Quality and Investigations team positions Reef Catchments well to understand the unique attributes of their region and chart the course towards achieving water quality improvement targets.

The short and flashy nature of catchments within the Mackay Whitsunday region means that all local waterways and creeks eventually flow into the Great Barrier Reef lagoon. Poor water quality in rivers increases sedimentation, nutrients, and pesticide levels in the inner reef shelf, resulting in heightened algal growth, pollutant buildup in marine species, and reduced light, thus smothering corals. This, in turn, diminishes the resilience of the Great Barrier Reef, hampering its ability to withstand stressors such as bleaching, crown-of-thorns outbreaks, and cyclone events. However, water quality investment, backed by the Reef 2050 Water Quality Improvement Plan, yields significant advantages for the Mackay Whitsunday region's local community. These initiatives enable organisations like Reef Catchments to invest locally, generate employment opportunities, enhance regional capacity, and meet community needs across multiple industries. The synergy between environmental protection and economic well-being is a win-win scenario, as it not only reduces pollutant run-off to the Great Barrier Reef, but also enhances the health, resilience, and productivity of the landscapes, supporting the local community and economy in the process.

Lower than average discharge was experienced across the Mackay Whitsunday region in 2021-2022. Total suspended sediment loads for the end of catchment sites (85 kt) were 18 per cent larger, particulate nitrogen (240 t) was 18 per cent lower, and particulate phosphorus (81 t) was 20 per cent lower than in 2020-2021 (72 kt, 280 t, 97 t, respectively). The 2021-2022 end of catchment load of dissolved inorganic nitrogen (150 t) was 53 per cent lower than in 2020-2021, driven by a reduction from 150 t to 22 t at O'Connell River at Caravan Park.

The Proserpine River produced the largest yields of total suspended sediment (120 t/km ^{2}), particulate nitrogen (240 kg/km ^{2}), particulate phosphorus (96 kg/km ^{2}) and dissolved inorganic nitrogen (160 kg/km ^{2}) in the 2021-2022 monitoring year.

Capricornia Catchments

Capricornia Catchments undertakes water quality sampling at the Isaac River in the northern parts of the Fitzroy basin, in collaboration with @Ag in Middlemount. Capricornia Catchments provides engaged and proactive leadership, gains and shares knowledge, and facilitates the sustainable, innovative, and productive utilisation of the region's natural resources for the community at a grassroots level. They adopt a community partnership approach to ensure collective well-being and environmental stewardship in the Fitzroy NRM region.

Capricornia Catchments continues its commitment to providing water samples from the Isaac River at May Downs Road, which it began sampling in 2017-2018. The data from these samples is used for various purposes, including informing government policies and investment decisions, supporting natural resource management choices by government and stakeholders, assessing localised environmental impacts, and educating both stakeholders and the community.

The implementation of the Monitoring and Sampling Manual techniques by Capricornia Catchments and @Ag staff ensures a consistent and scientifically rigorous approach to data collection, thereby providing all stakeholders with reliable information. The data aids in assessing the condition of the Isaac River catchment and discerning trends in Fitzroy basin water quality. This aligns with the overarching goal of managing the aquatic environment for sustainable development and preserving aquatic ecosystem health. Capricornia Catchments' Core Focus Areas are; supporting catchment and property scale monitoring programs, building partnerships with stakeholders, and supporting the planning and implementation of regional natural resource management plans – all consistent with their involvement in water quality monitoring of the Isaac River catchment.

Collecting samples for the GBRCLMP has meant the Capricornia Catchments team has gained new skills in water quality monitoring that can be used across other monitoring projects undertaken by the organisation.
Sampling at the Isaac River does become logistically tricky at times. During floods, access from Middlemount is cut off, meaning samples need to be collected primarily by staff located in Rockhampton. Conversely, during drought conditions the water level drops significantly with no flow and stagnant pools.

The Isaac River has never experienced larger than average annual discharge since monitoring at the site began in 2017-2018. In 2021-2022 the catchment received just 370 GL, 20 per cent of the long- term annual average flow. However, the total suspended sediment (250 kt, 12 t/km^2), particulate nitrogen (390 t, 84 kg/km^2), and particulate phosphorus (190 t, 38 kg/km^2) loads and yields were all the second highest for the site since monitoring began. Only the 2019-2020 year which received 980 GL of discharge resulted in larger sediment and particulate nutrient loads. Dissolved inorganic nitrogen loads (75 t) and yields (3.5 kg/km^2) in the Isaac River were 75 per cent lower than the largest monitored results recorded in 2018-2019 (310 t, 14 kg/km^2).

Mary River Catchment Coordinating Committee (MRCCC)

The Mary River Catchment Coordinating Committee (MRCCC) collects GBRCLMP samples in the Burnett Mary region. As a community-based organisation, it is keenly attuned to the public perception around the significance of their local waterways. Notably, the Mary River catchment encompasses several drinking water offtakes, and the provision of safe and efficient drinking water supplies is intrinsically linked to clean environmental water. Also, being an agricultural region, water quality plays a pivotal role in upholding the health and productivity of the landscapes. The Mary River catchment is a habitat for numerous threatened and endemic aquatic species, whose well-being hinges upon good water quality to sustain robust populations. The Mary River and its tributaries hold profound cultural and social significance, underpinning the care that the local community has demonstrated through over two decades of dedicated citizen science in the MRCCC's Waterwatch program, engaging more than 200 volunteers in monthly water quality monitoring efforts. In essence, the waterways not only connect the landscape and its inhabitants but also offer a lens through which the community can reflect on the past and chart the path forward. Waterway health and security provide a unifying thread for a diverse range of stakeholders, encompassing environment, culture, irrigation, drinking water supply, planning, and recreation.

For the first 20 years of its existence, MRCCC directed its efforts towards two key sites of paramount importance. Firstly, the preservation of the pools within the main trunk of the Mary River was a top priority, as they serve as critical habitat for a multitude of threatened aquatic species, including the Mary River cod (*Maccullochella mariensis*), Mary River turtle (*Elusor macrurus*), white-throated snapping turtle (*Elseya* *albagula*), and Australian lungfish (*Neoceratodus forsteri*). Secondly, the Ramsar-listed, internationally significant, Great Sandy Strait. Since inception, the MRCCC collaborated with landholders and partners to reduce riverbank erosion, under the premise that such remediation efforts would ultimately benefit the lower reaches of the Mary River and the Great Sandy Strait. Over the past decade however, a broader perspective has emerged, with the MRCCC recognising the impact the catchment has on the globally significant Great Barrier Reef. Consequently, the committee's work now aspires to make a positive impact in three crucial areas: the Mary River, the Great Sandy Strait, and the Great Barrier Reef.

MRCCC recently celebrated its 30th birthday, reflecting on three decades of dedicated integrated catchment management within the Mary River catchment. However, it is important to acknowledge that MRCCC is not working in isolation. Numerous Landcare Groups within the catchment have a long-standing history that predates MRCCC and remain active today.

Three decades ago, the MRCCC confronted concerns about riverbank degradation and embarked on a transformational journey, shifting the paradigm from "can't do" to "can do". Today, the MRCCC maintains its unwavering focus on the rehabilitation of the Mary River and its vital tributaries. Recent years have seen an expansion of the impact sphere, transcending the river itself to address the river's impact on the Great Barrier Reef, consequently leading to large-scale riverbank rehabilitation programs.

The Mary River catchment occupies a unique position, situated in close proximity to Southeast Queensland (SEQ) while lying just outside SEQ jurisdictional boundaries. This position results in substantial water extraction from the upper catchment for inter-basin transfers, supplying drinking water to the Sunshine Coast and northern Brisbane via the Northern Pipeline Interconnector. This practice essentially withholds a significant proportion of the original Mary River flow from the upper catchment, earmarked for the urban water needs of a growing SEQ. As a result, MRCCC views the burgeoning population of SEQ and Brisbane as a significant challenge to water quality in the Mary River and its tributaries, owing to diminished flow and increased occurrences of cease-to-flow. This predicament is further compounded by decreasing streamflow resulting from the expanding evaporative landscape in the western parts of the catchment.

MRCCC is acutely aware of the influence the Mary River has on the Great Sandy Strait and the southern Great Barrier Reef. Stakeholders in the lower River and Strait have reported the near-complete loss of seagrasses and the subsequent impact on dugongs, which rely on these seagrasses for survival. Furthermore, fine silt deposition on inshore reefs and sandbars, where turtles lay their eggs, is another concerning development. This fine silt is primarily attributed to occasional but catastrophic silt deposits from the Mary River. In the freshwater sections of the river, the infilling of deep pools, which are crucial for the endangered Mary River cod, remains a pressing concern for the community and has been for over three decades. Fortunately, numerous landholders have embraced catchment management works, undertaking on-ground projects and adopting best land management practices to counteract the decline in water quality.

Flooding impacted sites in the Mary River and Tinana Creek catchments in the second half of the monitoring year, driving loads at sites monitored by Mary River Catchment Coordinating Committee. Tinana Creek produced the largest total sediment (170 kt), particulate nitrogen (860 t), particulate phosphorus (250 t) and dissolved inorganic nitrogen (140 t) loads recorded at the site. Similarly, Mary River at Home Park generated loads of total suspended sediment, particulate nitrogen, particulate phosphorus, and dissolved inorganic nitrogen (1700 kt, 4200 t, 1500 t, and 1200 t respectively), which were the largest monitored in the Mary River by this program. The upstream Mary River at Fishermans Pocket sub-catchment produced 1400 kt, 3000 t, 1100 t and 1000 t of total suspended sediment, particulate nitrogen, particulate phosphorus and dissolved inorganic nitrogen, respectively. These loads represent 82 per cent of the total suspended sediment, 71 per cent of the particulate nitrogen, 73 per cent of the particulate phosphorus and 83 per cent of the dissolved inorganic nitrogen loads measured at the end of the catchment.

Mary River at Fishermans Pocket produced the largest yields of sediment and nutrients of the MRCCC monitored sites, with 460 t/km^2 of sediment, 980 kg/km^2 of particulate nitrogen, 360 kg/km^2 of particulate phosphorus, and 330 kg/km^2 of dissolved inorganic nitrogen generated.

The Water Quality & Investigations Technical Team

Much of the monitoring conducted by the GBRCLMP is done in areas which are often difficult to access, particularly during the large flow events that can occur multiple times per year. Relying solely on manual sampling of these sites can result in poor coverage, especially during very high flows. Remotely operated sites have been installed and maintained by the Water Quality & Investigations (WQI) technical team since the program's inception, with regular incremental improvements. The 2021-2022, an innovative technical design resulted in significant improvements in the safe installation and maintenance of flow measuring instrumentation, as described below.

The WQI Technical Team are responsible for installing and maintaining field equipment and communications, allowing for timely and accurate monitoring of what's occurring at site, and the communications with refrigerated automated samplers. Part of this work involves the monitoring of flow at locations which do not currently have accurately measured flow by external agencies, such as in tidal sites. The work involved in installing and maintaining much of this equipment is often conducted in challenging locations. Risks at these sites include, steep slippery banks, thick vegetation, weather factors such as heat, humidity and storms, vector borne diseases and crocodiles.

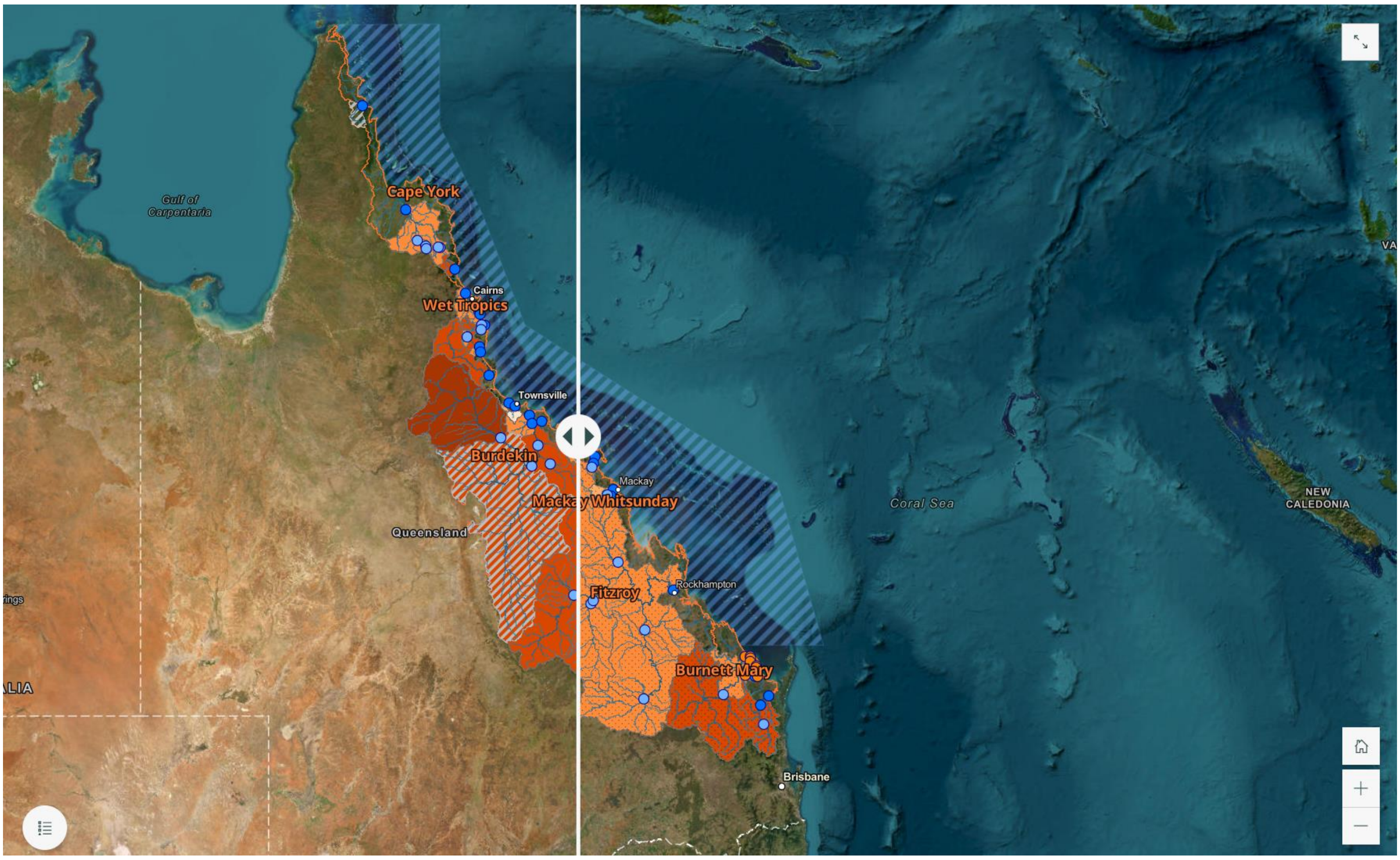
In order to minimise the risks associated with maintenance of horizontal acoustic doppler current profilers (HADCP) which monitor flow and must be situated below the surface of the water, the team designed and installed a counter-weight swing arm system. This was mounted to a large jetty pylon but proved cumbersome, especially when returning it to the river during strong flow conditions. This also created the potential to increase the overall risks involved with installing and maintaining the equipment. As a result, a new design was sourced from the Department of Regional Development, Manufacturing and Water for a fabricated acoustic doppler sliding mount system. This mount allows the HADCP to be raised above the waterline to be worked on, making it more safely accessible, before being lowered back into place in the water.

The first slide mount systems were installed in 2021 and following some minor design changes they have been deployed throughout a number of sites across the northern GBRCLMP catchments. The major benefit of a slide mount system for deploying, servicing and replacing HADCP's, is that it can be safely accessed from the river bank and a boat is no longer required.

The WQI Technical Team were awarded a 2022 Director General Safety Behaviour Award, recognising the innovation and the impacts on improving the safety and wellbeing of government staff.

SEDIMENT LOADS AND YIELD

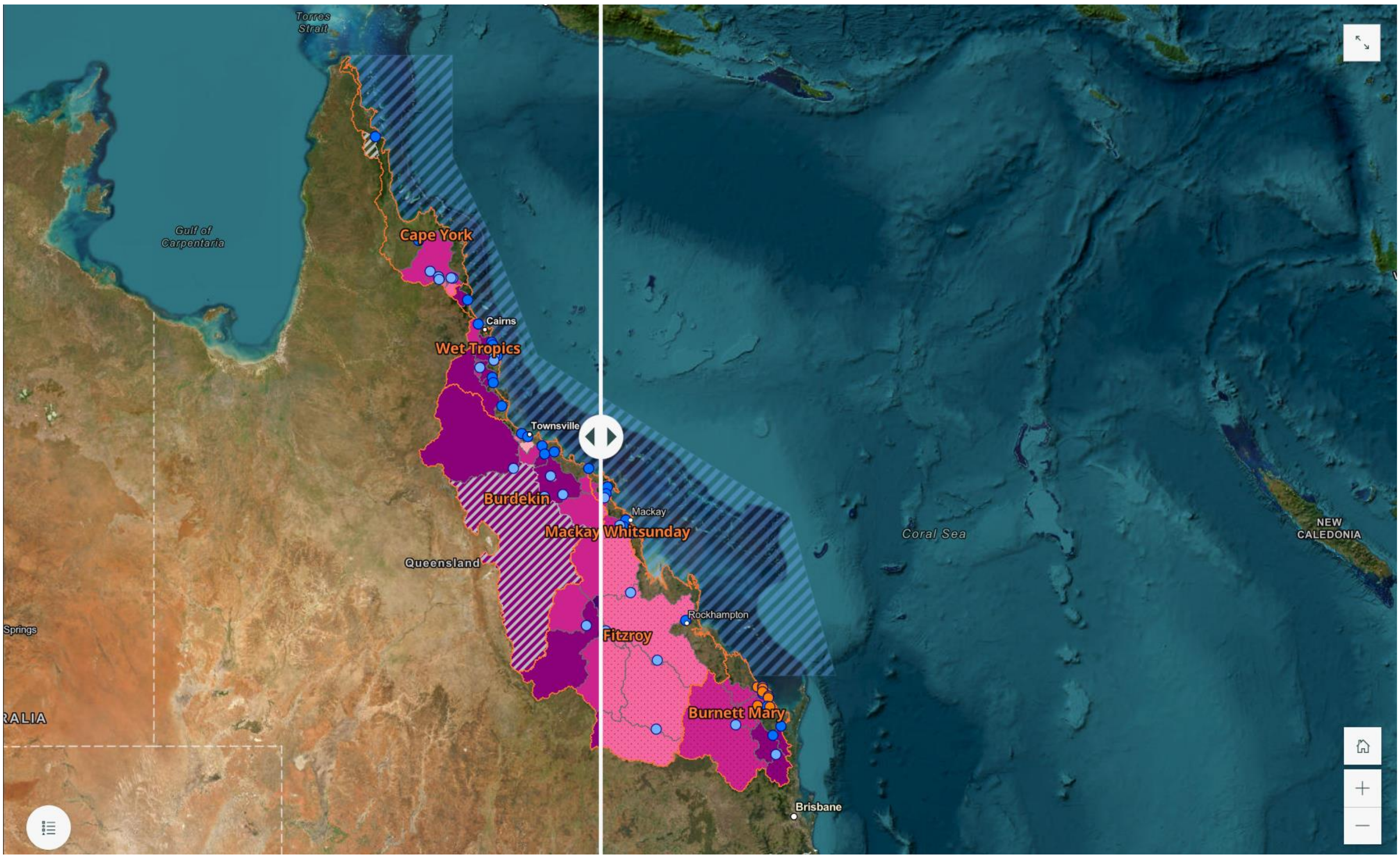
Sediments are a natural component of catchments and Reef ecosystems. However, when excessive amounts of fine sediment – the small particles which can remain in suspension and become easily transported – enter the river systems and are transported to the Reef, they can have a detrimental effect on inshore corals and seagrass meadows. Increased levels of fine sediments can cloud the water decreasing clarity and blocking sunlight from reaching the coral and seagrass, stunting their growth. As the sediments settle over time, they can impact the early life stages of corals and may even smother corals and seagrasses. Sediment can also carry nutrients and inorganic (e.g. metals) and organic (e.g. pesticides) contaminants from the catchment into the Reef environment.



Swipe to compare: Total suspended solid loads on the left-hand side, and total suspended solid yields on the right-hand side for the 2021-2022 monitoring year. Click on the menu in the bottom left corner of the map to view the legend.

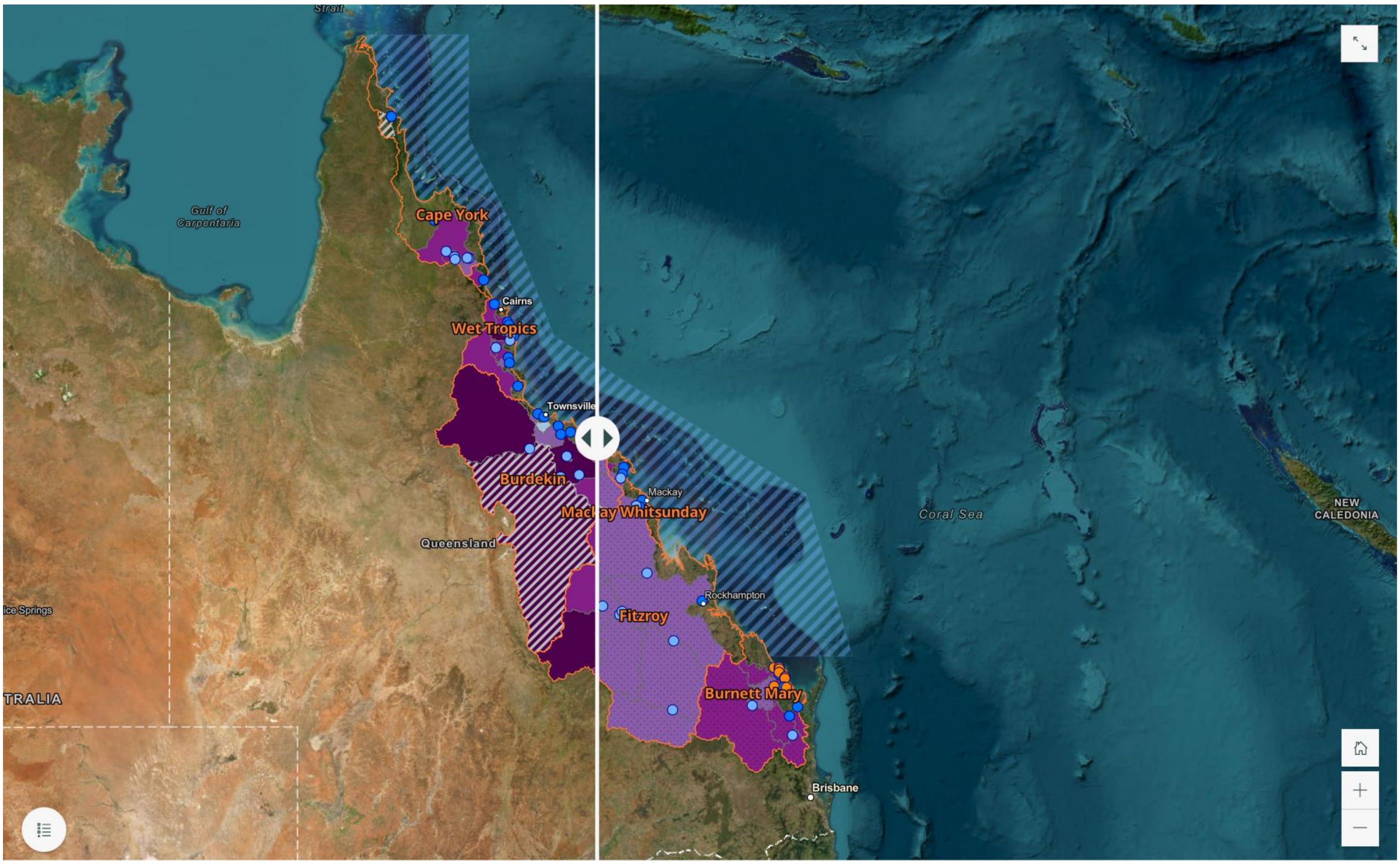
NITROGEN LOADS AND YIELDS

Nutrients are the natural chemical elements and compounds that plants and animals need to grow. Nitrogen is transported in run-off as tiny particles (particulates) and as dissolved constituents in water. The dissolved inorganic (and a proportion of the organic) nutrient forms are immediately available for biological uptake, and particulate nutrients may also become biologically available via mineralisation/desorption or via ingestion of particulates by biota. Nutrient imbalances can lead to an increased abundance of macroalgae and algal blooms, reducing available light for corals and seagrass. It can also result in increased crown-of-thorns starfish outbreaks and increase the susceptibility of corals to disease and coral bleaching.



Swipe to compare: Dissolved inorganic nitrogen loads on the left-hand side, and dissolved inorganic nitrogen yields on the right-hand side for the 2021-2022 monitoring year. Click on the menu in the bottom left corner of the map to view the legend.

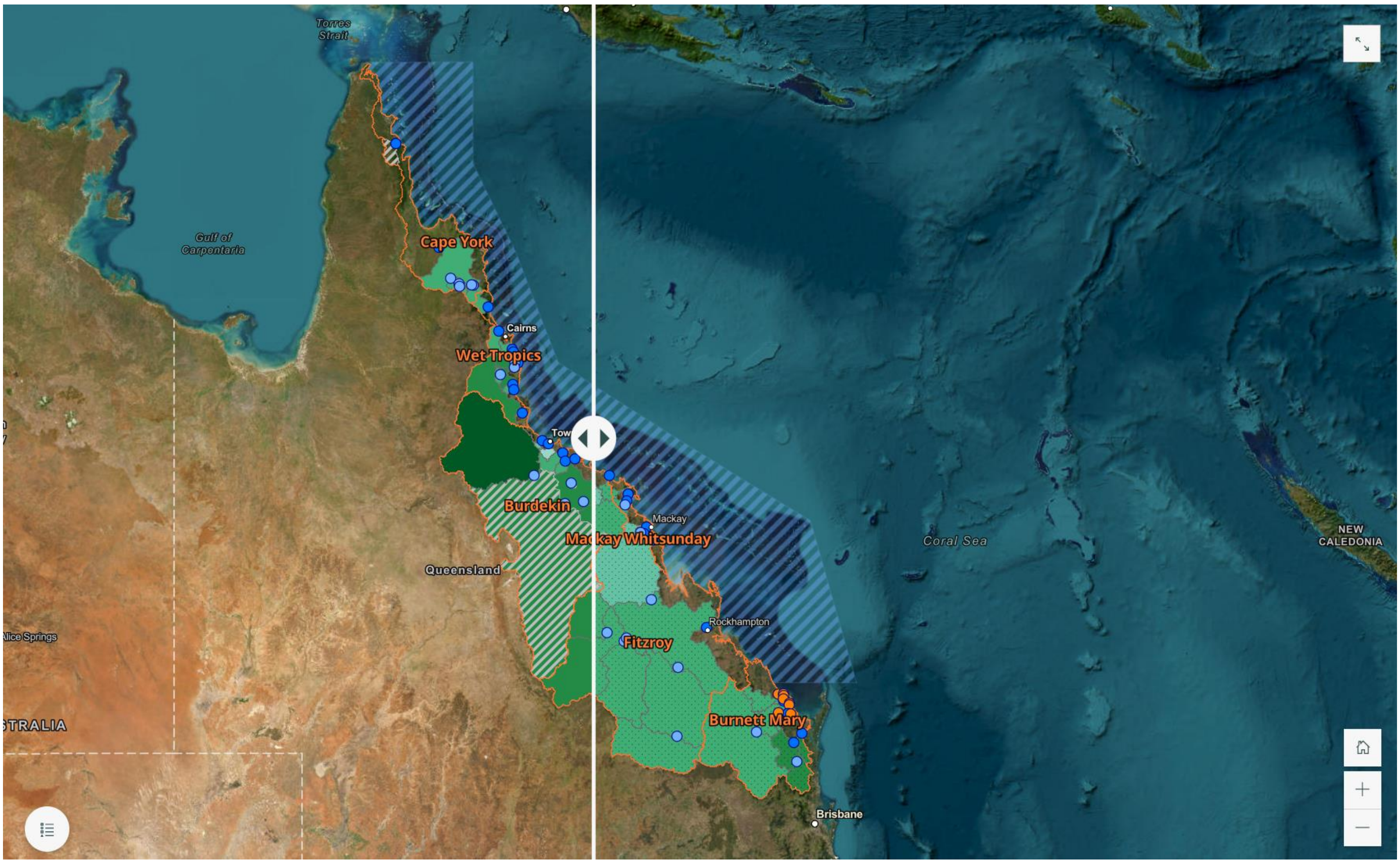
Particulate nitrogen and dissolved inorganic nitrogen are measured in the water samples and presented as loads and yields in this Story Map. Other forms of nitrogen are measured in the water sample and are presented as loads and yields in the spreadsheet in the **Downloads** tab.



Swipe to compare: Particulate nitrogen loads on the left-hand side, and particulate nitrogen yields on the right-hand side for the 2021-2022 monitoring year. Click on the menu in the bottom left corner of the map to view the legend.

PHOSPHORUS LOADS AND YIELDS

Nutrients are the natural chemical elements and compounds that plants and animals need to grow. Phosphorus is transported in run-off as tiny particles (particulates) and as dissolved constituents in water. The dissolved inorganic (and a proportion of the organic) nutrient forms are immediately available for biological uptake, and particulate nutrients may also become biologically available via mineralisation/desorption or via ingestion of particulates by biota. Particulate phosphorus may be absorbed onto soil particles or plant and animal organic matter. It can then be released slowly acting as a source of phosphorus for many years. It is measured in the water samples and presented as loads and yields in this Story Map. Other forms of phosphorus are measured in the water samples and are presented as loads and yields in the spreadsheet in the **Downloads** tab.



Swipe to compare: Particulate phosphorus loads on the left-hand side, and particulate phosphorus yields on the right-hand side for the 2021-2022 monitoring year. Click on the menu in the bottom left corner of the map to view the legend.

PESTICIDES

Percentage of aquatic species protected

The Reef 2050 WQIP 2025 water quality pesticide target is: *to protect at least 99 per cent of aquatic species at the end-of-catchments*. The monitored data for the 2015-16 to 2017-18 monitoring years formed the basis of the Pesticide Risk Baseline model published in the 2017 and 2018 Reef Report Card, and this baseline is used to assess distance from the pesticide target. Data obtained in subsequent monitoring years, including 2018-2019 and 2019-2020 were used to calculate Pesticide Risk Condition for the 2019 and 2020 Reef Water Quality Report Cards.

All pesticide concentration data used for the calculation of pesticide risk were obtained from the analyses of water samples collected either manually or by automatic sampling equipment. For the current Story Map, the concentrations of 22 reference pesticides measured in water samples collected from GBRCLMP monitoring sites were used to calculate the daily percentage of species affected. An example of daily percentage of species affected is provided in Figure 5 below.

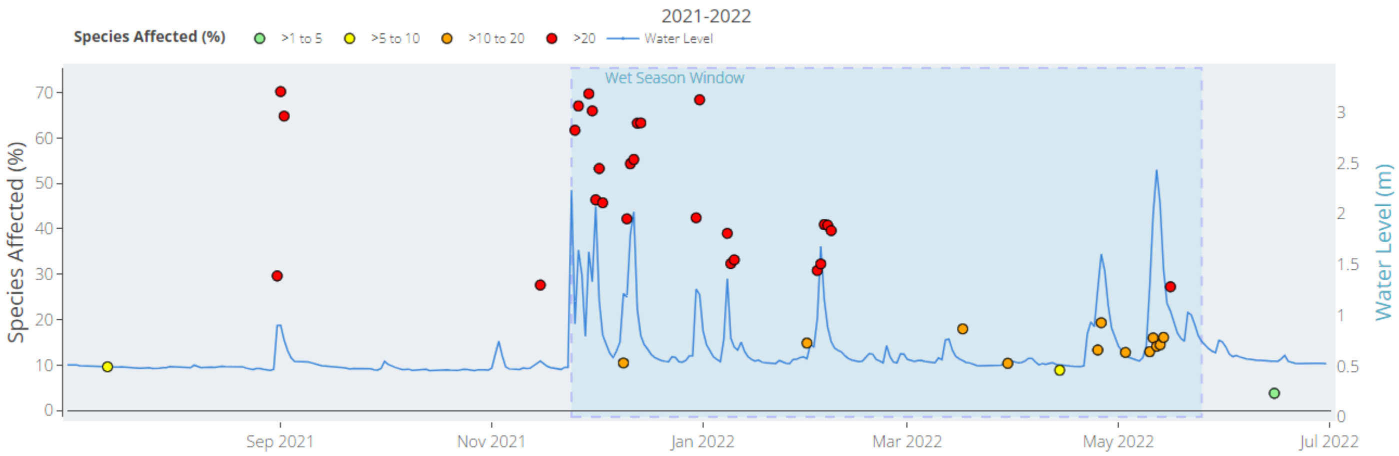


Figure 5. Daily percentage of species affected by exposure to all 22 pesticides at the Sandy Creek at Homebush site in the Mackay Whitsunday region. The shaded area indicates the 182 day risk window for which the Pesticide Risk Metric was calculated in the 2021-2022 monitoring Year. Data sourced from the Pesticide Risk Metric Dashboard.

These data were then transformed to an average percentage of species protected (i.e. the reciprocal of percentage of species affected) in the aquatic ecosystem over a standardised wet season (i.e. 182 days from the date of first flush at each site). The average percentage of species protected over a standardised wet season is termed the Pesticide Risk Metric. The Pesticide Risk Metric is an estimate of the proportion of the aquatic ecosystem that is protected (or affected), from direct effects of pesticides expressed as a percentage. For example, if a Pesticide Risk Metric value is 98 per cent species protection, this means that 98 per cent of aquatic species should not experience sub-lethal or lethal effects resulting directly from exposure to pesticides present in that waterbody. It also means that two per cent of aquatic species could experience some effects, such as reduced population levels, reduced growth or reduced reproduction. The high variability in the daily percentage of species affected is not conveyed by the 182-day Pesticide Risk Metric and is therefore note-worthy. It remains unknown if the peaks in risk, particularly at the beginning of the wet season, result in more perverse outcomes for aquatic ecosystems than that which is estimated by the 182-day Pesticide Risk Metric. As part of the confidence assessments that are used for the reporting (e.g. Reef Water Quality Report Card and regional report cards), research to validate the risk estimated by the Pesticide Risk Metric is an ongoing priority of Paddock to Reef Programs.

The Pesticide Risk Metric results presented here are for waterways monitored under the Great Barrier Reef Catchment Loads Monitoring Program and should be interpreted as an assessment of current pesticide risk, not progress towards target. The results are for the monitoring sites and should be viewed as an indicator of what may be discharged to the Great Barrier Reef lagoon. The unmonitored portion of the catchment or sub-catchment may contribute, transform, dilute or degrade contaminants before they discharge to the Great Barrier Reef lagoon. For a representation of the data at a basin or regional scale, refer to the most recent Reef Water Quality Report Card.

For more details on the pesticides and their modes of action (e.g. PSII inhibiting herbicides, ALS inhibitors, etc.) see *Program Design* in the **Downloads** tab. A detailed explanation of the method for calculating the Pesticide Risk Metric is also available. All pesticide concentration data used to calculate the Pesticide Risk

Metric are available in the Pesticide Reporting Portal. All charts used below to describe pesticide condition were generated, and can be explored in, either the Pesticide Risk Metric Dashboard or the Pesticide Reporting Portal. Please note that the Pesticide Risk Metric results presented in the narrative below, are generally expressed graphically as per cent of species affected rather than per cent of species protected (see Figure 6).

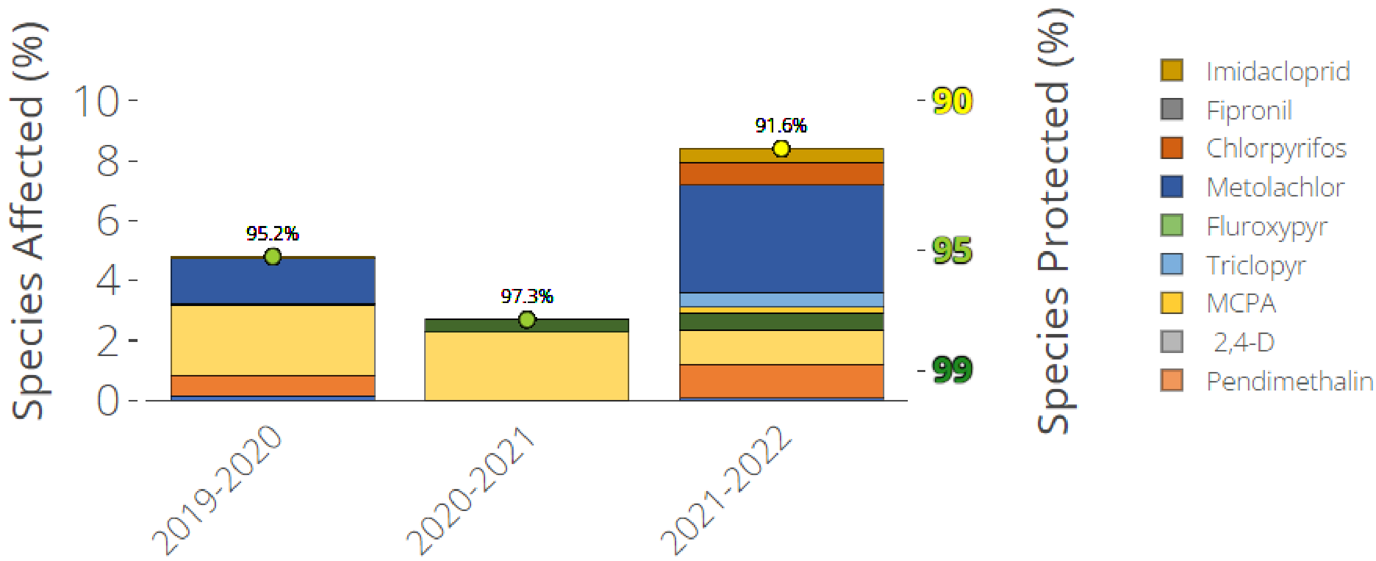


Figure 6. Graphical representation of the contributions to pesticide risk at Elliot River at Mays Crossing. The left axis provides a percent of species affected scale, and the right axis express the same data on a percent of species protected scale (per cent protected = 100 — per cent affected). Data sourced from the Pesticide Risk Metric Dashboard.

Pesticide results

During the 2021-2022 monitoring year, 27 end-of-catchment sites, 9 sub-catchment sites and 8 fine-scale sites were monitored for pesticides across six regions (Cape York, Wet Tropics, Burdekin, Mackay Whitsunday, Fitzroy and Burnett Mary).

Catchment monitoring

2021-2022 was the first monitoring year that pesticide risk was measured in the Cape York region. Two sites were monitored: Normanby River at Kalpowar Crossing and Laura River at Beefwoods. Risk was very low for both sites with >99 per cent species protection.

The risk categories for monitored sites within the Wet Tropics region remained consistent with the risk observed in previous years. There were four newly monitored sites. Three of these sites were established as part of a review and recalibration of the Pesticide Risk Metric. Fig Tree Creek at Bruce Highway was established as a near pristine site with only rainforest above the site, and as expected, displayed very low risk. Saltwater Creek at Cook Highway was established as a site where sugarcane (12%) and Conversation (80%) were the dominant land uses, and Emerald Creek at Emerald Weir was established as a site with a high proportion of mixed horticulture immediately above the site. Both these sites displayed low risk in the 2021-2022 year.

The fourth site, Catherina Creek at Catherina Creek Road, is associated with one of the near real-time monitoring sites established as part of the RP232 project. This site was monitored because it has the largest per cent of land use as sugarcane within the program with approximately 88 per cent of the land use as sugarcane with an additional approximate 5 per cent of land use attributed to urban use. It should be noted that the Catherina Creek site is one of the smallest catchments within the program that monitors pesticides, only draining a catchment of 24 square kilometres. As a consequence of the intensive agriculture and small area (i.e. low dilution potential) of the catchment, the site displayed very high risk with only 52.3 per cent of species protected, which is the highest risk observed within the program. Imidacloprid and diuron are the main pesticides contributing to the risk at this site which are commonly observed at sites with intensive sugarcane land use (see Figure 7).

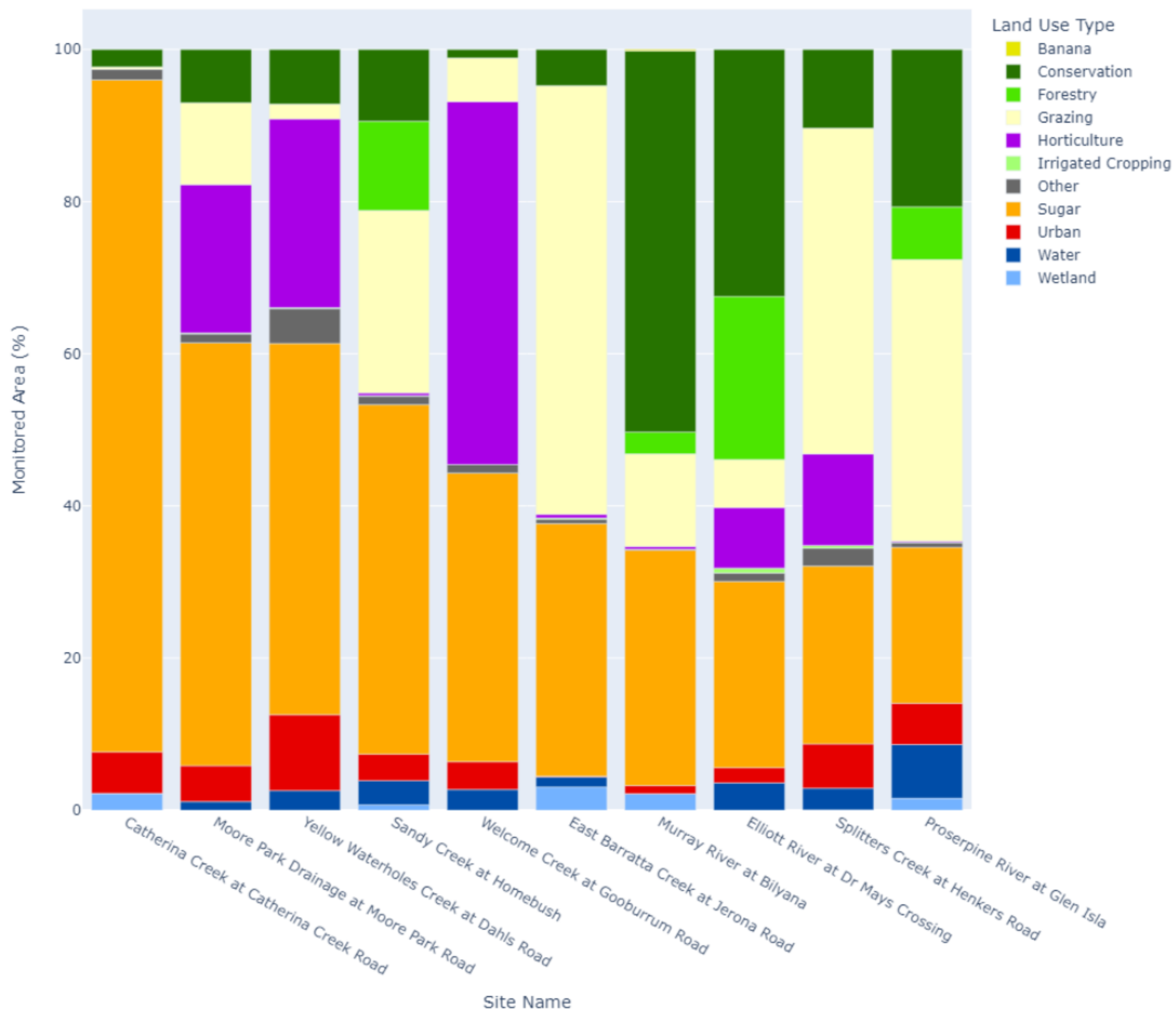


Figure 7. Monitored area land use for ten sites in GBRCLMP with the largest per cent land use of sugarcane.

Since monitoring at this site commenced in 2018-2019, Murray River at Bilyana had consistently displayed the lowest level of species protection in the Wet Tropics up until 2020-2021. In the 2021-2022 monitoring year, this site had drier conditions compared to previous years with only one large event that occurred in late April when risk is often lower for this site (Figure 8). Consequently, this has resulted in a higher per cent of species protected (89.6%) for the site than previous years.

Figure 8. Daily percentage of species affected by exposure to all 22 pesticides at the Murray River at Bilyana site in the Wet Tropics region. The shaded area indicates the 182 day risk window for which the Pesticide Risk Metric was calculated. Data sourced from the Pesticide Risk Metric Dashboard.

In the Burdekin region, risk remained very low (>99 per cent species protected) for Black River at Bruce Highway and Ross River at Aplins Weir Headwater; however, risk was higher than previously monitored years for the other five sites. Although the main pesticides contributing to risk at each of the five sites remains consistent with the previous year, the contribution to overall risk from metolachlor and imazapic is greater at all sites than in previous years (Figure 9).

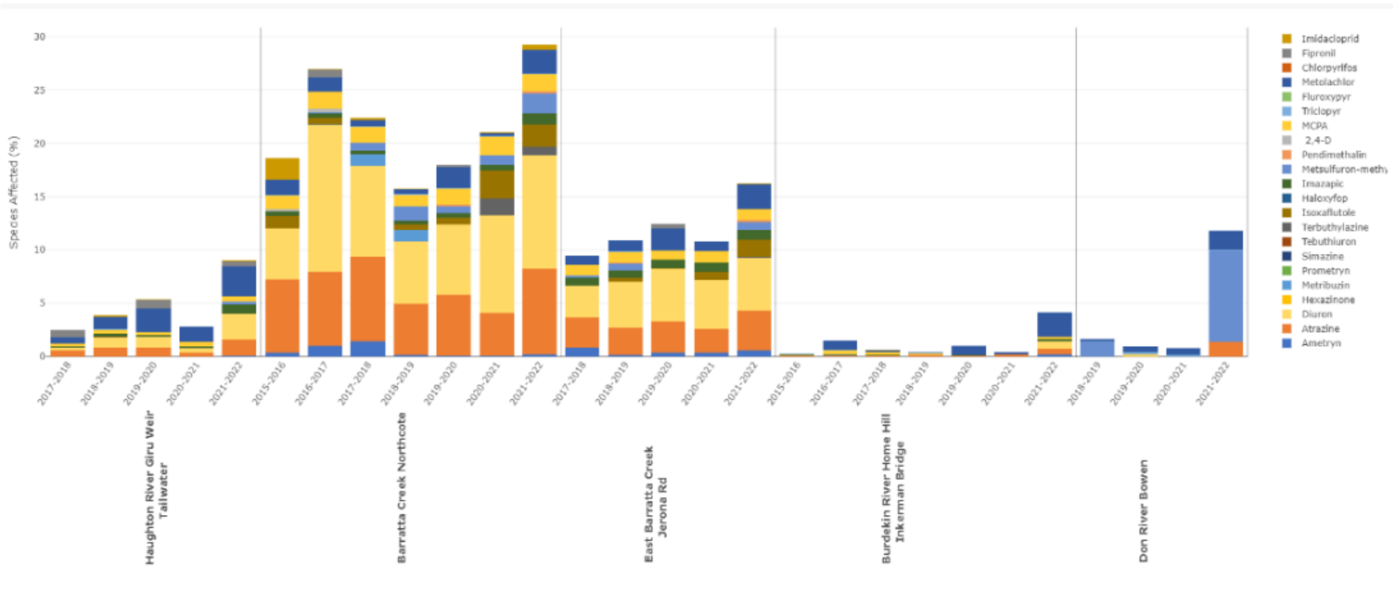


Figure 9. Plot showing Individual pesticide contributions to risk as estimated by the Pesticide Risk Metric for all sites monitored in 2021-2022 in the Burdekin region. Data sourced from the Pesticide Risk Metric Dashboard.

There is a noticeable increase in risk at Don River at Bowen where risk has previously been very low or low and increased to high (<90 per cent of species protected) in 2021-2022. Metsulfuron-methyl was the largest contributor to risk at the site as there were nine elevated detects of metsulfuron-methyl during the wet season period (Figure 9). The Don catchment experienced very dry conditions throughout the wet season which reduced the number of opportunities for sampling during ambient (low flow) conditions (Figure 10). The average wet season Pesticide Risk Metric score uses both event samples and ambient samples to generate a wet season average for the per cent of species affected for the site. The absence of ambient samples has resulted in a higher risk Pesticide Risk Metric score for the site because only high flow event samples were available for use in the calculation. Although the per cent of species affected is reflective for the monitored site Don River at Bowen, the GBRCLMP advises the wet season Pesticide Risk Metric score is inadequate to be used beyond the monitored site. Please note that for these reasons, the Don River was not scored for the assessment of Current Pesticide Risk in the Reef Water Quality Report Card 2021 and 2022.

Figure 10. Daily per cent of species affected by exposure to all 22 pesticides at the Don River at Bowen site in the Wet Tropics region. The shaded area indicates the 182 day risk window for which the pesticide risk metric was calculated. Data sourced from the Pesticide Risk Metric Dashboard.

In the Mackay Whitsunday region, pesticide risk remained consistent with previous years with risk categories remaining in the moderate to very high categories for all monitored sites. The pesticide risk also remained consistent with previous years for monitored sites within the Fitzroy region with metolachlor as the largest contributor to pesticide risk for the region. Monitoring recommenced at Calliope River at Bruce Highway where pesticide risk was very low (>99 per cent of species protected) consistent with the risk observed in 2018-2019 when it was last monitored.

The Burnett Mary region experienced above average or very much above average rainfall with the start of the wet season occurring earlier than in previous years and consequently capturing an earlier risk period. Risk was higher for six of the fine-scale monitoring sites and one end-of-catchment site (Burnett River at Quay Street Bridge) in those catchments where sugarcane constitutes a large proportion of land use (Moore Park Drainage at Moore Park Rd, Welcome Creek at Gooburrum Rd, Splitters Creek at Henkers Rd). Imidacloprid remains the dominant contributor to pesticide risk because of its importance in the control of greyback canegrub. However, across the region, the herbicide metolachlor was within the top three contributing pesticides towards overall risk for all eleven sites except for two smaller fine-scale monitoring sites (Moore Park Drainage at Moore Park Road and Fairydale at Norton Road' Figure 11). Metolachlor has a wide variety of uses to control broadleaf weeds and annual grass weeds on many crops including sugarcane, brassicas, cereals and grains (Infopest). The primary land uses within the monitored catchments in the Burnett Mary are varied, and include sugarcane, mixed horticulture and grazing. There it is not usual to see metolachlor as a main contributor to risk across the entire region.

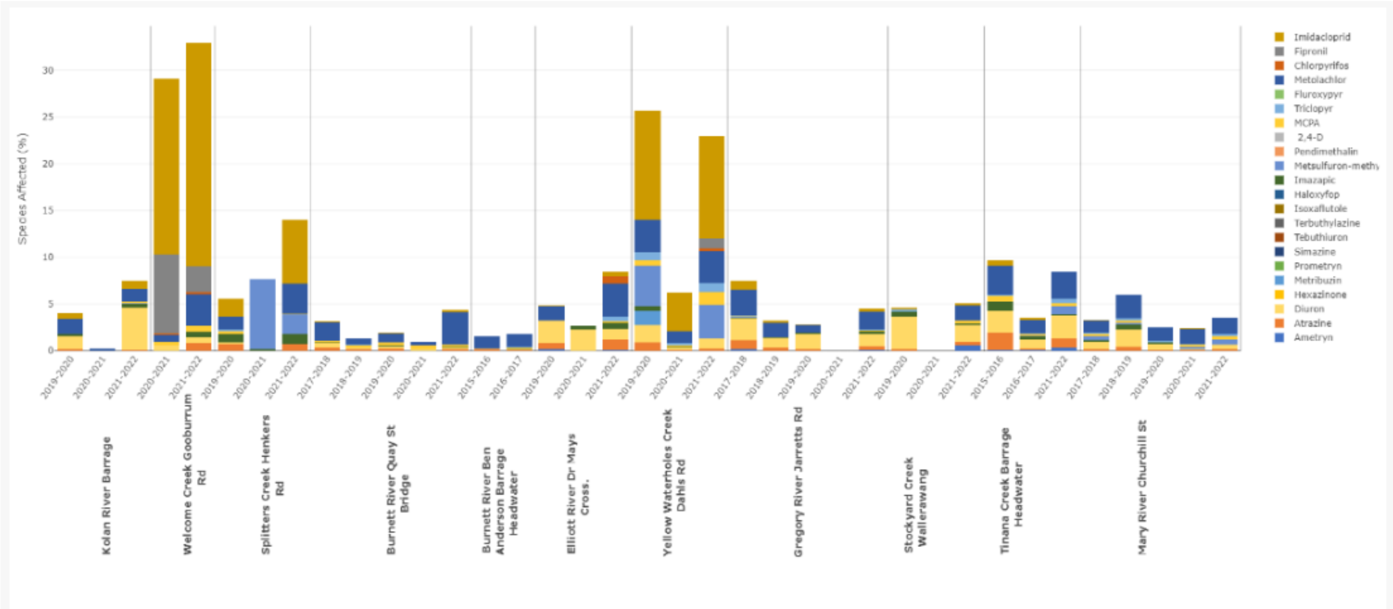


Figure 11. Plot showing individual pesticide contributions to risk as estimated by the Pesticide Risk Metric for all sites monitored in 2021-2022 in the Burnett Mary region. Data sourced from the Pesticide Risk Metric Dashboard..

Moore Park Drainage at Moore Park Road had ten detects of the insecticide Fipronil, which has not been observed previously at this site. This resulted in Fipronil becoming one of the main contributors to risk for the Moore Park site in 2021-2022 (Figure 12). Fipronil was also newly detected at Yellow Waterholes at Dahls Creek Road site; however, contributed less to the overall risk than at Moore Park (Figure 12). Fipronil is an insecticide that is approved for use on different horticulture crops such potatoes, cauliflower, broccoli, mushrooms and sweet potatoes to combat pests such as weevils, crickets, wireworms and caterpillars (Infopest). It can also be used on sugarcane to combat the sugarcane weevil borer (Sugar Research Australia 2013). Considering the land use at the Moore Park sites is approximately 56 per cent sugarcane and 19 per cent horiculture and Yellow Waterholes catchment is approximately 49 per cent sugarcane and 25 per cent horticulture an increase in pest pressure during the relatively wet 2021-2022 monitoring year from one or both land use types in likely.

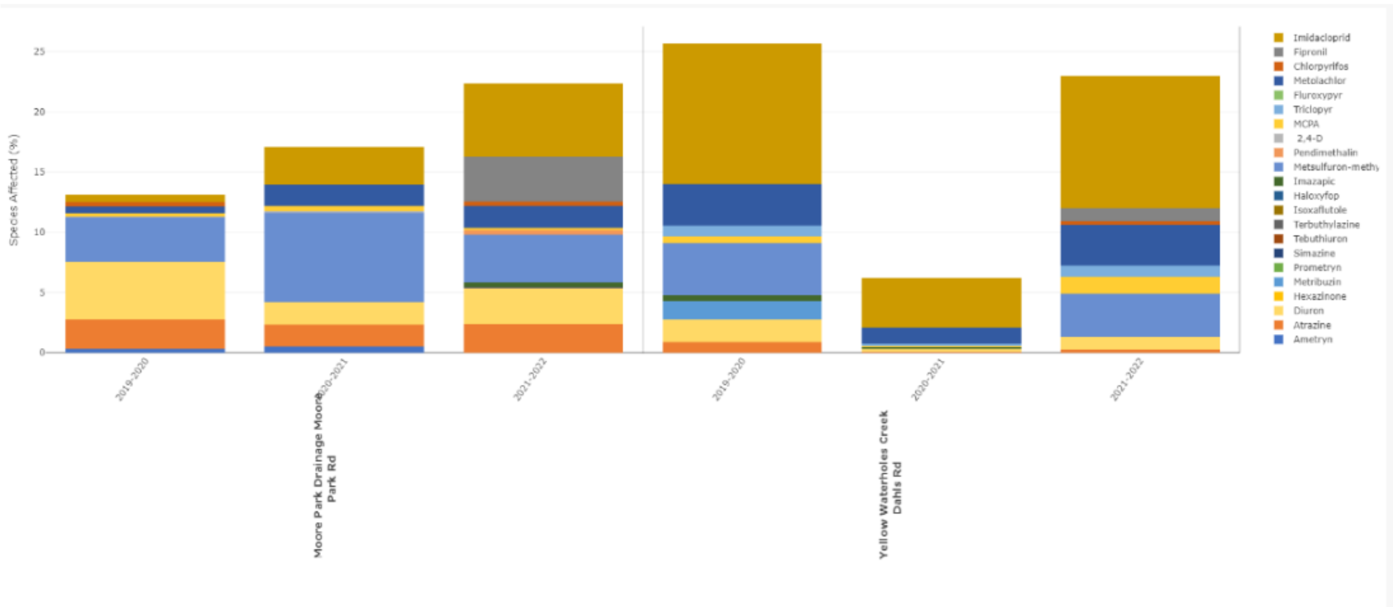


Figure 12. Plot showing individual pesticide contributions to risk as estimated by the Pesticide Risk Metric for Moore Park Drainage at Moore Park Road and Yellow Waterholes Creek at Dahls Road site in the Burnett Mary region. Data sourced from Pesticide Risk Metric Dashboard.

DOWNLOADS

Great Barrier Reef Catchment Loads 2021-2022

All loads results presented in this Story Map can be downloaded as a spreadsheet here.

Program Design

The Tier III GBRCLMP *Program Design* and detailed method can be viewed here.

Pesticide Concentration Data

The Pesticide Reporting Portal provides access to GBRCLMP pesticide monitoring data for the six GBR regions and sites within South East Queensland. Remote-telemetered water level data provide context, allowing landholders and managers to investigate the influence of overland flow on pesticide loss under different management scenarios.

GBRCLMP Pesticide Risk Metric dashboard

The Great Barrier Reef Catchment Loads Monitoring Program Pesticide Risk Metric Dashboard provides access to calculated Pesticide Risk Metric data and Pesticide Contribution data for all sites referred to in GBRCLMP – Condition Report 2021-2022 and previous monitoring years.

GBRCLMP Loads dashboard

The Great Barrier Reef Catchment Loads Monitoring Program Loads Dashboard provides access to all historical loads, yield and discharge data reported by the GBRCLMP.

Land use

The land use data presented in this Story Map were adapted from the land use data developed by Queensland Land Use Mapping Program. Current land use data for the entire state of Queensland are freely available for download from the Queensland Spatial Catalogue – QSpatial. Search for "Land use mapping - 1999 to Current - Queensland".

Land use data for the areas upstream of the GBRCLMP monitoring sites can be downloaded as a spreadsheet here.

Rainfall

Rainfall data (total rainfall and decile rainfall) were downloaded from the Bureau of Meteorology website.

PDF version of Story Map

A text-only version of this Story Map (2021-2022) can be downloaded here.

Our other Story Maps

All annual GBRCLMP Condition Reports can be found here.

Photography

High-resolution images were sourced from either Unsplash, the WQI team or WQI stakeholders.

CONTACT US

Water Quality and Investigations Team

The *Water Quality and Investigations* Team sits within the *Water Ecosystem Science* branch, in the Department of Environment, Science and Innovation, *Queensland* Government.

The Water Quality and Investigations Team includes highly specialised water quality scientists, statisticians, technical specialists, hydrographers, ecotoxicologists and GIS experts.

The team is responsible for the delivery of two key water quality monitoring programs: the Great Barrier Reef Catchment Loads Monitoring Program and the South East Queensland Catchment Loads Monitoring Program. Both programs support the monitoring and reporting roles of the Department as part of Reef 2050 WQIP and South East Queensland Healthy Waterways initiatives.

Further to these programs, the team is actively involved in the environmental investigations, assessments and analyses relating to pollution events, ecotoxicology, water quality and aquatic ecosystem health.

Contact

For more information about the Great Barrier Reef Catchment Loads Monitoring Program please contact:

wqi@qld.gov.au

Water Quality and Investigations, Department of Environment, Science and Innovation, Queensland Government

Acknowledgements

The GBRCLMP is grateful to the Queensland Government hydrographers who were responsible for the installation and maintenance of all Queensland Department of Natural Resources Mines and Energy gauging stations and associated infrastructure, and for the collection and validation of flow data that remain critical to the results presented in this Story Map.

The authors wish to thank all stakeholders who assisted in the collection of water samples during the 2021-2022 monitoring year, including Queensland Parks and Wildlife staff, Laura Rangers and South Cape York Catchments Inc., Mulgrave Landcare and Catchment Group Inc., Johnstone River Catchment Management Association, Tully Sugar Pty Ltd, AquaSea Enterprises, Burdekin Bowen Integrated Floodplain Management Advisory Committee Inc., Reef Catchments, Capricornia Catchments Inc., Fitzroy River Water, Burnett Catchment Care Association, Mary River Catchment Coordinating Committee, Lana Polglase, Christina Howley, Peter Bradley, Sylvia Conway, Beau Nash, Gulf Savannah NRM, Colt Pitt, Aaron Davis, Chris Dench, Ray Byrd, Robbie Price, Tania Brown, Noel and Penny Bartley, Kevin Brignull, David Erfurth, Tony Wolfe, Peter and Sally Griffiths, Mark Orreal, Dianne Coulter and Shane Jackson and Tracey Muller. Thanks also go to the Queensland Government catchment modellers and to all members, partners and stakeholders of the Reef 2050 WQIP and the Paddock to Reef program.

The GBRCLMP would like to acknowledge the assistance and advice provided by the Science and Technology Division Chemistry Centre and Queensland Health Forensic and Scientific Services. The contribution of industry and other Queensland Government departments in providing advice regarding the analysis and interpretation of results is greatly appreciated.

The authors would like to thank members of the Reef Independent Science Panel and the Office of the Great Barrier Reef for reviewing the Condition Report and Story Map platform. Thanks are also extended to Dr Stephen Lewis and Dr Mark Landers for reviewing the Condition Report and Program Design documents.

TERMS OF USE

The Queensland Government requests citation in the following manner:

Water Quality & Investigations, 2024, *Great Barrier Reef Catchment Loads Monitoring Program: Loads and yields for sediment and nutrients, and Pesticide Risk Metric results (2021–2022) for rivers that discharge to the Great Barrier Reef*, Department of Environment, Science and Innovation, Brisbane, Australia.

Water Quality and Investigations acknowledges all team members who contributed to the 2021-2022 Story Map:

Reinier M Mann, Ryan DR Turner, Catherine Neelamraju, David Orr, Ben Ferguson, Francisco Souza Dias, Rae Huggins, Kylee Welk, Olivia King, Jennifer Strauss, Matt Sinclair, Shaun Fisher, Stephen Wallace, Cesar A Villa, Cameron Roberts, Jordan Glen, Dane Goddard, Jessica-Lee Orreal, Alexander Bezzina, Emma Arnett, Dane Hawes, Eleanor Smith, Ben Houseman, Megan Skelton, David Keenan, Hayley Kaminski, Owen Carey-Foster and Daniel Livsey.

Disclaimer

APPENDIX A: HYDROGRAPH PLOTS OF DISCHARGE AND SAMPLE COLLECTION ILLUSTRATING SAMPLE REPRESENTIVITY FOR LOADS

Figures in Appendix A are presented in the order of the location of the catchment in Queensland from north to south.

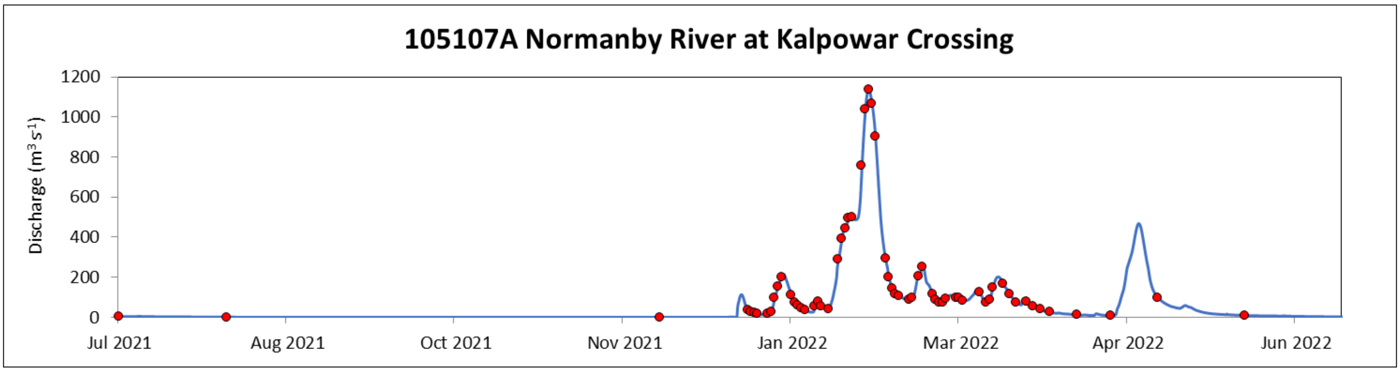


Figure 13 Hydrograph showing modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Normanby River at Kalpowar Crossing between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

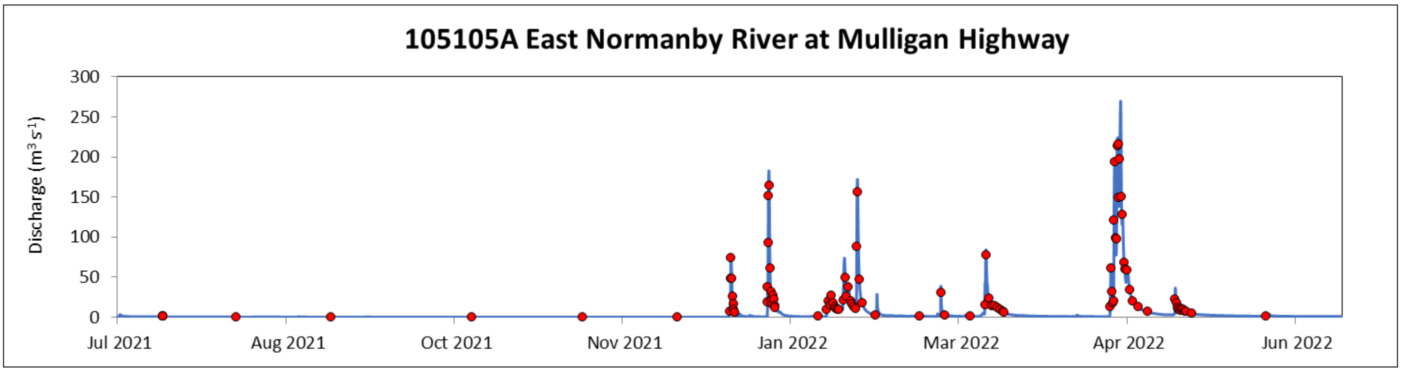


Figure 14 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the East Normanby River at Mulligan Highway between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

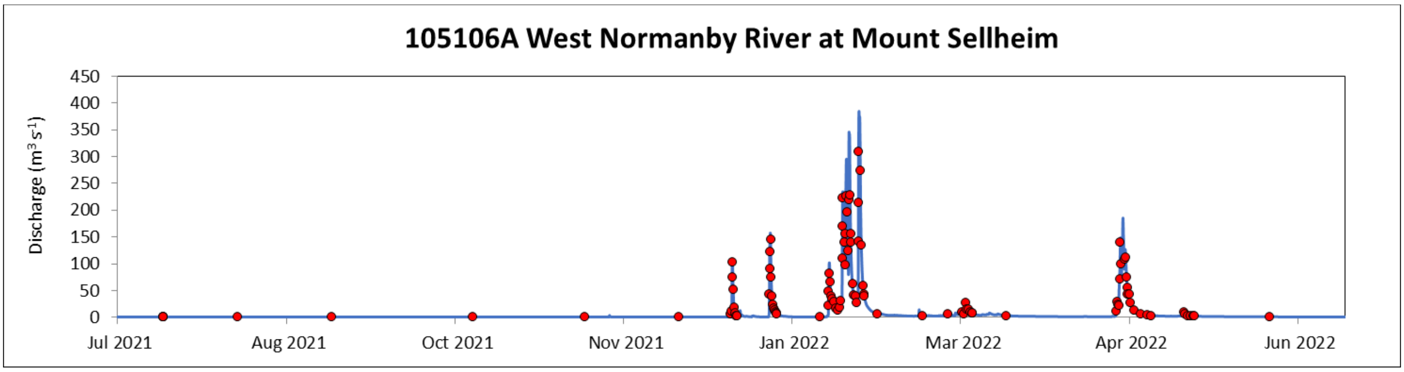


Figure 15 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the West Normanby River at Mount Sellheim between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

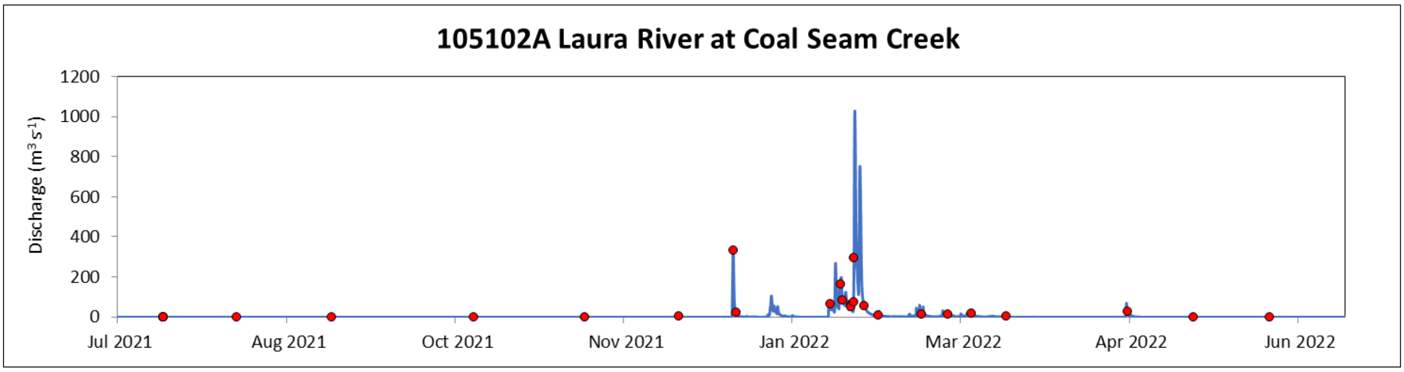


Figure 16 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Laura River at Coal Seam Creek between 1 July 2021 and 30 June 2022. Representivity rating was moderate for all analytes.

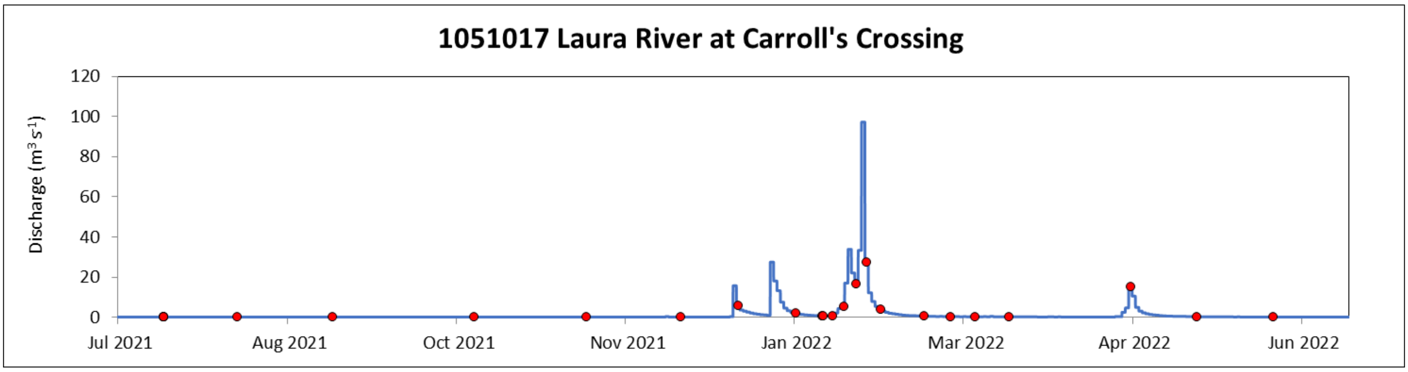


Figure 17 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Laura River at Carroll's Crossing between 1 July 2021 and 30 June 2022. Representivity rating was indicative for all analytes.

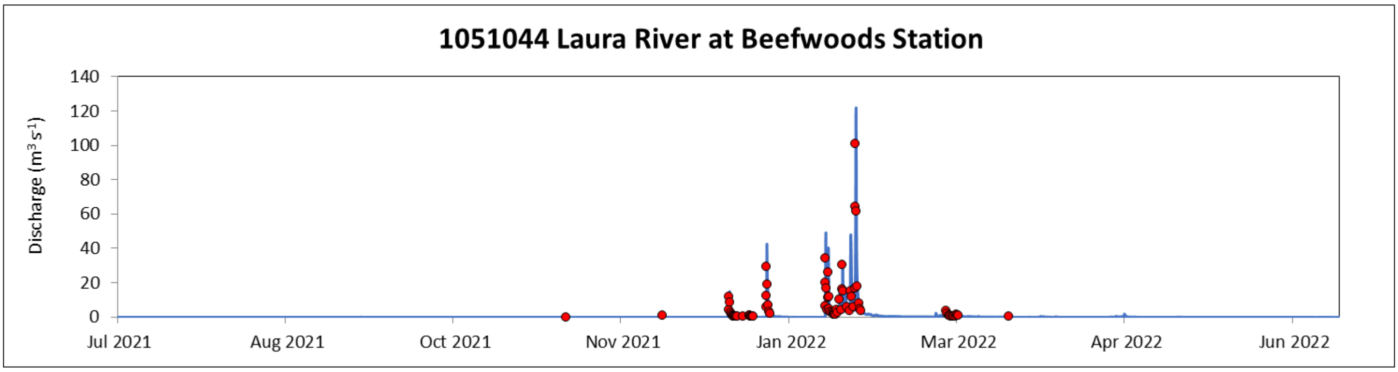


Figure 18 Hydrograph showing measured and modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Laura River at Beefwoods Station between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

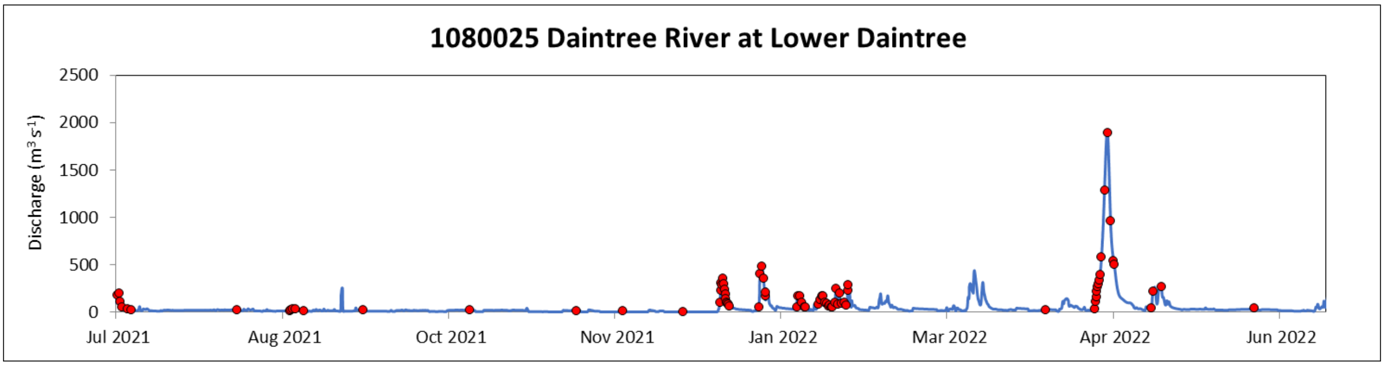


Figure 19 Hydrograph showing measured and modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Daintree River at Lower Daintree between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

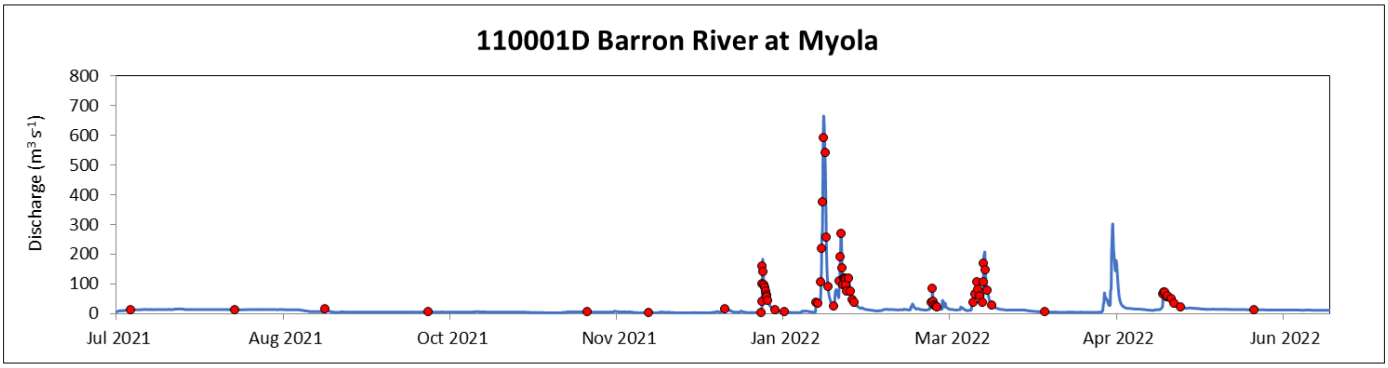


Figure 20 Hydrograph showing measured and modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Barron River at Myola between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

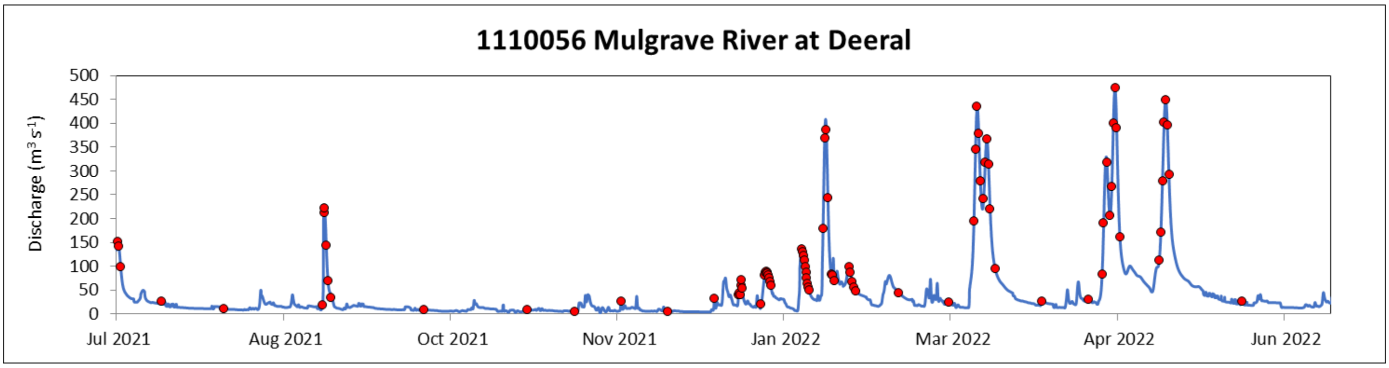


Figure 21 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Mulgrave River at Deeral between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

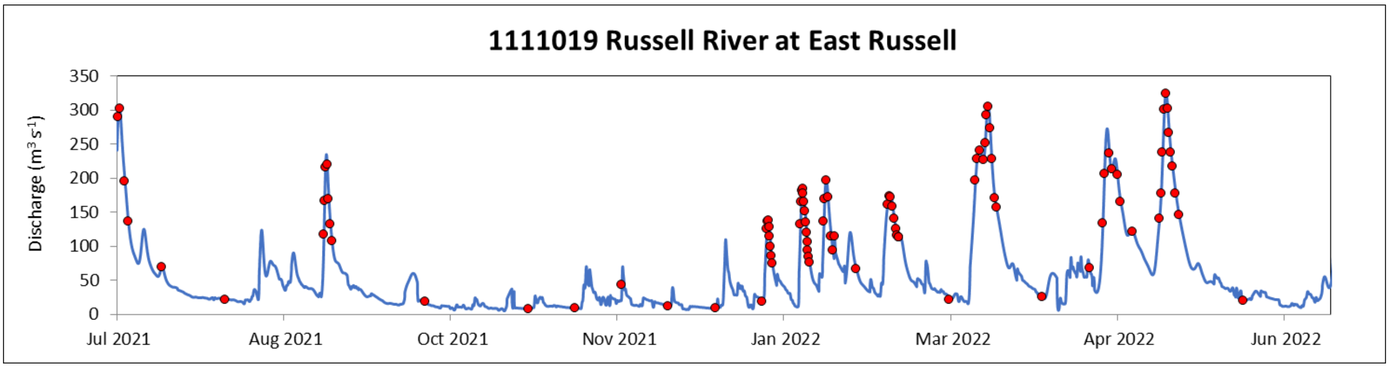


Figure 22 Hydrograph showing measured and modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Russell River at East Russell between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

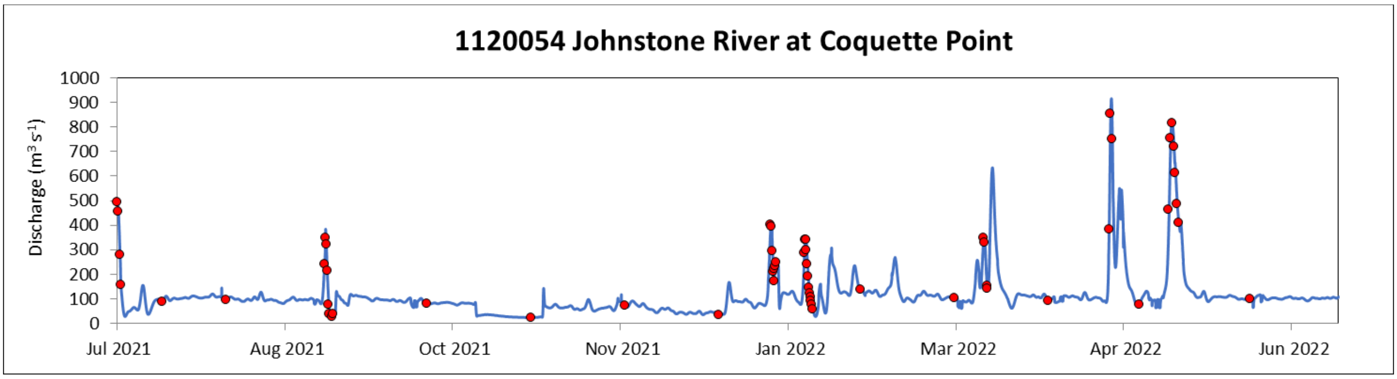


Figure 23 Hydrograph showing measured and modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Johnstone River at Coquette Point between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

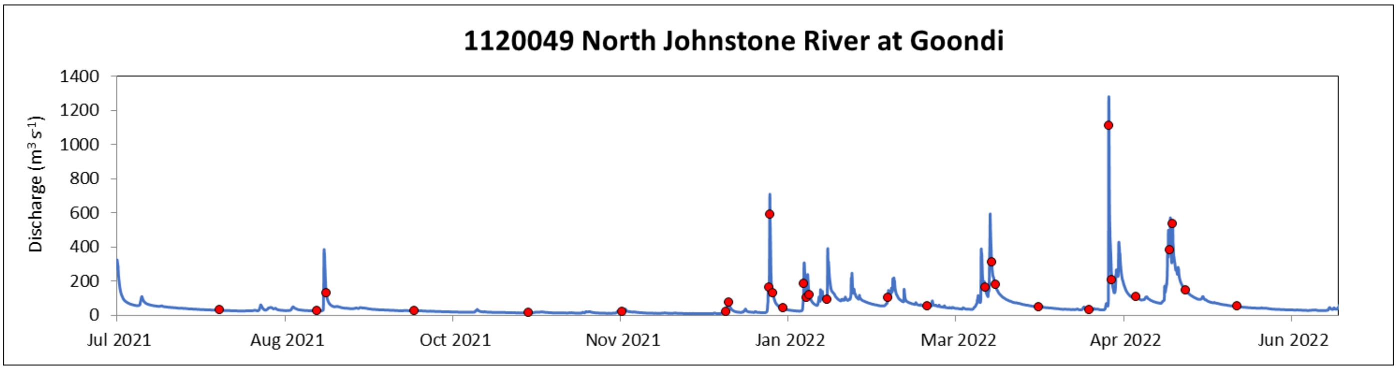


Figure 24 Hydrograph showing measured and modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the North Johnstone River at Goondi between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

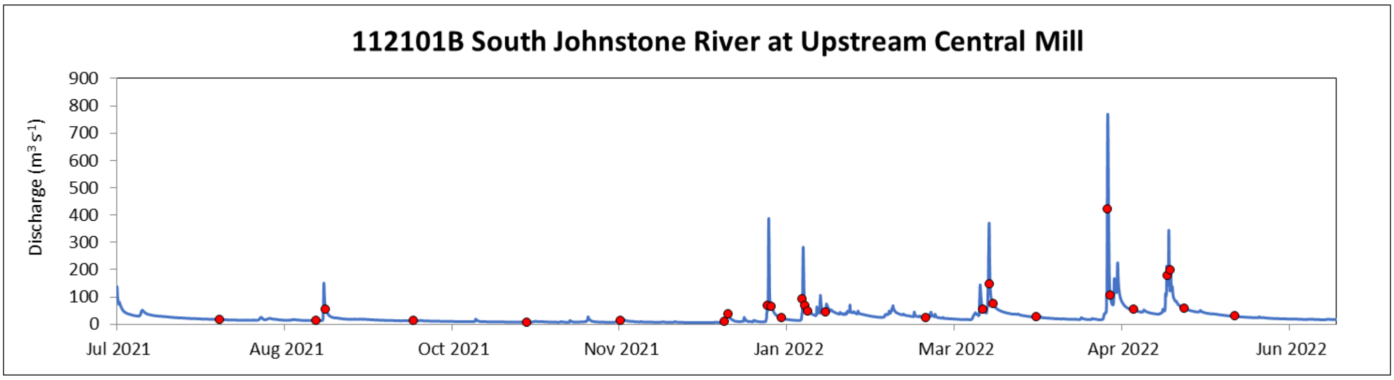


Figure 25 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the South Johnstone River at Upstream Central Mill between 1 July 2021 and 30 June 2022. Representivity rating was moderate for all analytes.

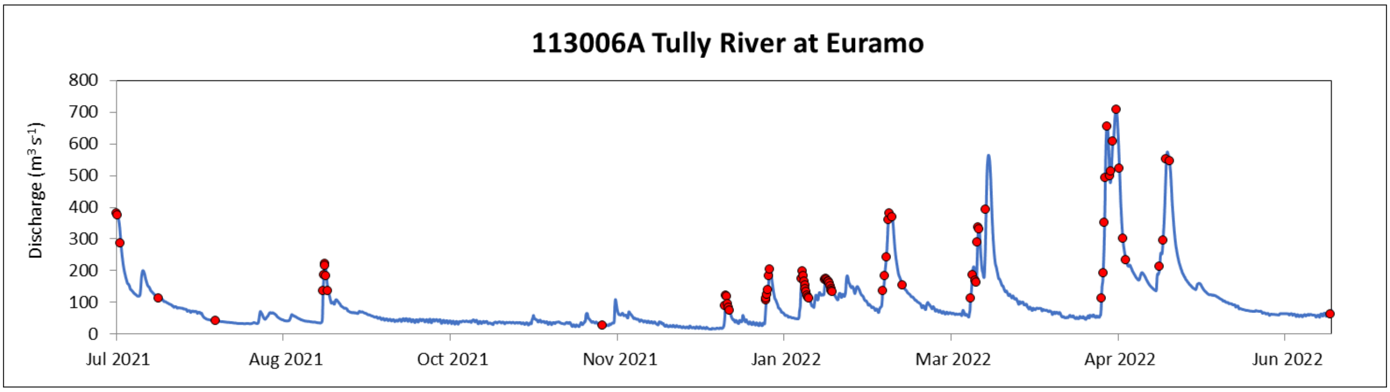


Figure 26 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Tully River at Euramo between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

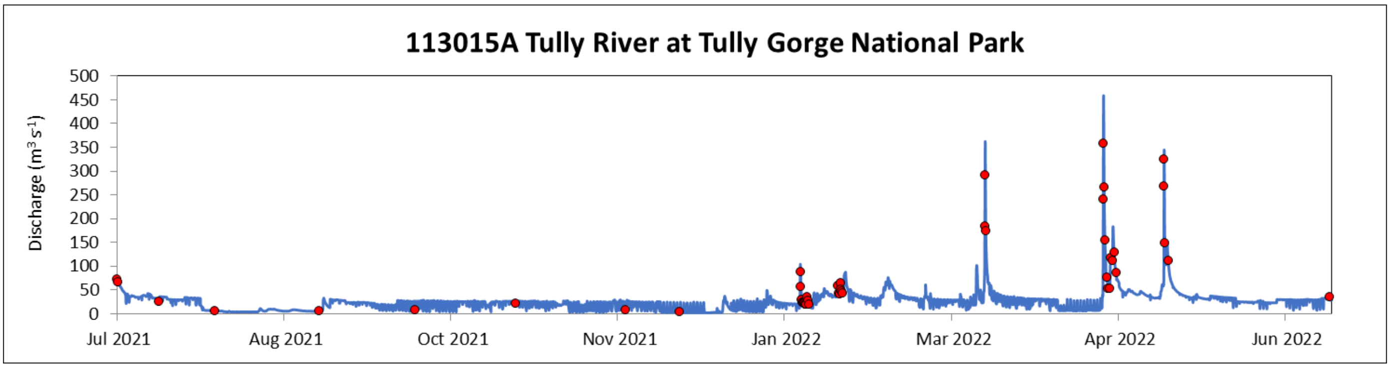


Figure 27 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Tully River at Tully Gorge National Park between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

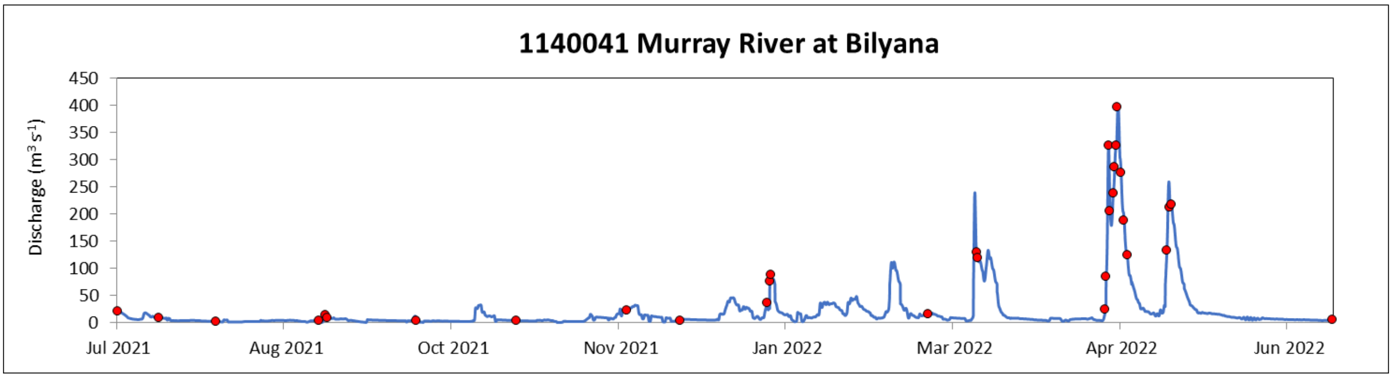


Figure 28 Hydrograph showing measured and modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Murray River at Bilyana between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

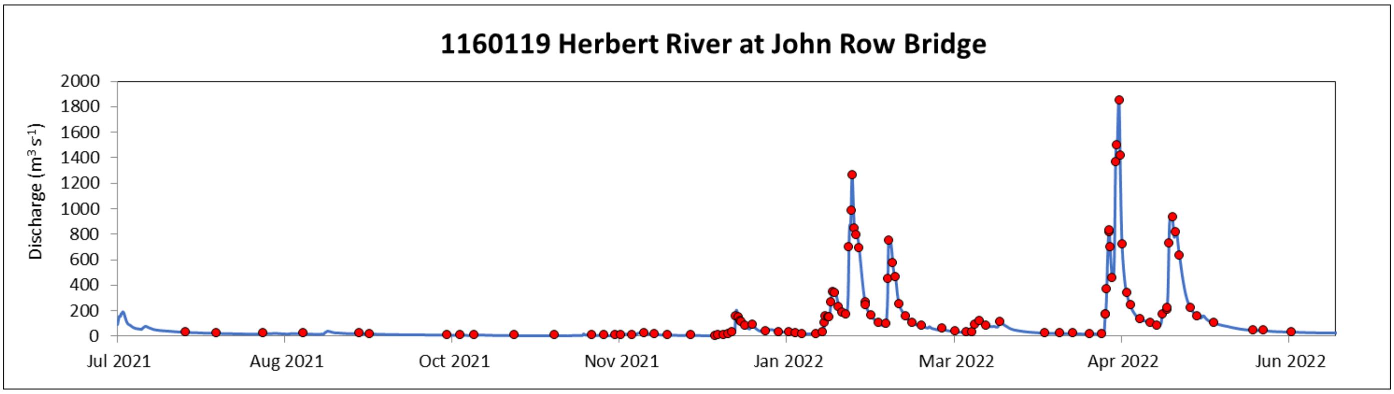


Figure 29 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Herbert River at John Row Bridge between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

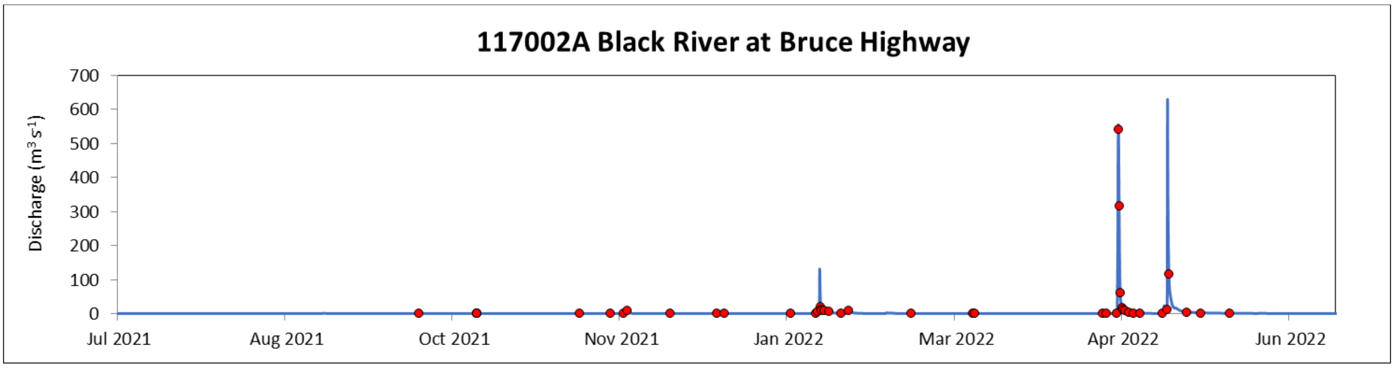


Figure 30 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Black River at Bruce Highway between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

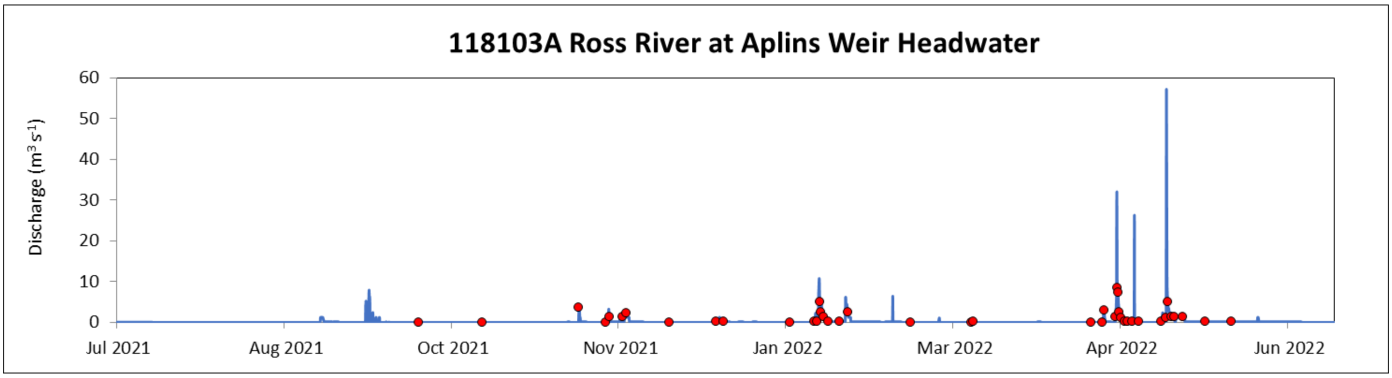


Figure 31 Hydrograph showing modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Ross River at Aplins Weir Headwater between 1 July 2021 and 30 June 2022. Representivity rating was indicative for all analytes.

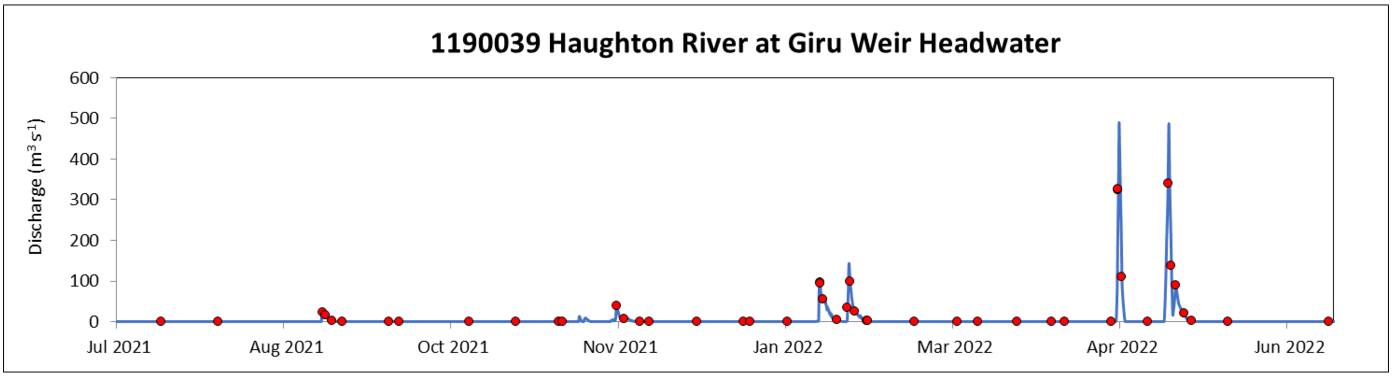


Figure 32 Hydrograph showing measured and modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Haughton River at Giru Weir Headwater between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

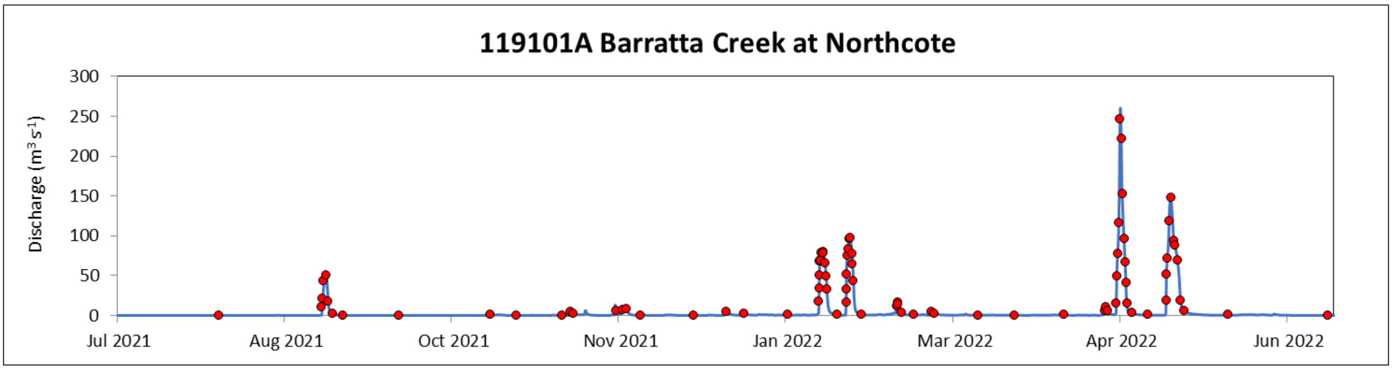


Figure 33 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Barratta Creek at Northcote between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analyes.

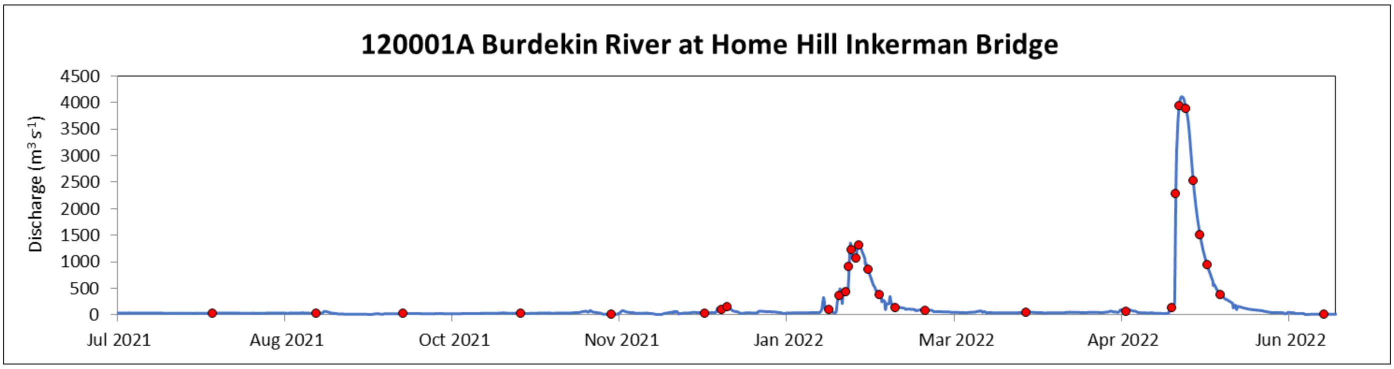


Figure 34 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Burdekin River at Home Hill Inkerman Bridge between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

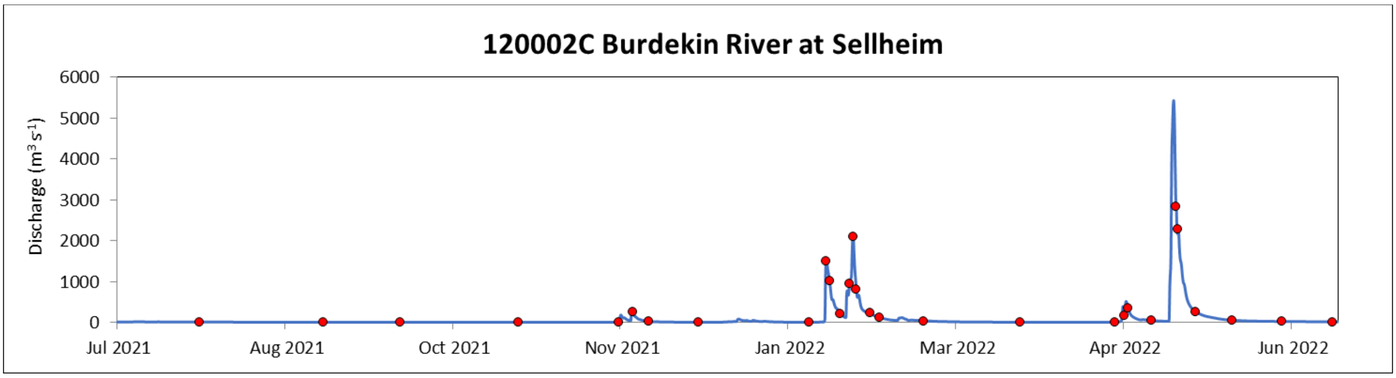


Figure 35 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Burdekin River at Sellheim between 1 July 2021 and 30 June 2022. Representivity rating was moderate for all analytes.

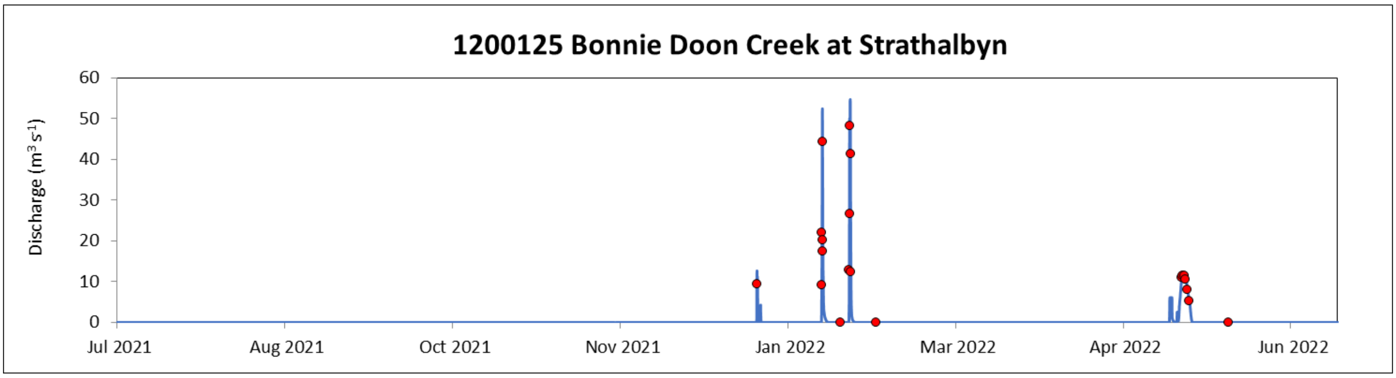


Figure 36 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients (red circles) in the Bonnie Doon Creek at Strathalbyn between 1 July 2021 and 30 June 2022. Representivity rating was good for total suspended solids and total nutrients.

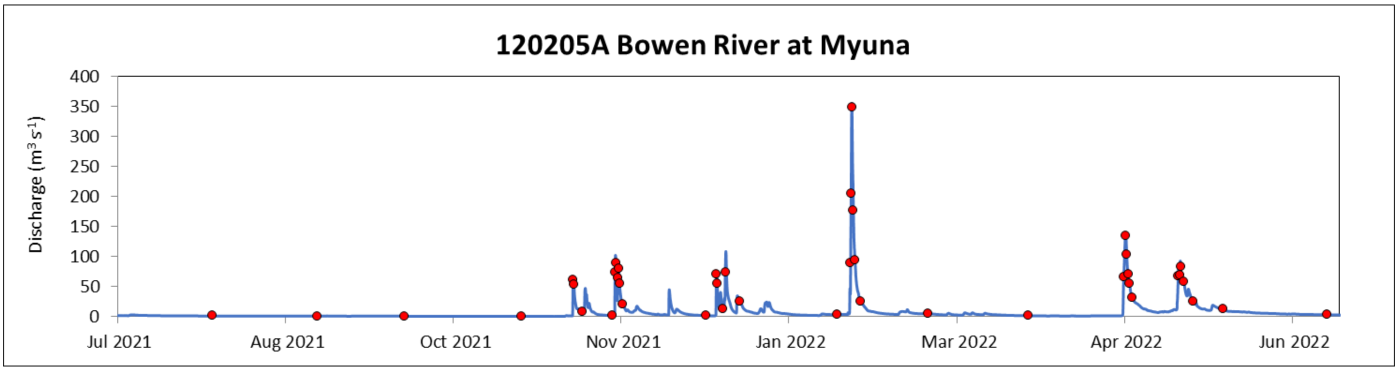


Figure 37 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Bowen River at Myuna between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

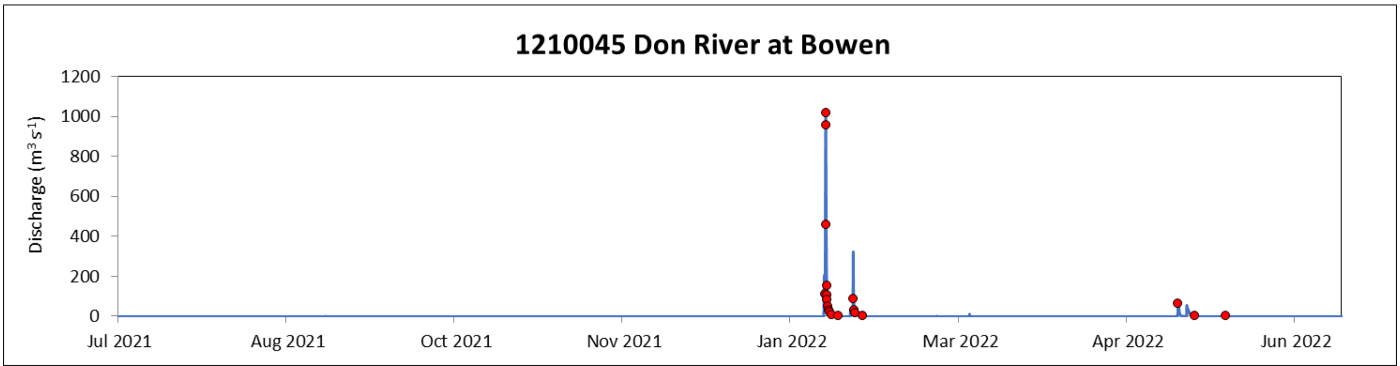


Figure 38 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Don River at Bowen between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

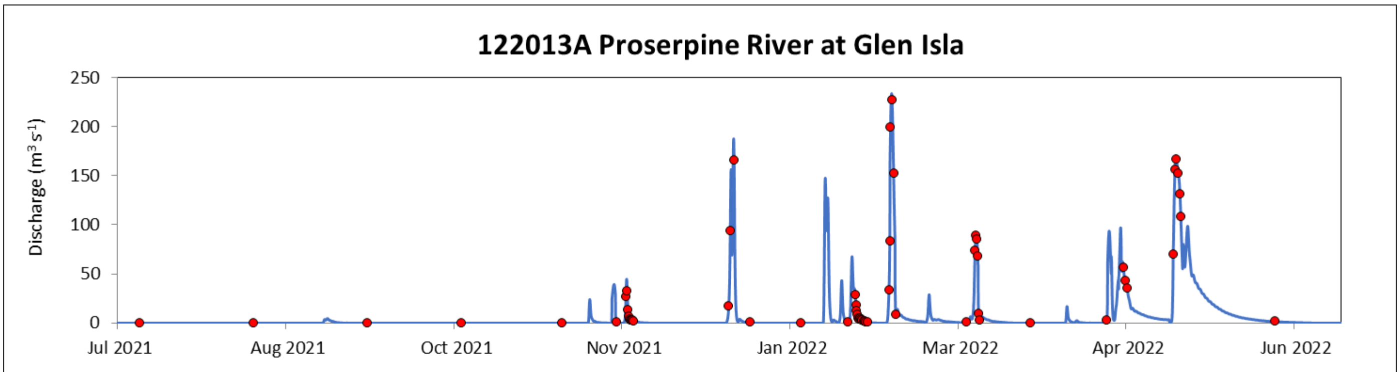


Figure 39 Hydrograph showing measured and modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Proserpine River at Glen Isla between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

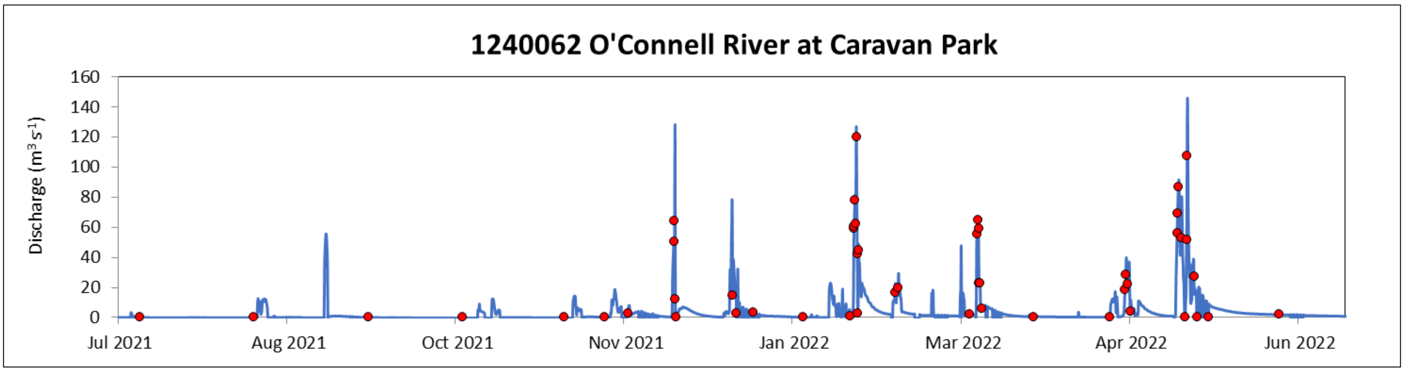


Figure 40 Hydrograph showing measured and modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the O'Connell River at Caravan Park between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

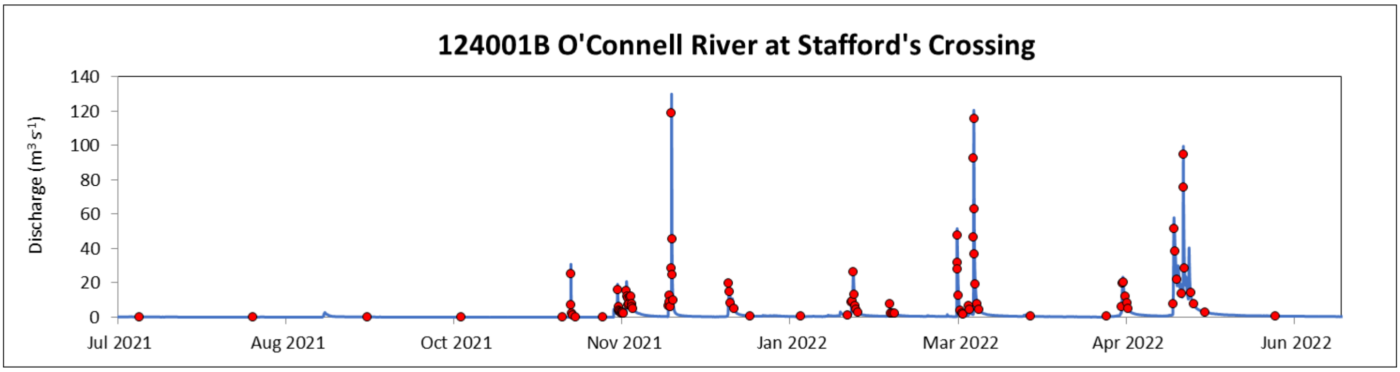


Figure 41 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the O'Connell River at Stafford's Crossing between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

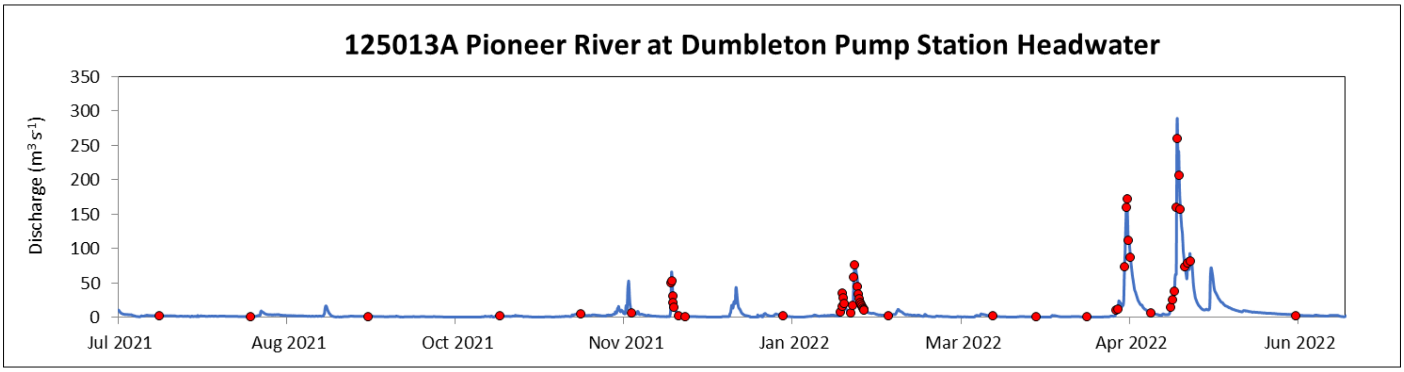


Figure 42 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Pioneer River at Dumbleton Pump Station Headwater between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

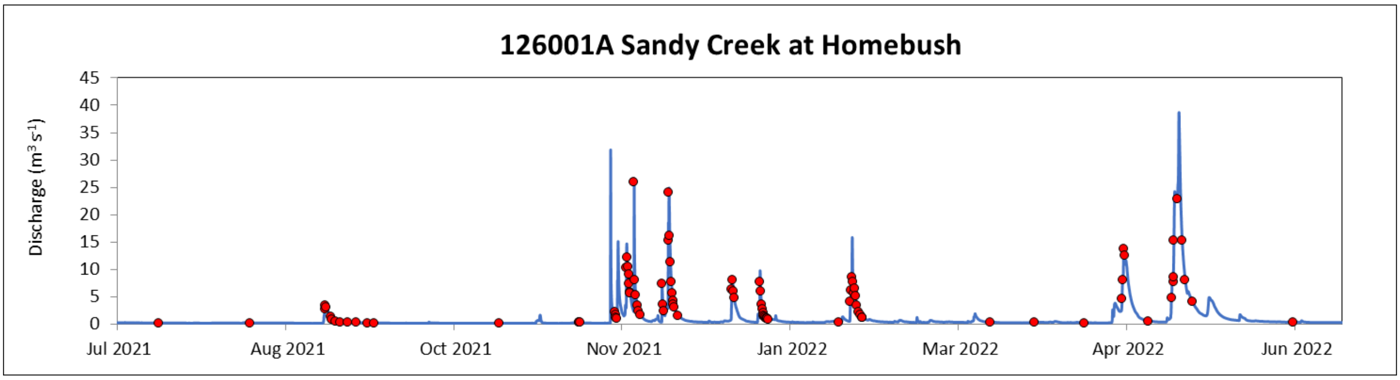


Figure 43 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in Sandy Creek at Homebush between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

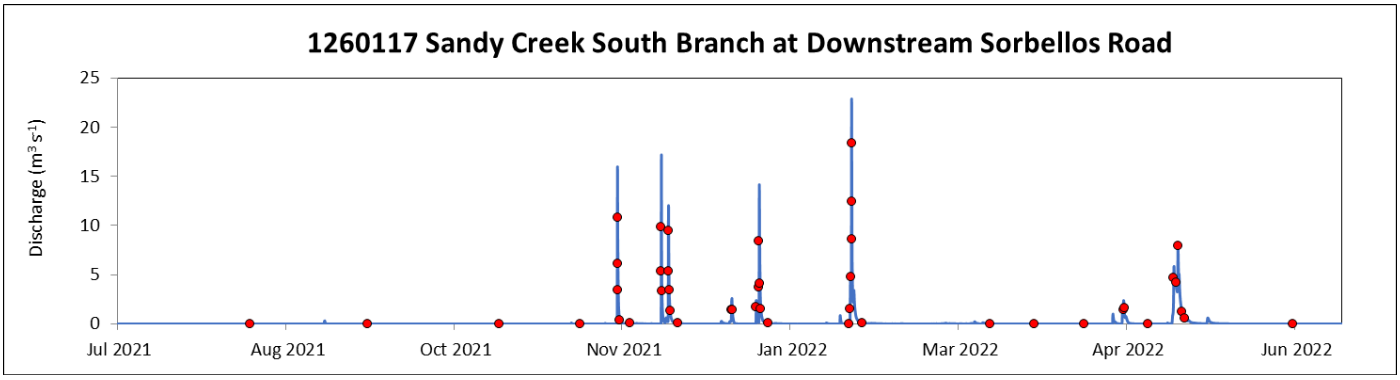


Figure 44 Hydrograph showing modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in Sandy Creek South Branch at Downstream Sorbellos Road between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

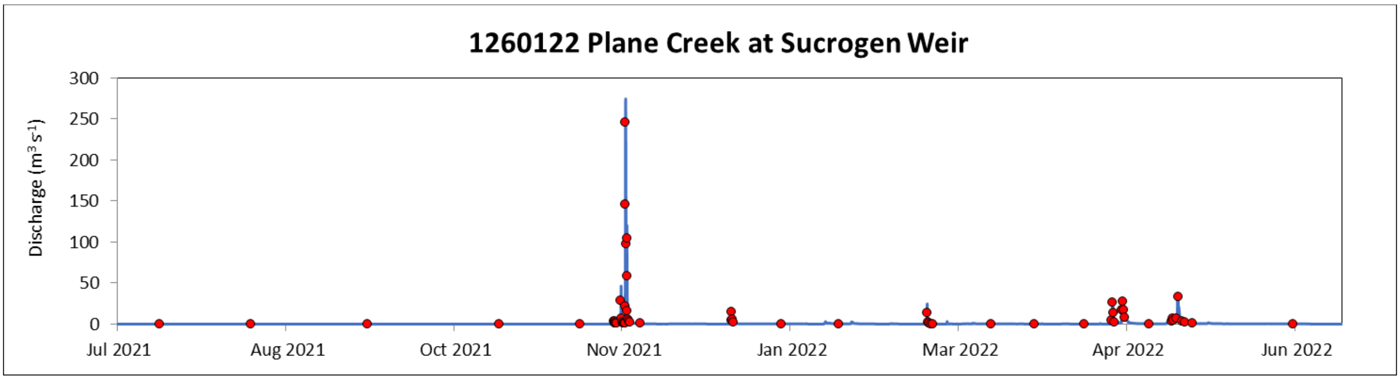


Figure 45 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in Plane Creek at Sucrogen Weir between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

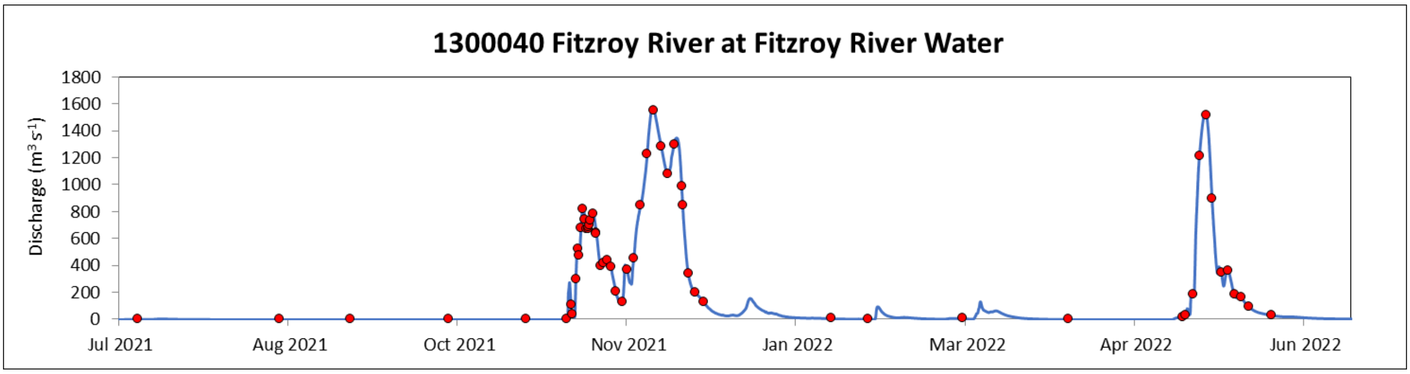


Figure 46 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in Fitzroy River at Fitzroy River Water between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

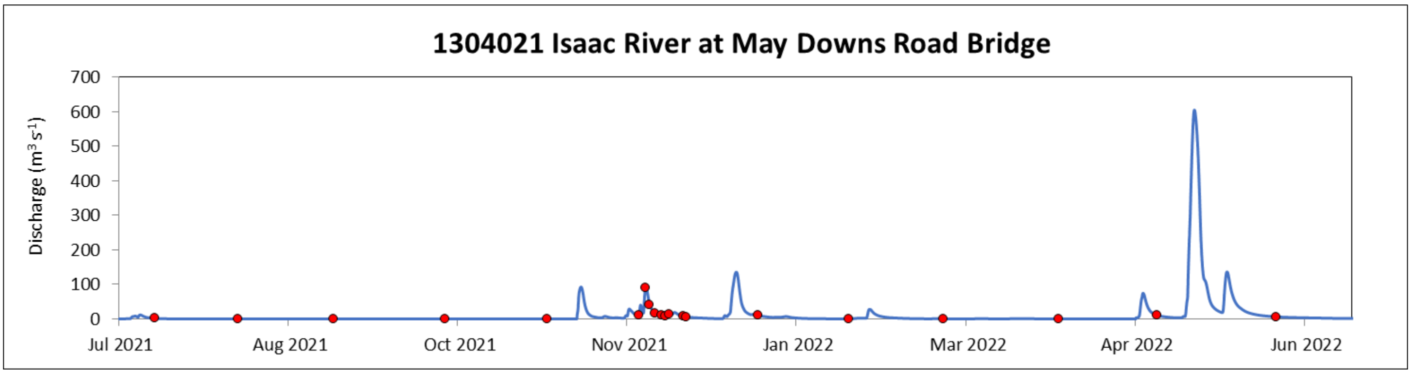


Figure 47 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Isaac River at May Downs Road Bridge between 1 July 2021 and 30 June 2022. Representivity rating was indicative for all analytes.

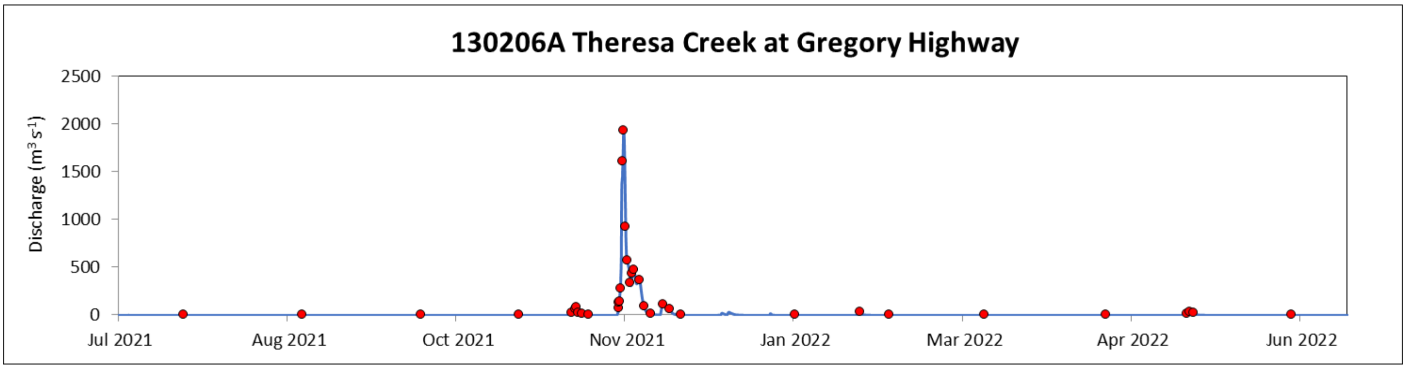


Figure 48 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Theresa Creek at Gregory Highway between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

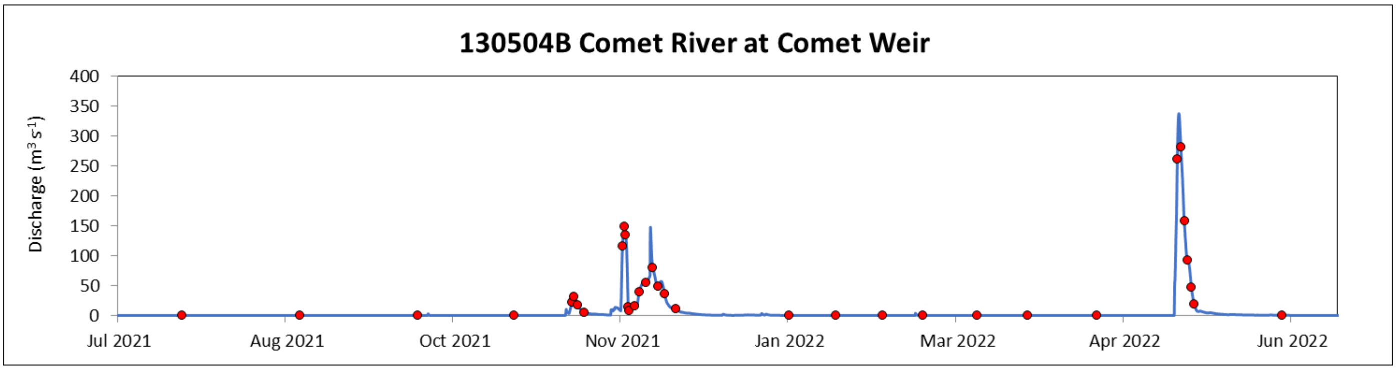


Figure 49 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Comet River at Comet Weir between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

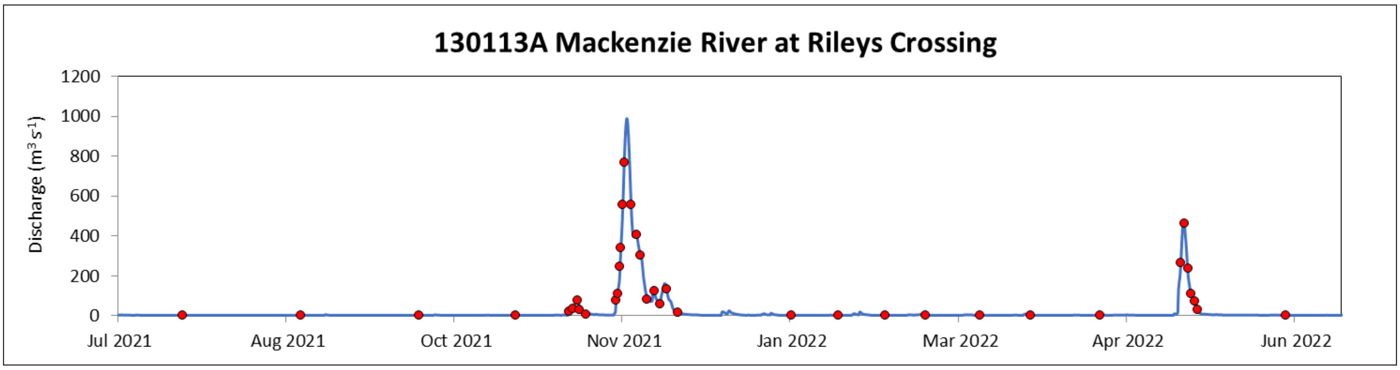


Figure 50 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Mackenzie River at Rileys Crossing between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

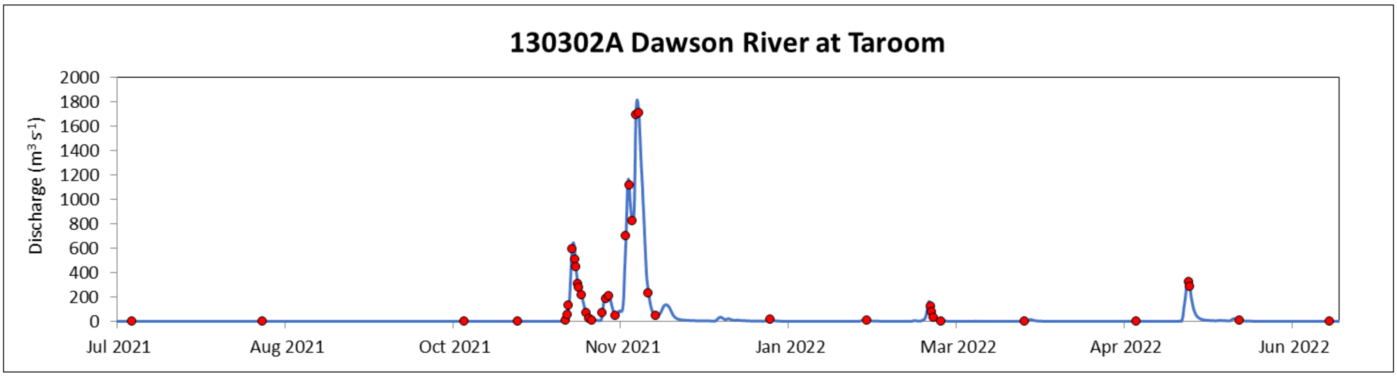


Figure 51 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Dawson River at Taroom between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

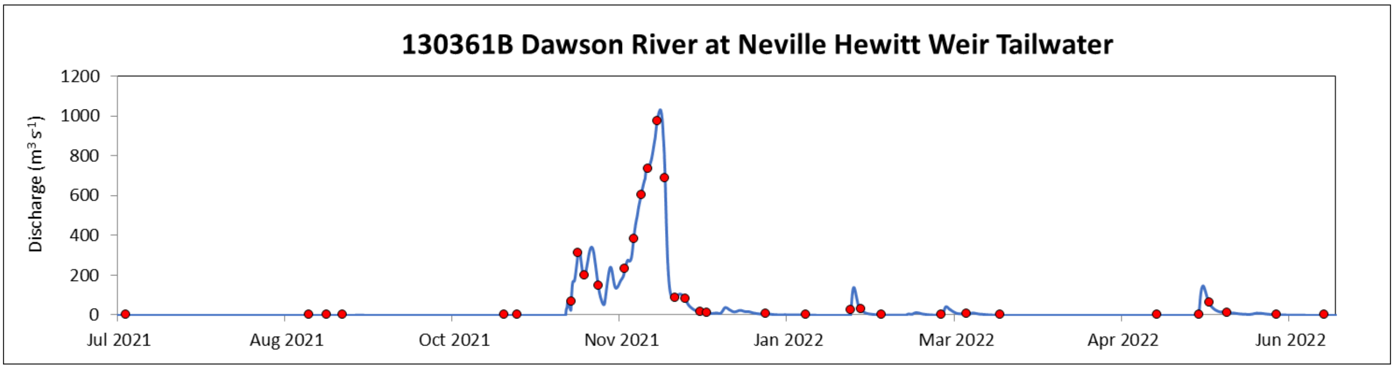


Figure 52 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Dawson River at Neville Weir Tailwater between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

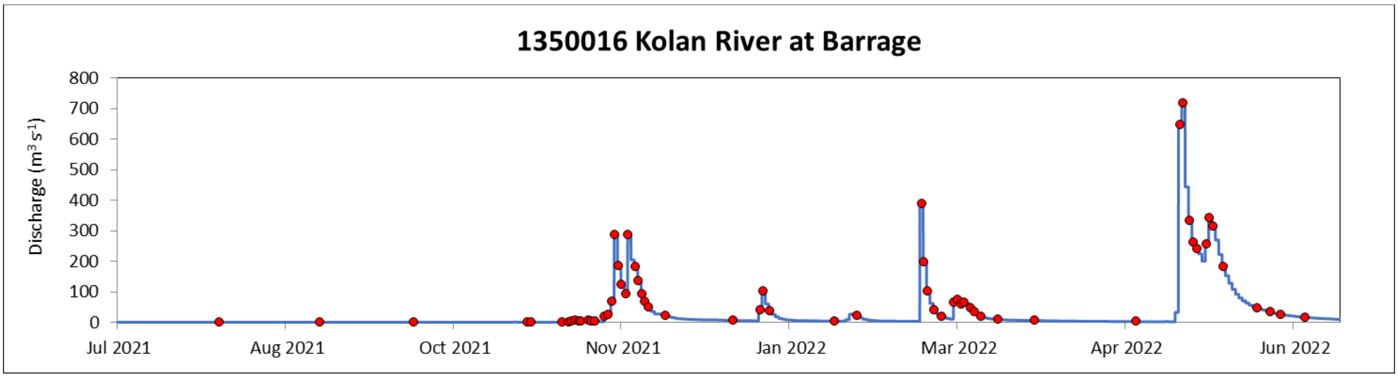


Figure 53 Hydrograph showing modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Kolan River at Barrage between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

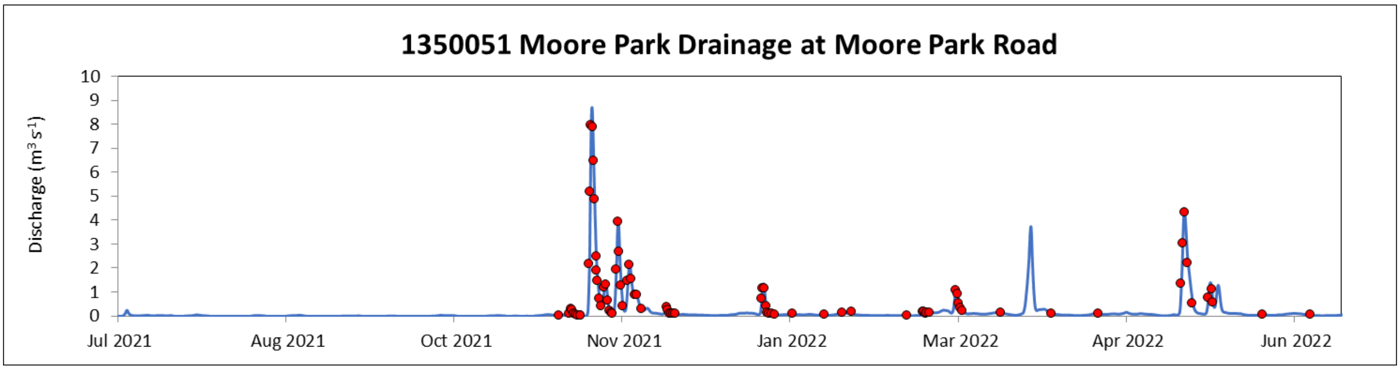


Figure 54 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Moore Park Drainage at Moore Park Road between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

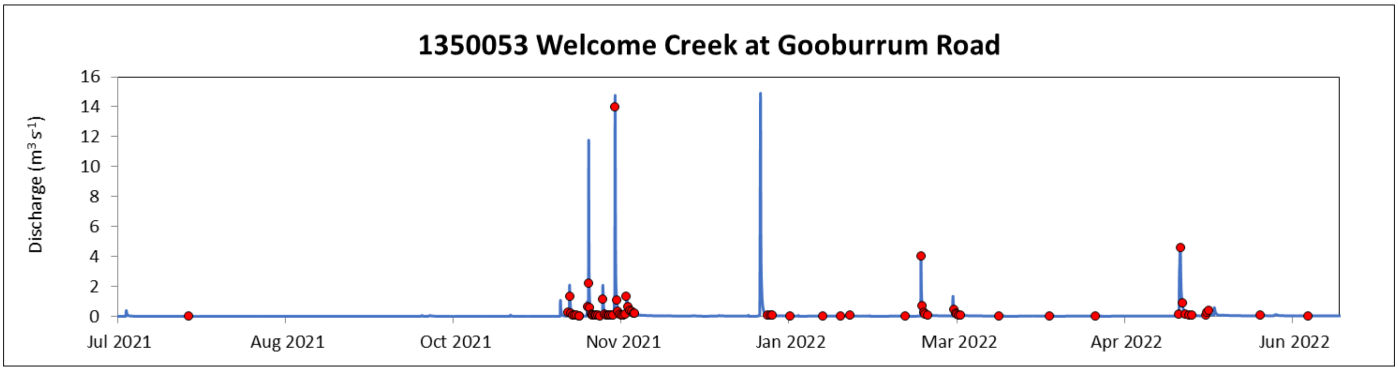


Figure 55 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Welcome Creek at Gooburrum Road between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

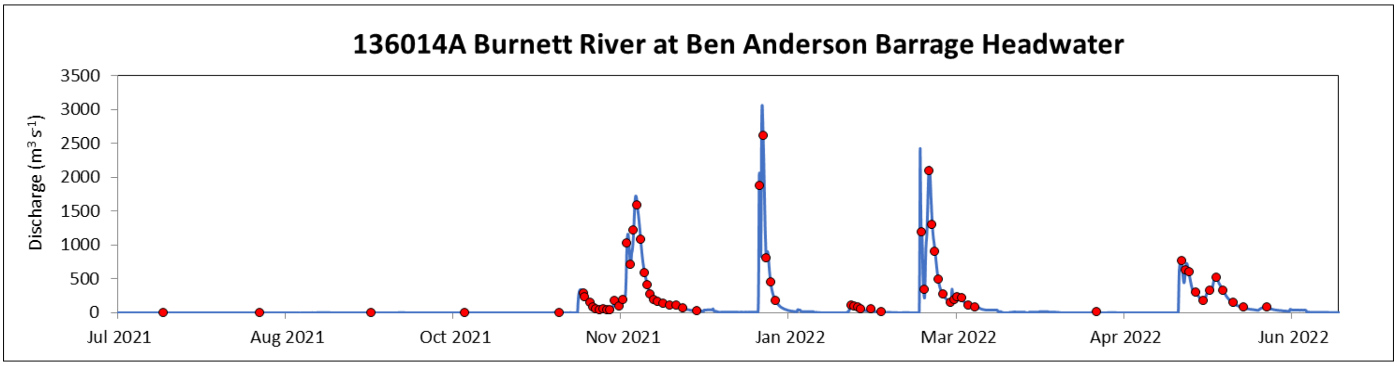


Figure 56 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Burnett at Ben Anderson Barrage Headwater between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

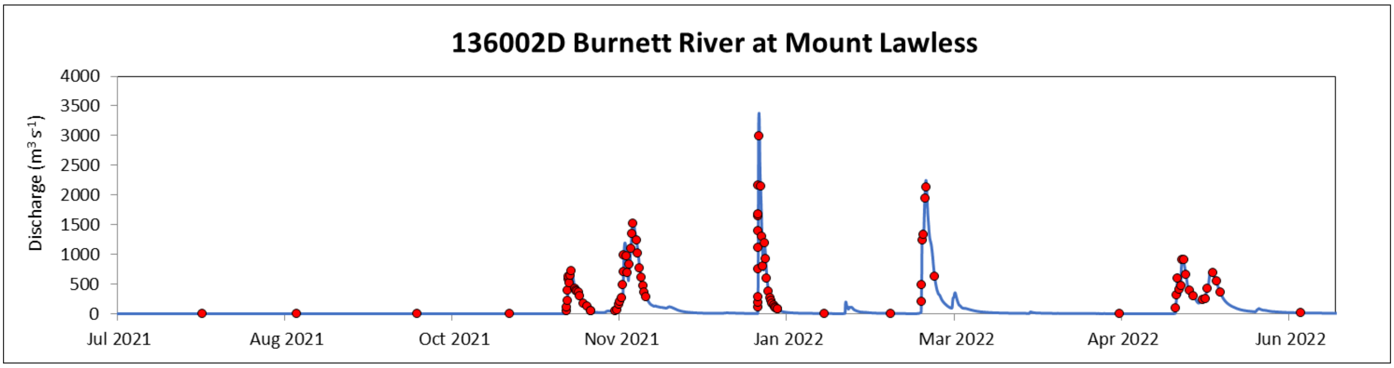


Figure 57 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Burnett River at Mount Lawless between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

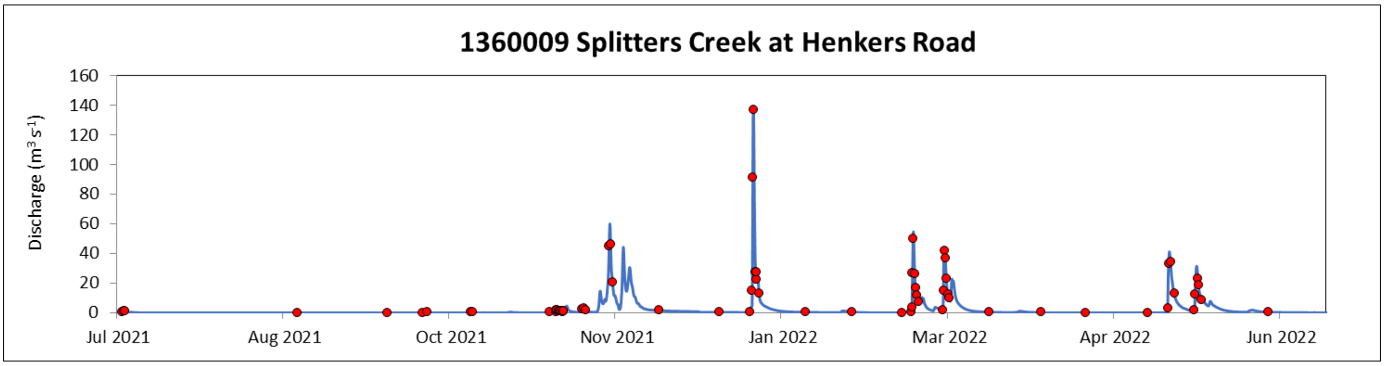


Figure 58 Hydrograph showing modelled discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Splitters Creek at Henkers Road between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

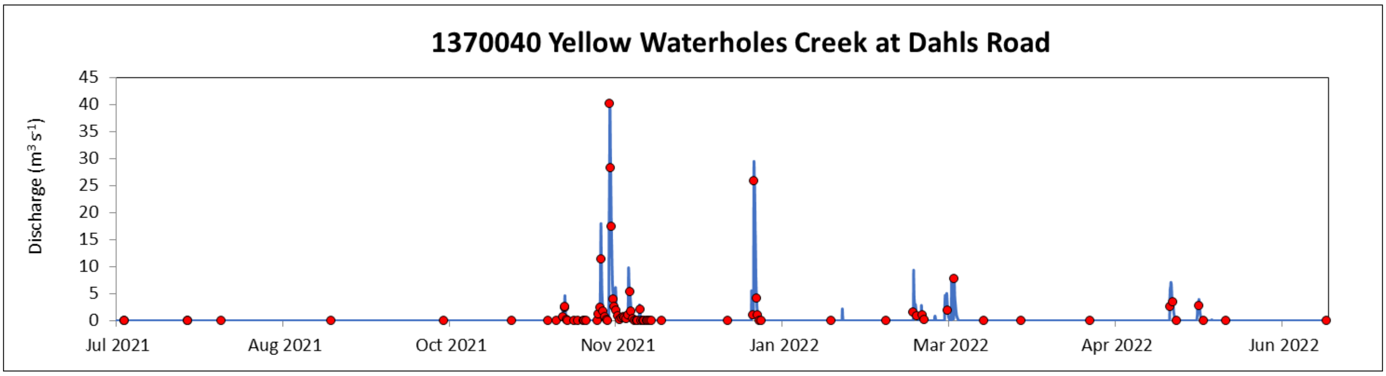


Figure 59 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Yellow Waterholes at Dahls Road between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

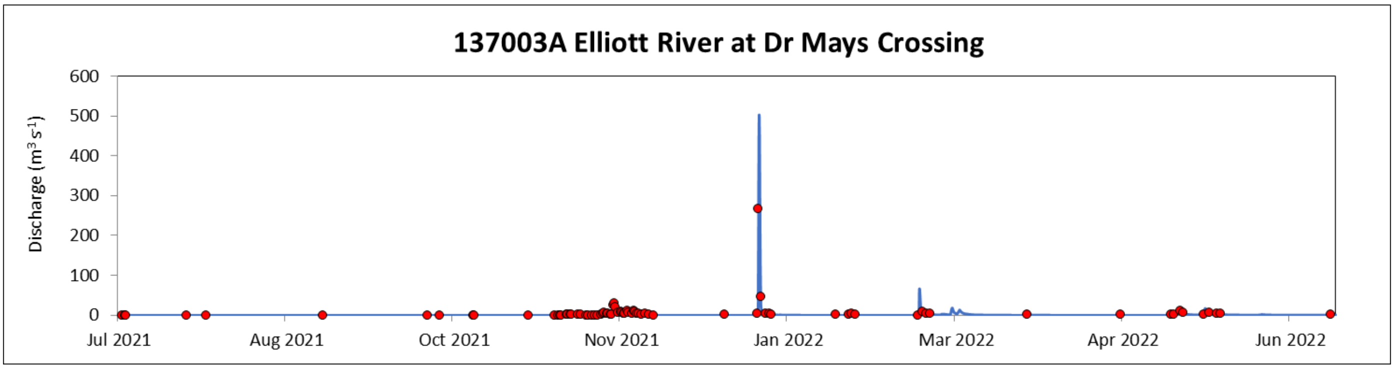


Figure 60 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Elliot River at Dr Mays Crossing between 1 July 2021 and 30 June 2022. Representivity rating was moderate for all analytes.

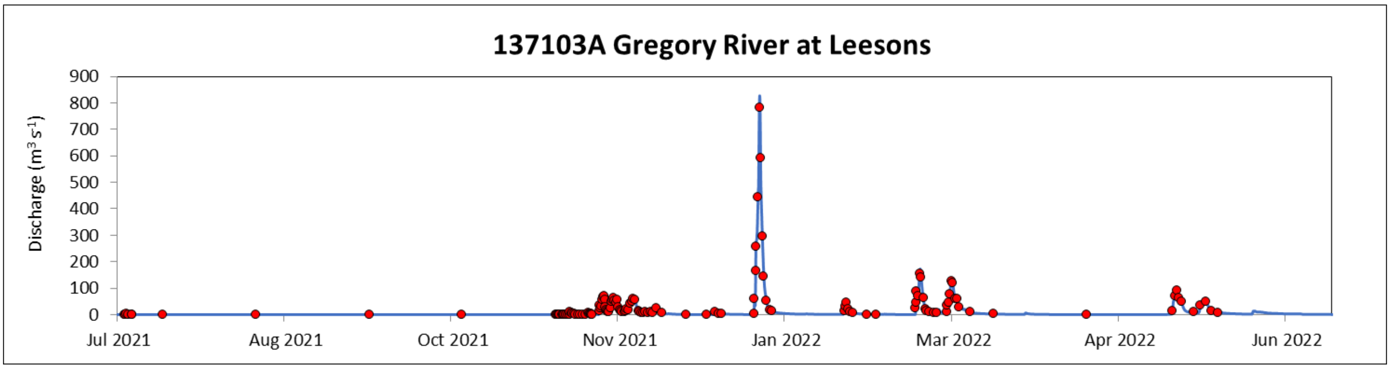


Figure 61 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Gregory River at Leesons between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

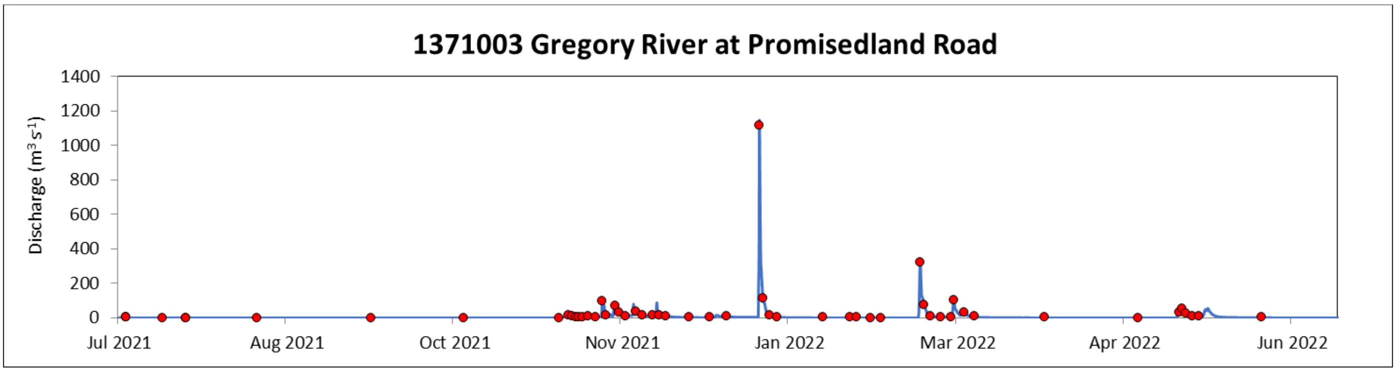


Figure 62 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Gregory River at Promiseland Road between 1 July 2021 and 30 June 2022. Representivity rating was good for all analytes.

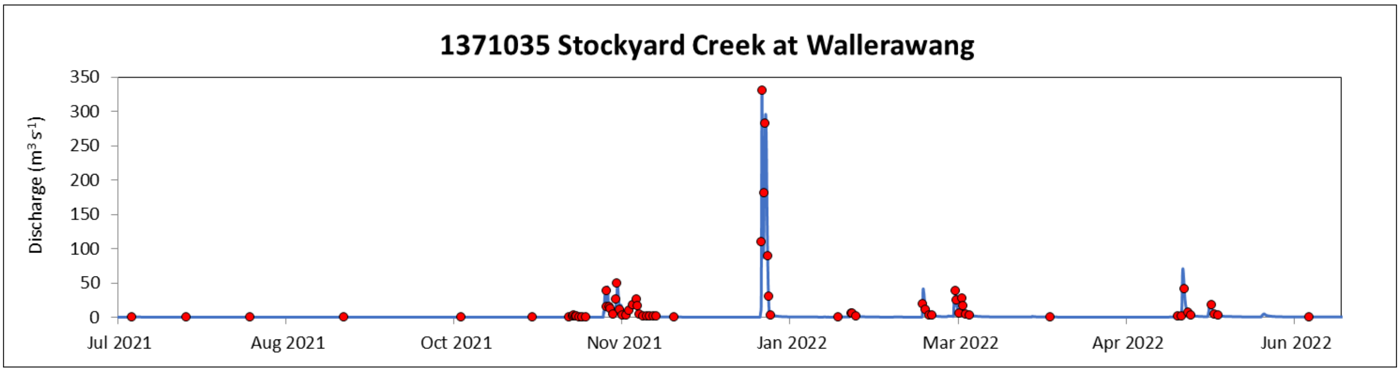


Figure 63 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Stockyard Creek at Wallerawang between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

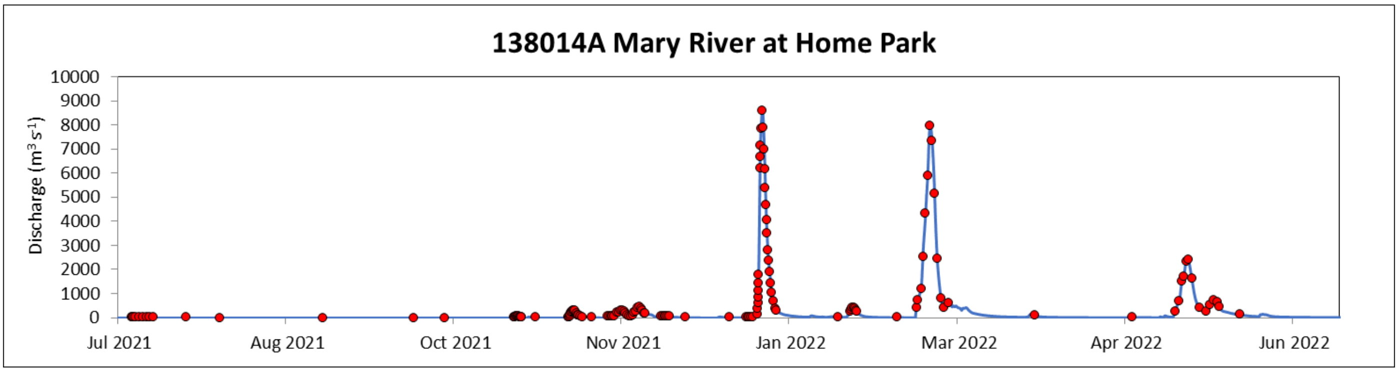


Figure 64 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Mary River at Home Park between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

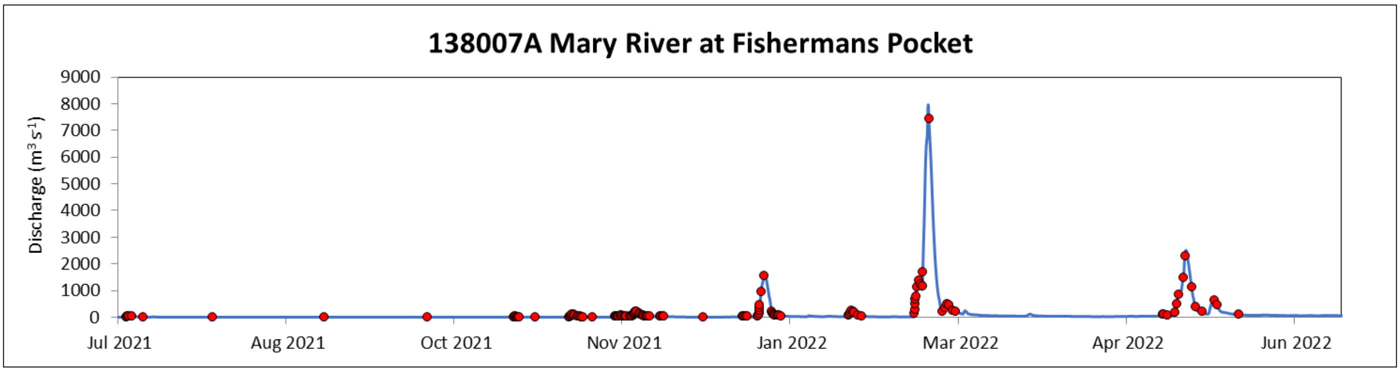


Figure 65 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Mary River at Fishermans Pocket between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

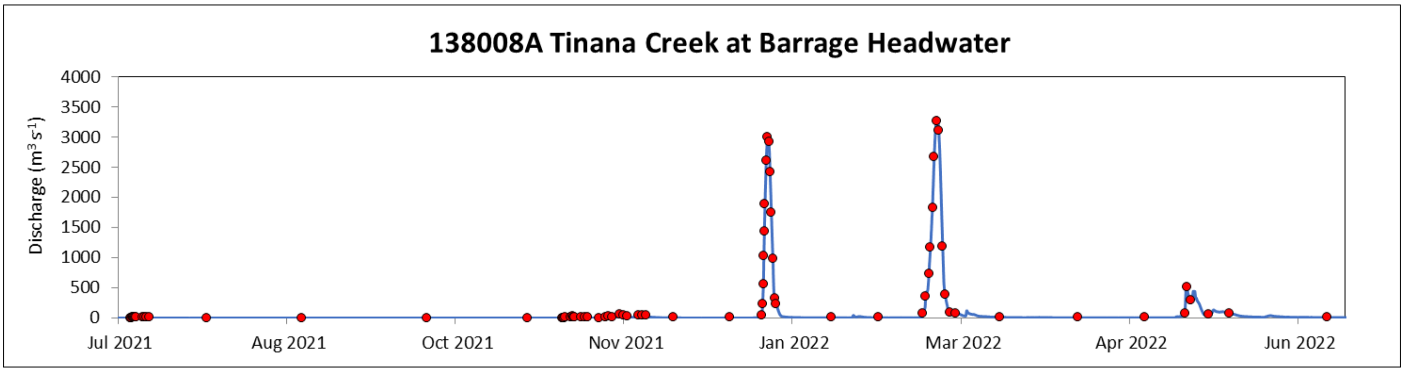


Figure 66 Hydrograph showing measured discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Tinana Creek at Barrage Headwater between 1 July 2021 and 30 June 2022. Representivity rating was excellent for all analytes.

APPENDIX B: CALCULATION OF DISCHARGE DATA FOR 2021-2022 MONITORING YEAR

This appendix contains the calculation method used to prepare discharge data for the 2021-2022 Great Barrier Reef Catchment Loads Monitoring Program Condition Report. Sites listed in Table 1 of Appendix B are presented in the order of the location of the catchment in Queensland from north to south.

Table 1 Calculation method used to prepare discharge data for the 2021-2022 reporting year, including the application of time and flow factors where required.

Gauging station	River and site name	Discharge calculation
105107A	Normanby River at Kalpowar Crossing	Measured
105105A	East Normanby River at Mulligan Highway	Measured
105106A	West Normanby River at Mount Sellheim	Measured
105102A	Laura River at Coal Seam Creek	Measured
1051017	Laura River at Carroll's Crossing	Modelled
1051044	Laura River at Beefwoods Station	Measured and Modelled*
1080025	Daintree River at Lower Daintree	Measured and Modelled*
110001D	Barron River at Myola	Measured
1110056	Mulgrave River at Deeral	Measured and Modelled*
1111019	Russell River at East Russell	Measured and Modelled*
1120049	North Johnstone River at Goondi	Measured and Modelled* *(flow factored from 112004A North Johnstone River at Tung Oil)*
1120054	Johnstone River at Coquette Point	Measured
112101B	South Johnstone River at Upstream Central Mill	Measured
113006A	Tully River at Euramo	Measured
113015A	Tully River at Tully Gorge National Park	Measured
1140041	Murray River at Bilyana	Measured and Modelled*
1160119	Herbert River at John Row Bridge	Measured *(flow factored from 116001F Herbert River at Ingham)*
117002A	Black River at Bruce Highway	Measured
118103A	Ross River at Aplins Weir Headwater	Modelled
1190039	Haughton River at Giru Weir Headwater	Measured and Modelled*
119101A	Barratta Creek at Northcote	Measured
120001A	Burdekin River at Home Hill Inkerman Bridge	Measured *(flow factored from 120006B Burdekin River at Clare)*
120002C	Burdekin River at Sellheim	Measured
1200125	Bonnie Doon Creek at Strathalbyn	Measured

Gauging station	River and site name	Discharge calculation
120205A	Bowen River at Myuna	Measured
1210045	Don River at Bowen	Measured *(flow factored from 121003A Don River at Reeves)*
122013A	Proserpine River at Glen Isla	Measured and Modelled*
1240062	O'Connell River at Caravan Park	Measured and Modelled*
124001B	O'Connell River at Stafford's Crossing	Measured
125013A	Pioneer River at Dumbleton Pump Station Headwater	Measured *(flow factored from 125016A Pioneer River at Dumbleton Weir Tailwater)*
126001A	Sandy Creek at Homebush	Measured
1260117	Sandy Creek South Branch at Downstream Sorbellos Road	Measured and Modelled*
1260122	Plane Creek at Sucrogen Weir	Measured and Modelled*
1300040	Fitzroy River at Fitzroy River Water	Measured *(flow factored from 130005A Fitzroy River at the Gap where* $Time_{1300000} = Time_{130005A} + 14.5hrs$*)*
1304021	Isaac River at May Downs Road Bridge	Measured *(flow factored from 130401A Isaac River at Yatton)*
130206A	Theresa Creek at Gregory Highway	Measured
130504B	Comet River at Comet Weir	Measured
130113A	Mackenzie River at Rileys Crossing	Measured
130302A	Dawson River at Taroom	Measured
130361B	Dawson River at Neville Hewitt Weir Tailwater	Measured *(flow factored from 130322A Dawson River at Beckers)*
1350016	Kolan River at Barrage	Modelled
1350051	Moore Park Drainage at Moore Park Road	Measured
1350053	Welcome Creek at Gooburrum Road	Measured
136014A	Burnett River at Ben Anderson Barrage Headwater	Measured *(flow factored from 136007A Burnett River at FigTree Creek & 136011A Degilbo Creek at Coringa where* $Discharge_{136014A} = Discharge_{136007A} + Discharge_{136011A}$*)*
136002D	Burnett River at Mount Lawless	Measured
1360009	Splitters Creek at Henkers Road	Modelled
1370040	Yellow Waterholes Creek at Dahls Road	Measured
137003A	Elliott River at Dr Mays Crossing	Measured
137103A	Gregory River at Leesons	Measured
1371003	Gregory River at Promisedland Road	Measured

Gauging station	River and site name	Discharge calculation
1371035	Stockyard Creek at Wallerawang	Measured
138014A	Mary River at Home Park	Measured
138007A	Mary River at Fishermans Pocket	Measured
138008A	Tinana Creek at Barrage Headwater	Measured#

* Discharge monitoring was made possible due to the installation of Horizontal Acoustic Doppler Current Profiler (HADCP) technology, as these sites are heavily affected by tidal flows. See Appendix C for a detailed breakdown of the source of discharge data used for load calculation at these sites.

At sites with managed discharge (e.g. gated weirs), measured flows take into account variations in cross-section that result from active releases from infrastructure