Reef Water Quality Protection Plan

Total suspended solids, nutrient and pesticide loads (2014–2015) for rivers that discharge to the Great Barrier Reef

Great Barrier Reef Catchment Loads Monitoring Program

Australian Government

Queensland Government

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Executive summary

Poor water quality within the Great Barrier Reef lagoon, which occurs as a consequence of the export of diffuse pollutants from catchments, is a significant threat to the health and resilience of the Reef. Sediment, nutrients and pesticides leaving agricultural land have been identified as the most significant cause of poor water quality within the Reef lagoon (Brodie et al. 2013a). The Reef Water Quality Protection Plan 2013 (Reef Plan 2013), which this report relates to, has the long-term goal of 'ensuring that by 2020 the quality of water entering the Reef from broad scale land use has no detrimental effect on the health and resilience of the Great Barrier Reef' (DPC 2013a).

Reef Plan 2013 established new land and catchment management targets and water quality targets that are measured against baseline conditions outlined in the preceding Reef Water Quality Protection Plan 2009. These reduction targets, to be achieved in 2018, are: at least a 20 per cent reduction in anthropogenic end-of-catchment loads of sediment and particulate nutrients; at least a 50 per cent reduction in anthropogenic end-of-catchment dissolved inorganic nitrogen loads; and at least a 60 per cent reduction in end-of-catchment pesticide loads.

Progress towards the Reef Plan 2013 water quality targets is measured based on modelled values (Waters et al. 2014) through the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (Paddock to Reef program). The Paddock to Reef program includes catchment scale water quality monitoring of pollutant loads entering the Great Barrier Reef lagoon that is implemented through the Great Barrier Reef Catchment Loads Monitoring Program.

Under Reef Plan 2013, pollutant loads are calculated annually by the Great Barrier Reef Catchment Loads Monitoring Program in the following natural resource management regions and priority basins:

- Cape York region – Normanby basin
- Wet Tropics region – Barron, Mulgrave-Russell, Johnstone, Tully and Herbert basins
- Burdekin region – Burdekin and Haughton basins
- Mackay Whitsunday region – O'Connell, Pioneer and Plane basins
- Fitzroy region – Fitzroy basin
- Burnett Mary region – Burnett and Mary basins.

This report presents annual loads calculated using monitoring data (monitored annual loads) and yields of pollutants based on data from the 2014–2015 monitoring year (i.e. 1 July 2014 to 30 June 2015). The data made available through the Great Barrier Reef Catchment Loads Monitoring Program provides a foundation to validate the catchment models used to monitor progress against Reef Plan 2013 water quality targets, and thus, assist in the effective management of Queensland and Australian natural resources. Of equal importance are the raw concentrations data that underpin this report and represent one of the most significant water quality data sets available nationally – a resource used extensively for projects well beyond the objectives of the Great Barrier Reef Catchment Loads Monitoring Program, and integral to the long-term health and resilience of the Great Barrier Reef.

During the 2014–2015 monitoring year, 18 end-of-catchment sites and seven nested sub-catchment sites across the 14 basins, were monitored for total suspended solids and nutrients. Pesticides were monitored at a sub-set of 15 end-of-catchment sites and one nested sub-catchment site across 12 basins. This is the first year that monitored annual loads have been reported for the Mulgrave and Russell catchments – previously only event loads were reported for these sites during the 2013–2014 monitoring year.

Total annual rainfall was generally below average to very much below average in the monitored catchments in the Cape York, Wet Tropics, Burdekin and Mackay Whitsunday natural resource management regions. The monitored catchments of the Fitzroy and Burnett Mary regions generally received average rainfall with the lower southern Fitzroy catchment and northern Burnett catchment receiving above average rainfall owing to Tropical Cyclone Marcia which crossed the coast north of Rockhampton in late February 2015.

During the 2014–2015 monitoring year, the Russell River was the only catchment where discharge was equal to the long-term mean. In the Barron, Mulgrave, North Johnstone, South Johnstone and Tully rivers, discharge was less than the long-term mean (51–72 per cent). River discharge in the Herbert catchment in the southern Wet Tropics region, and all monitored catchments of the Burdekin and Mackay Whitsunday regions was less than half the long-term mean, with discharge in the Burdekin River only attaining nine per cent of the long-term mean with an exceedance probability of 88 per cent. In the Fitzroy and Burnett catchments, discharge was approximately half the long-term mean. Discharge in the Mary River was 80 per cent of the long-term mean. The low discharge across most catchment areas is similar to the conditions that existed during the previous monitoring year (Garzon-Garcia et al. 2015).

Across the six natural resource management regions, the monitored catchments generated approximately 2.4 million tonnes of total suspended solids, 12,000 tonnes of total nitrogen and 2900 tonnes of total phosphorus. The Fitzroy catchment generated the largest loads of total suspended solids and nutrients, accounting for 38 per cent of the total suspended solids load; 27 per cent of the total nitrogen load; and 44 per cent of the total phosphorus load. Despite an exceptionally low discharge compared to its long-term mean, the Burdekin catchment contributed 30 per cent of the combined total suspended solids load and 14 per cent of the total phosphorus load. The North Johnstone catchment made substantial contributions of total nitrogen and particulate nitrogen, and the Tully and Russell catchments made substantial contributions of dissolved inorganic nitrogen – 49 per cent of the combined dissolved inorganic nitrogen load was derived from the Wet Tropics region.

Catchment yields (the load divided by the monitored surface area of the catchment) provide a measure of the supply of pollutants from monitored catchments. This metric allows a comparison of the rate of pollutant delivery between catchments standardised by area. The highest monitored yields of total suspended solids, total nitrogen, particulate nitrogen, total phosphorus and particulate phosphorus occurred in the North Johnstone catchment, which is consistent with findings from previous years. The Russell catchment produced the highest yields of dissolved inorganic nitrogen and dissolved organic nitrogen. The highest yield of dissolved inorganic phosphorus was derived from the Sandy Creek catchment. The Haughton and Burdekin catchments produced the lowest yields of most analytes, owing in part to the exceptionally low discharge during the 2014–2015 monitoring year.

The total monitored annual loads of photosystem II inhibiting herbicides[1] exported past the monitoring sites were (from largest to smallest): 1400 kg of total atrazine; 810 kg of total diuron; 410 kg of tebuthiuron; 280 kg of hexazinone; and 7.7 kg of ametryn. The combined toxicity-based load (toxic pesticide load[2]) of all monitored sites was 930 kg TEq_{diuron}, with total diuron accounting for 86 per cent or 810 kg TEq_{diuron}. The Russell catchment produced the highest toxic pesticide load, 220 kg TEq_{diuron}, accounting for 23 per cent of the combined monitored toxic pesticide load. The Tully (160 kg TEq_{diuron}) and Pioneer (110 kg TEq_{diuron}) catchments also accounted for a high proportion of the toxic pesticide load during the 2014–2015 monitoring year.

The highest land use yield (the load divided by the total surface area of land uses where the pesticide is registered for use) of ametryn and total atrazine were in the Barratta Creek catchment with the yield of total atrazine more than double the yield in all other monitored catchments. The highest monitored land use yields of diuron and hexazinone were derived from the Russell catchment with the yield of diuron much larger relative to all other monitored catchments. The highest land use yield of tebuthiuron was in the O'Connell catchment, which is consistent with previous monitoring years.

This is the sixth technical report to be released by the Great Barrier Reef Catchment Loads Monitoring Program and the second under Reef Plan 2013. The Paddock to Reef Integrated Monitoring, Modelling and Reporting Program was reviewed in 2013. That review resulted in the decommissioning of several nested sub-catchment sites and establishment of new end-of-catchment sites to provide data for previously unmonitored catchments and improve spatial alignment of the Great Barrier Reef Catchment Loads Monitoring Program and the Marine Monitoring Program – all changes are outlined in the 2013–2014 Great Barrier Reef Catchment Loads Monitoring Program technical report (Garzon-Garcia et al. 2015). Funding of the Great Barrier Reef Catchment Loads Monitoring Program is committed until mid-2018, with additional funding for added monitoring at new sites beginning in July 2016 through to mid-2020.

In order to maintain consistency in the reported data, the underlying methods of the Great Barrier Catchment Loads Monitoring Program have not changed substantially over the years. During the 2014–2015 monitoring year, two key improvements to the program were: the continuation of analysis of water samples for alternate pesticides (pesticides being applied in place of the commonly used photosystem II inhibiting herbicides such as diuron) which was funded by the Queensland Department of Environment and Heritage Protection (under project RP75C – monitored annual loads of alternate pesticides); and the commissioning of the end-of-catchment monitoring sites on the Mulgrave River and Russell River – the capital cost of these sites was co-funded by Terrain NRM and the Department of Science, Information Technology and Innovation. A substantial dataset has been obtained from these two sites in only the first full year of operation, providing critical data (e.g. markedly increasing the monitored annual load of dissolved inorganic nitrogen by 22 per cent and the toxic pesticide load by 48 per cent) to inform our understanding of the risks to the Great Barrier Reef from poor water quality in the Wet Tropics region.

[1] Photosystem II herbicides inhibit electron transport in the photosystem II reaction centre (located in the thylakoid membranes), which is required for converting light into chemical energy in plant photosynthesis.

[2] A toxic pesticide load is the combined load of a group of pesticides that have been converted to the mass of one particular pesticide, based on the pesticides' relative toxicities.

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1 Introduction

The Great Barrier Reef World Heritage Area is located off the north-east coast of Australia and is recognised as the largest coral reef ecosystem in the world (Furnas 2003). Its ecological, social and economic importance is widely acknowledged (DPC 2013a). In economic terms, industries associated with the Great Barrier Reef generate approximately $5.6 billion annually to the Queensland economy (QAO 2015). Poor water quality caused by pollutant runoff exported from catchments adjacent to the Great Barrier Reef is considered one of the most significant threats to the Great Barrier Reef World Heritage Area (Wachenfeld et al. 1998; State of Queensland and Commonwealth of Australia 2003; Wooldridge et al. 2006; Brodie et al. 2008, 2009, 2010, 2013a and 2013b; DPC 2008, 2009a and 2013a; Hunter and Walton 2008; Packett et al. 2009; Schaffelke et al. 2013). Agricultural land has been identified as the major source of these pollutants (e.g. Brodie et al. 2013a; Brodie et al. 2013b; Schaffelke et al. 2013).

In 2015, the Australian and Queensland government released the Reef 2050 Long-Term Sustainability Plan, which is an overarching framework to protect and manage the Great Barrier Reef from 2015–2050. This plan responds to the challenge of managing the health of the Great Barrier Reef in order to protect the Outstanding Universal Values identified in the World Heritage listing, whilst allowing continued ecologically sustainable development and use of this natural resource. The Reef 2050 Long-Term Sustainability Plan incorporates the water quality improvement goals and target of the Reef Water Quality Protection Plan 2013 (Reef Plan 2013) (DPC 2013a).

In order to improve water quality entering the Great Barrier Reef lagoon from these catchments, the Queensland and Australian governments cooperatively initiated Reef Plan (DPC 2003), which was updated in 2009 (DPC 2009a) and 2013 (DPC 2013a) as part of a commitment towards refining its approach and targets as new information emerged. Reef Plan 2009 held the short-term goal of halting and reversing the decline in water quality entering the Great Barrier Reef lagoon. Reef Plan 2013 builds on the earlier plan and includes refined land and catchment management targets and water quality targets that were set to be achieved by 2018.

The Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (Paddock to Reef program) measures and reports progress towards the Reef Plan goal and targets through annual publication of a report card. The Paddock to Reef program is a collaboration involving governments, industry, regional natural resource management bodies, landholders and research organisations (DPC 2009b, 2013b). It is a world-leading approach to integrate data and information on management practices, catchment indicators, water quality and the health of the Great Barrier Reef.

The Great Barrier Reef Catchment Loads Monitoring Program was implemented in 2005 to monitor and report on loads of total suspended solids, nutrients and pesticides and assist in evaluating progress towards the water quality targets of Reef Plan. This is the sixth Great Barrier Reef Catchment Loads Monitoring Program report and the second under Reef Plan 2013 (DPC 2013a). Financial contributions by regional stakeholders in recent years has allowed the Great Barrier Reef Catchment Loads Monitoring Program to increase the number of catchments monitored under Reef Plan 2013 to 25 sites in 14 priority basins for total suspended solids and nutrients and 16 sites in 12 basins for pesticides. Under Reef Plan 2009, the Great Barrier Reef Catchment Loads Monitoring Program monitored total suspended solids and nutrients at 25 sites in 11 priority basins and pesticides at 11 sites in eight priority basins (Turner et al. 2012, 2013; Wallace et al. 2014, 2015; Garzon-Garcia et al. 2015).

Evidence of elevated anthropogenic loads of total suspended solids, nutrients and pesticides exported to the Great Barrier Reef lagoon since European settlement has been reported extensively (e.g. Eyre 1998; Wachenfeld et al. 1998; Fabricius et al. 2005; McKergow et al. 2005; Hunter and Walton 2008; Packett et al. 2009; Brodie et al. 2010; Kroon et al. 2010, 2012 and 2013; DPC 2011; Joo et al. 2011; Smith et al. 2012; Turner et al. 2012 and 2013; Wallace et al. 2014 and 2015; Waters et al. 2014; Garzon-Garcia et al. 2015). The anthropogenic load of total suspended solids exported to the Great Barrier Reef is estimated to have increased by 2.9 times over the predevelopment load (Waters et al. 2014). Similar increases above the predevelopment load were reported by Waters et al. (2014) for a variety of forms of nutrients including total nitrogen (1.8 times), total phosphorus (2.3 times) and dissolved inorganic nitrogen (2.0 times). Similar increases for pesticides could not be calculated as they were not present before European settlement. These estimates of the increase since pre-European times are considerably smaller than the earlier estimates of McKergow et al. (2005) and Kroon et al. (2010).

There are 35 basins that flow into the Great Barrier Reef lagoon and cover an area of approximately 424,000 square kilometres (DPC 2011). These basins extend from the tropics to the subtropics and cover over 1,500 kilometres of the eastern coastline of Queensland (DPC 2011). Across the study area, there are substantial climatic, hydrological and geological differences within and between basins and their catchments. These factors contribute to a high variation in river discharge and pollutant loads measured between catchments and years (Furnas et al. 1997; Devlin and Brodie 2005; Joo et al. 2012; Smith et al. 2012; Turner et al. 2012 and 2013; Wallace et al. 2014 and 2015; Garzon-Garcia et al. 2015;). The majority of pollutant loads are generated during the wet season, typically as runoff during high flow events from catchments adjacent to the Great Barrier Reef (Nicholls 1988; Eyre 1998; Smith et al. 2012; Turner et al. 2012 and 2013; Kroon et al. 2013; Wallace et al. 2014 and 2015; Garzon-Garcia et al. 2015).

Of these 35 basins, 14 priority basins were monitored by the Great Barrier Reef Catchment Loads Monitoring Program in the 2014–2015 monitoring year. These priority basins were selected based on the Paddock to Reef Program Design 2013–2018 (DPC 2013b), which targets high priority areas. The 14 priority basins and the natural resource management regions in which they occur are the:

- Cape York region – Normanby basin
- Wet Tropics region – Barron, Mulgrave-Russell, Johnstone, Tully and Herbert basins
- Burdekin region – Burdekin and Haughton basins
- Mackay Whitsunday region – O’Connell, Pioneer and Plane basins
- Fitzroy region – Fitzroy basin
- Burnett Mary region – Burnett and Mary basins.

Grazing is the single largest land use within the Great Barrier Reef catchments (DPC 2011), accounting for around 80 per cent of the total area (DSITI 2016). Other significant land uses include conservation, forestry, sugarcane, horticulture and other cropping. In the Cape York region, the Normanby basin is dominated by grazing and a large amount of land set aside for conservation in State protected areas. In the Wet Tropics region, the main land uses are grazing in the west, sugarcane on the coastal flood plains and small areas of horticulture. Large areas of the Wet Tropics region are also set aside for conservation purposes in the Wet Tropics World Heritage Area. Land use in the Burdekin region is dominated by grazing with irrigated sugarcane, horticulture and cropping located in the lower Burdekin and Haughton basins. Within the Mackay Whitsunday region, the O'Connell, Pioneer and Plane basins are dominated by grazing. This region also contains relatively large areas of sugarcane cultivation along the coastline and nature conservation. Grazing, dry land cropping, irrigated cotton and forestry are the dominant land uses within the Fitzroy region. Land use within the Burnett Mary region is a mixture of grazing, dairy, horticulture, sugarcane and other cropping (DPC 2011).

This report presents monitored annual loads and yields (the load divided by the monitored surface area of the catchment) for 18 end-of-catchment sites and seven nested sub-catchment sites across the 14 priority basins for sediments (measured as total suspended solids) and nutrients, and monitored annual pesticide loads as well as annual toxic pesticide loads for a sub-set of 15 end-of-catchment sites and one nested sub-catchment site across 12 priority basins during the 2014–2015 monitoring year. The loads of total suspended solids and nutrients were calculated using the same methods in each of the technical reports issued under the Great Barrier Reef Catchment Loads Monitoring Program (Turner et al. 2012 and 2013; Wallace et al. 2014 and 2015; Garzon-Garcia et al. 2015) and the toxic pesticide loads were calculated following Smith et al. (2017a).

All data presented in this report are the loads and yields exported from the area upstream of the monitoring site(s) in each catchment or sub-catchment, and for two reasons these pollutant loads do not represent the total load discharged to the Great Barrier Reef lagoon. Firstly, not all catchments that drain to the Great Barrier Reef lagoon were monitored. Secondly, not all the end-of-catchment monitoring sites are located at the mouth of the river or creek (refer to Section 2.1) and in this unmonitored portion of the catchment or sub-catchment there may be addition, removal, transformation or degradation of total suspended solids, nutrients and pesticides. This report does not link land uses, management practices or soil erosion processes (e.g. gullies, channel/bank or hill-slope erosion) to loads or yields of total suspended solids or nutrients but does present land use yields of pesticides. The reported loads are calculated from monitored water quality, which provides a point of truth to validate the modelled catchment loads. The loads predicted by the catchment models are used to report on progress towards water quality targets in the annual Reef Plan Report Card (DPC 2011; DPC 2013c; DPC 2013d; DPC 2014; DPC 2015; SoQ 2016).

Previous publications of the Great Barrier Reef Catchment Loads Monitoring Program have presented loads for the periods 2006–2009 (Joo et al. 2012), 2009–2010 (Turner et al. 2012), 2010–2011 (Turner et al. 2013), 2011–2012 (Wallace et al. 2014), 2012–2013 (Wallace et al. 2015) and 2013–2014 (Garzon-Garcia et al. 2015).

2 Methods

2.1 Monitoring sites

Fourteen priority basins were identified for monitoring under the Paddock to Reef program (DPC 2013b). The majority of monitoring sites (Figure 2.1 and Table 2.1) are located at existing Queensland Government stream gauging stations installed and maintained by the Department of Natural Resources and Mines. Sites are classified as either end-of-catchment or nested sub-catchment sites. 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 and typically not subject to tidal influence. In many cases, end-of-catchment sites are located some way upstream of the mouth of the river, and the influence of runoff from areas lower in the catchment on water quality cannot be assessed. Nested sub-catchment sites were selected to provide specific water quality data on various land uses or on a geographical region for enhanced validation of catchment models. All nested sub-catchment monitoring sites are located upstream of an end-of-catchment site monitored as part of the Great Barrier Reef Catchment Loads Monitoring Program.

In the 2014–2015 monitoring year, two tidally influenced end-of-catchment sites in the lower Mulgrave River and Russell River were fully commissioned. Horizontal Acoustic Doppler Current Profilers were installed at both sites and were fully operational during all flow events allowing for the calculation of annual pollutant loads for these catchments for the first time (previously only event loads were reported in the 2013–2014 monitoring year). Detailed information relating to the calculation of discharge at all sites is presented in Section 2.6.

Under Reef Plan 2013, 25 sites located in 14 basins were selected to monitor total suspended solids and nutrients (Table 2.2), while 16 sites were selected to monitor pesticides (Table 2.2) (DPC 2013b). All sites monitored in the 2014–2015 monitoring year are the same sites monitored in the 2013–2014 monitoring year with the inclusion of annual loads reported for the Mulgrave and Russell catchments. Summary information on each monitoring site is included in Table 2.1.

2.2 Rainfall

Rainfall totals and rainfall decile data were obtained from the Commonwealth of Australia, Bureau of Meteorology National Climate Centre (BoM 2015a; BoM 2015b). These data were synthesised using ArcGIS to create maps of Queensland to display total annual rainfall and annual rainfall deciles for the 2014–2015 monitoring year.

2.3 Water quality sampling

Water samples were collected according to methods outlined in the Environmental Protection (Water) Policy Monitoring and Sampling Manual (DEHP 2013). Water quality samples were collected between 1 July 2014 and 30 June 2015. Two different sampling methods were used to collect water samples, depending on equipment availability and suitability for use at each site. The two methods used were manual grab sampling and automatic grab sampling using refrigerated pump samplers. The specific sampling methods employed at each site are shown in Table 2.2.

Intensive sampling (daily or every few hours) occurred during high flow events and monthly sampling was undertaken during low or base flow (ambient) conditions. Where possible, total suspended solids, nutrients and pesticide samples were collected concurrently. Approximately 30 per cent of the total suspended solids and nutrient samples were collected by manual grab sampling and 70 per cent were collected using refrigerated automatic pump samplers. Pesticide samples were manually collected at eight sites and collected using refrigerated automatic samplers fitted with glass bottles at eight sites. All water samples were stored and transported in accordance with the Environmental Protection (Water) Policy Monitoring and Sampling Manual (DEHP 2013).

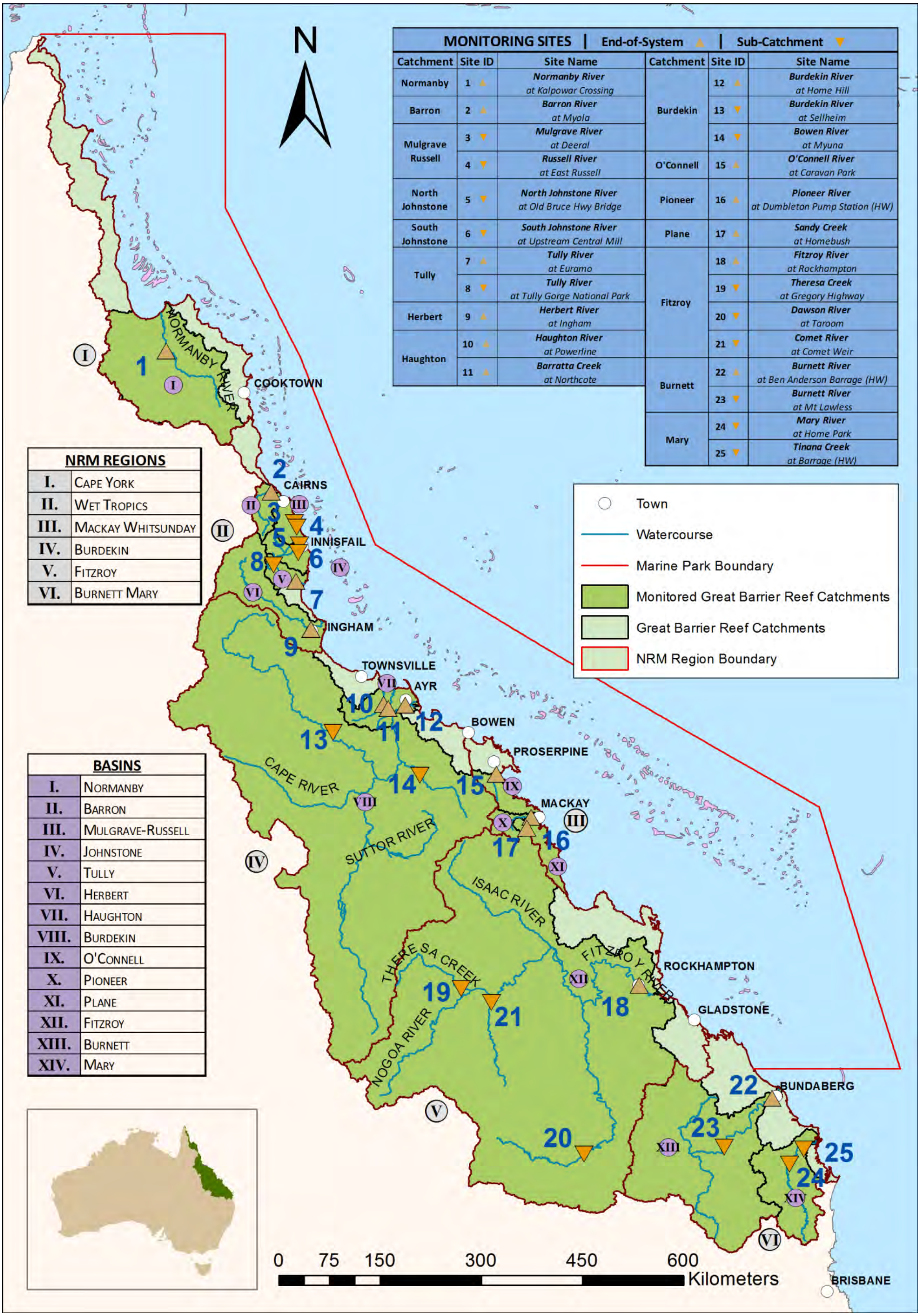


Figure 2.1 Map indicating the natural resource management regions, basins and sites where the Great Barrier Reef Catchment Loads Monitoring Program monitored during the 2014–2015 monitoring year.

Table 2.1 Summary information on sites monitored during the 2014–2015 monitoring year by the Great Barrier Reef Catchment Loads Monitoring Program. Text in bold relate to end-of-catchment sites, all others relate to nested sub-catchment sites.

NRM region	Basin	Catchment	Gauging station	River and site name	Site location		Basin surface area (km^2)*	Catchment surface area (km^2)	Monitored surface area (km^2)	Catchment monitored (%)
					Latitude	Longitude				
Cape York	Normanby	**Normanby River**	**105107A**	**Normanby River at Kalpowar Crossing**	**-14.9185**	**144.2100**	24,408	**15,030**	**12,920**	**86**
Wet Tropics	Barron	**Barron River**	**110001D**	**Barron River at Myola**	**-16.7998**	**145.6121**	2182	**2149**	**1933**	**90**
	Mulgrave-Russell	**Mulgrave River**	**1110056**	**Mulgrave River at Deeral**	**-17.2075**	**145.9264**	1979	**804**	**789**	**98**
		Russell River	**1111019**	**Russell River at East Russell**	**-17.2672**	**145.9544**		**560**	**522**	**93**
	Johnstone	**North Johnstone River**	**1120049**	**North Johnstone River at Old Bruce Highway Bridge (Goondi)**	**-17.5059**	**145.9920**	2321	**1082**	**960**	**90**
		South Johnstone River	**112101B**	**South Johnstone River at Upstream Central Mill**	**-17.6089**	**145.9791**		**545**	**400**	**73**
	Tully	**Tully River**	**113006A**	**Tully River at Euramo**	**-17.9921**	**145.9425**	1683	**1563**	**1450**	**93**
		Tully River	113015A	Tully River at Tully Gorge National Park	-17.7726	145.6503		1563	482	31
	Herbert	**Herbert River**	**116001F**	**Herbert River at Ingham**	**-18.6328**	**146.1427**	9843	**8817**	**8584**	**97**
Burdekin	Haughton	**Haughton River**	**119003A**	**Haughton River at Powerline**	**-19.6331**	**147.1103**	4043	**2037**	**1773**	**87**
		Barratta Creek	**119101A**	**Barratta Creek at Northcote**	**-19.6923**	**147.1688**		**1226**	**759**	**62**
	Burdekin	**Burdekin River**	**120001A**	**Burdekin River at Home Hill**	**-19.6436**	**147.3958**	130,120	**129,930**	**129,930**	**100**
		Burdekin River	120002C	Burdekin River at Sellheim	-20.0078	146.4369		36,252	36,252	100
		Bowen River	120205A	Bowen River at Myuna	-20.5833	147.6000		9449	7107	75
Mackay Whitsunday	O'Connell	**O'Connell River**	**1240062**	**O'Connell River at Caravan Park**	**-20.5664**	**148.6117**	2387	**860**	**819**	**95**
	Pioneer	**Pioneer River**	**125013A**	**Pioneer River at Dumbleton Pump Station**	**-21.1441**	**149.0753**	1570	**1570**	**1466**	**93**
	Plane	**Sandy Creek**	**126001A**	**Sandy Creek at Homebush**	**-21.2831**	**149.0228**	2534	**465**	**326**	**70**
Fitzroy	Fitzroy	**Fitzroy River**	**1300000**	**Fitzroy River at Rockhampton**	**-23.3175**	**150.4819**	142,552	**139,289**	**139,159**	**98**
		Theresa Creek	130206A	Theresa Creek at Gregory Highway	-23.4292	148.1514		8632	8485	98
		Comet River	130504B	Comet River at Comet Weir	-23.6125	148.5514		17,297	16,422	95
		Dawson River	130302A	Dawson River at Taroom	-25.6376	149.7901		50,764	15,847	31
Burnett Mary	Burnett	**Burnett River**	**136014A**	**Burnett River at Ben Anderson Barrage Head**	**-24.8896**	**152.2922**	33,207	33,179	**32,841**	**99**
		Burnett River	136002D	Burnett River at Mt Lawless	-25.54471	151.6549			29,356	88
	Mary	**Mary River**	**138014A**	**Mary River at Home Park**	**-25.76833**	**152.5274**	9467	**9161**	**6872**	**75**
		Tinana Creek	**138008A**	**Tinana Creek at Barrage Head Water**	**-25.57196**	**152.7173**		**1291**	**1284**	**99**

NRM = natural resource management. *This includes the whole basin area, which contains catchments which might not drain directly to the monitored river but are considered part of the same basin.

Table 2.2 Summary information of analytes measured and sample collection methods used by the Great Barrier Reef Catchment Loads Monitoring Program during the 2014–2015 monitoring year. Text in bold relate to end-of-catchment sites, all others relate to nested sub-catchment sites.

NRM region	Basin	Catchment	Gauging station	River and site name	Analytes measured	Sample collection method
Cape York	Normanby	**Normanby River**	**105107A**	**Normanby River at Kalpowar Crossing**	**TSS & Nut.**	**Manual**
Wet Tropics	Barron	**Barron River**	**110001D**	**Barron River at Myola**	**TSS & Nut.**	**Manual and automatic**
	Mulgrave-Russell	**Mulgrave River**	**1110056**	**Mulgrave River at Deeral***	**TSS, Nut. & Pesticides**	**Manual and automatic**
		Russell River	**1111019**	**Russell River at East Russell***	**TSS, Nut. & Pesticides**	**Manual and automatic**
	Johnstone	**North Johnstone River**	**1120049~**	**North Johnstone River at Old Bruce Highway Bridge (Goondi)**	**TSS, Nut. & Pesticides**	**Manual**
		South Johnstone River	**112101B**	**South Johnstone River at Upstream Central Mill**	**TSS & Nut.**	**Manual**
	Tully	**Tully River**	**113006A**	**Tully River at Euramo**	**TSS, Nut. & Pesticides**	**Manual and automatic**
		Tully River	113015A	Tully River at Tully Gorge National Park	TSS & Nut.	Manual and automatic
	Herbert	**Herbert River**	**116001F**	**Herbert River at Ingham**	**TSS, Nut. & Pesticides**	**Manual**
Burdekin	Haughton	**Haughton River**	**119003A**	**Haughton River at Powerline**	**TSS, Nut. & Pesticides**	**Manual**
		Barratta Creek	**119101A**	**Barratta Creek at Northcote**	**TSS, Nut. & Pesticides**	**Manual and automatic**
	Burdekin	**Burdekin River**	**120001A~**	**Burdekin River at Home Hill**	**TSS, Nut. & Pesticides**	**Manual**
		Burdekin River	120002C	Burdekin River at Sellheim	TSS & Nut.	Manual
		Bowen River	120205A	Bowen River at Myuna	TSS & Nut.	Manual and automatic
Mackay Whitsunday	O'Connell	**O'Connell River**	**1240062~**	**O'Connell River at Caravan Park***	**TSS, Nut. & Pesticides**	**Manual and automatic**
	Pioneer	**Pioneer River**	**125013A~**	**Pioneer River at Dumbleton Pump Station**	**TSS, Nut. & Pesticides**	**Manual and automatic**
	Plane	**Sandy Creek**	**126001A**	**Sandy Creek at Homebush**	**TSS, Nut. & Pesticides**	**Manual and automatic**
Fitzroy	Fitzroy	**Fitzroy River**	**1300000~**	**Fitzroy River at Rockhampton**	**TSS, Nut. & Pesticides**	**Manual**
		Theresa Creek	130206A	Theresa Creek at Gregory Highway	TSS & Nut.	Manual
		Comet River	130302A	Dawson River at Taroom	TSS & Nut.	Manual
		Dawson River	130504B	Comet River at Comet Weir	TSS, Nut. & Pesticides	Manual
Burnett Mary	Burnett	**Burnett River**	**136014A~**	**Burnett River at Ben Anderson Barrage Head Water**	**TSS, Nut. & Pesticides**	**Manual**
		Burnett River	136002D	Burnett River at Mt Lawless	TSS & Nut.	Manual and automatic
	Mary	**Mary River**	**138014A**	**Mary River at Home Park**	**TSS, Nut. & Pesticides**	**Manual and automatic**
		Tinana Creek	**138008A**	**Tinana Creek at Barrage Head Water**	**TSS, Nut. & Pesticides**	**Manual and automatic**

TSS = total suspended solids, Nut. = nutrients, Pesticides = photosystem II inhibiting herbicides and alternate pesticides (See Table 7.1, Appendix A), ~ = These are not gauging stations – flow is determined from upstream gauging stations as outlined in Table 2.4, * = Acoustic Doppler Current Profiler installed.

2.4 Quality control

During the 2014–2015 monitoring year the Great Barrier Reef Catchment Loads Monitoring Program continued to implement its quality management system. This system has been used to govern all aspects of the program delivery since 2010 to ensure consistency and transparency in all areas of the program. Continual improvement in the program delivery has been achieved during the 2014–2015 monitoring year through implementation of the quality management system as demonstrated by:

- ongoing delivery of the Great Barrier Reef Catchment Loads Monitoring Quality Management training package to staff in partner organisations including Mulgrave Landcare and Catchment Group, Herbert Productivity Services, Tully Sugar, Johnstone River Catchment Management Association and Catchment Solutions Limited,
- upgrade to software in order to enhance triggering of automatic samplers to improve collection of samples through all stages of the hydrograph,
- installation of automatic water quality samplers with glass bottles at the Tully River to allow for the automatic collection of water samples for analysis of pesticides (use of glass bottles is consistent with Australian and international standards), and
- commissioning of Horizontal Acoustic Doppler Current Profilers and flow gauging at the Mulgrave and Russell rivers.

2.5 Water quality sample analysis

Total suspended solids and nutrient analyses were undertaken by the Science Division Chemistry Centre (Dutton Park, Queensland) according to Standard Methods 2540 D, 4500-NO_3 I, 4500-NH_3 H, 4500-N_{org} D and 4500-P G (APHA-AWWA-WEF 2005). Total suspended solids samples were analysed using a gravimetric method and nutrient samples were analysed via segmented flow analysis (colourimetric techniques).

Queensland Health Forensic and Scientific Services Organics Laboratory (Coopers Plains, Queensland) analysed the water samples for pesticides. All pesticide samples were extracted via solid phase extraction and analysed using liquid chromatography-mass spectrometry (LC-MS) to quantify 47 pesticides (Appendix A) that included five photosystem II inhibiting herbicides (ametryn, atrazine including its breakdown products desethyl atrazine and desisopropyl atrazine, diuron including its breakdown product 3,4-dichloroaniline, hexazinone and tebuthiuron). The solid-phase extraction coupled with the LC-MS analysis detects organic compounds with low octanol-water partition coefficient values (i.e. they tend to have high aqueous solubility) – Table 7.2 in Appendix A provides the octanol/water partition coefficients (log Kow) for all measured pesticides. For the purpose of this report, atrazine together with its breakdown products (desethylatrazine and desisopropyl atrazine) is reported as ‘total atrazine’ and diuron and its breakdown product (3,4-dichloroaniline) are reported as ‘total diuron’. The total atrazine concentration for each sample was calculated according to Equation 1, which was then used to calculate a total atrazine load:

Equation 1

$$Total\ atrazine = C_e \times \frac{M_a}{M_e} + C_i \times \frac{M_a}{M_i} + C_a$$

where C = concentration, M = molecular weight, a = atrazine, e = desethylatrazine and i = desisopropyl.

The total diuron concentration for each sample was calculated according to Equation 2, which was then used to calculate a total diuron load:

Equation 2

$$Total\ diuron = C_{dc} \times \frac{M_d}{M_{dc}} + C_d$$

where C = concentration, M = molecular weight, d = diuron and dc = 3,4-dichloroaniline.

The Science Division Chemistry Centre (Dutton Park, Queensland) and Queensland Health Forensic and Scientific Services (Coopers Plains, Queensland) laboratories are both accredited by the National Association of Testing Authorities (NATA, Australia). Table 2.3 provides a summary of all analysed parameters, their practical quantitation limits and analytical uncertainty (measured as the 95 per cent confidence interval of the standard deviation).

Table 2.3 Summary information for each analyte measured and the corresponding practical quantitation limit and uncertainties.

Monitored pollutants	Abbreviation	Analytes measured	Practical quantitation limit	Uncertainty ±% (as reported by laboratory)
Sediments				
Total suspended solids	TSS	Total suspended solids	1 mg L^{-1}	12
Nutrients				
Total nitrogen	TN	Total nitrogen as N	0.03 mg L^{-1}	15
Particulate nitrogen	PN	Total nitrogen (suspended) as N	0.03 mg L^{-1}	15
Dissolved organic nitrogen	DON	Organic nitrogen (dissolved) as N	0.03 mg L^{-1}	15
Ammonium nitrogen as N	NH_4-N	Ammonium nitrogen as N	0.002 mg L^{-1}	8
Oxidised nitrogen as N	NO_x-N	Oxidised nitrogen as N	0.001 mg L^{-1}	8
Dissolved inorganic nitrogen	DIN	Ammonium nitrogen as N + Oxidised nitrogen as N	0.002 mg L^{-1}	8
Total phosphorus	TP	Total Kjeldahl phosphorus as P	0.02 mg L^{-1}	12
Particulate phosphorus	PP	Total phosphorus (suspended) as P	0.02 mg L^{-1}	15
Dissolved organic phosphorus	DOP	Organic phosphorus (dissolved) as P	0.02 mg L^{-1}	15
Dissolved inorganic phosphorus	DIP	Phosphate phosphorus as P	0.001 mg L^{-1}	8
Pesticides				
Ametryn	Pesticide (PSII inhibiting herbicide)	Ametryn	0.01 µg L^{-1}	52
Total atrazine		Atrazine, desethyl atrazine and desisopropyl atrazine	0.01 µg L^{-1}	24
Total diuron		Diuron and 3,4-dichloroaniline	0.01 µg L^{-1}	21
Hexazinone		Hexazinone	0.01 µg L^{-1}	11
Tebuthiuron		Tebuthiuron	0.01 µg L^{-1}	9

2.6 River discharge

During the 2014–2015 monitoring year discharge was calculated using one of four methods:

- measured discharge from existing Department of Natural Resources and Mines gauging station
- 'time and flow factored' measured discharge from existing Department of Natural Resources and Mines gauging station (Table 2.4)
- modelled flows generated in the Source Catchments platform using the Sacramento rainfall runoff model, where the Parameter Estimation Tool (PEST) was coupled with Source for the calibration process; or
- a combination of modelled flow and flow measured by Horizontal Acoustic Doppler Current Profiler.

Where monitoring sites were located at existing Department of Natural Resources and Mines gauging stations, river discharge data (hourly-interpolated flow, $m^3\,s^{-1}$) were extracted from the Department of Natural Resources and Mines, Surface Water Database using Hydstra pre-programmed scripts (DNRM 2012). The method used to calculate discharge by the Surface Water Database is presented in Appendix B. The preference was to use archived discharge data with a quality code[3] of 10 to 30, based on the Department of Natural Resources and Mines hydrographic methodology for quality rating flow data (DNRM 2014) (see Table 7.9, Appendix C, for an explanation of quality coding). If such data were not available due to a gauging station error, discharge data with a quality code of 59 or 60 were used (see Appendix C).

When samples were collected at sites without an operational gauging station (due to logistic or workplace health and safety reasons, or site decommissioning) a 'timing and flow factor' was calculated. Timing and flow factors were based on flow data from the nearest upstream gauging station(s). Timing and flow factors were applied to discharge data used in the calculation of loads during the 2014–2015 monitoring year at: North Johnstone River at Old Bruce Highway Bridge (Goondi), Burdekin River at Home Hill, O'Connell River at Caravan Park, Fitzroy River at Rockhampton and Burnett River at Ben Anderson Barrage Head Water (Table 2.4). Timing and flow factors were only used for the Pioneer River at Dumbleton Pump Station and Burnett River at Mt Lawless for the purpose of calculating long-term mean discharge – both of these sites now have an operational gauging station (Table 3.1). In general, the factors adjust the flow to account for the delay in the time it takes water to flow from the gauging station to the water quality sampling site and for the change in flow volume due to large changes in catchment area (i.e. greater than four per cent).

During the 2014–2015 monitoring year discharge in the Mulgrave and Russell rivers was calculated using a combination of measured and modelled flows. Flow in the Mulgrave and Russell rivers was measured using Horizontal Acoustic Doppler Current Profilers. The mounting position of this equipment above the low tide water level in low flow conditions required that modelled flows be used for daily flow calculations during the low flow period. During high flow periods, the Horizontal Acoustic Doppler Current Profilers are able to measure continuously providing a more precise measure of discharge during flood events. Further information relating to the calculation of discharge at these sites is provided in Appendix D.

[3] Quality codes are used to differentiate between reliability of discharge values available for the calculation of loads. Quality codes of 59 and 60 are interpolated discharge values.

In the Tinana Creek catchment only modelled discharge was used for the calculation of pollutant loads as there remains insufficient flow gauging data to generate a rating table for this site. The modelled flows at this site were generated in the Source Catchments platform using the Sacramento rainfall runoff model for the period 1 July 1970 to 30 June 2015. The Parameter Estimation Tool (PEST) was coupled with Source for the calibration process following the approach detailed in Zhang et al. (2013). Details for the calibration statistics can be found in Zhang (2015a).

Table 2.4 Timing and flow factors applied to calculate discharge at non-gauged monitoring sites and recently installed gauging stations# during the 2014–2015 monitoring year.

Gauging station	River and site name	Timing and flow factors
1110056	Mulgrave River at Deeral	Estimated from modelled discharge and measured flow – see Appendix D
1111019	Russell River at East Russell	Estimated from modelled discharge and measured flow – see Appendix D
1120049	North Johnstone River at Old Bruce Highway Bridge (Goondi)#	Estimated from discharge data for Tung Oil GS 112004A where: Discharge $_{\text{North Johnstone River at Old Bruce Highway Bridge (Goondi)}}$ = Discharge $_{\text{North Johnstone River at Tung Oil}}$
120001A	Burdekin River at Home Hill#	Estimated from discharge data for Clare GS 120006B where: Discharge $_{\text{Burdekin River at Home Hill}}$ = Discharge $_{\text{Burdekin River at Clare}}$
1240062	O'Connell River at Caravan Park	Estimated using the HYCRSUM function in Hydstra using discharge data for Andromache River GS 124003A and O'Connell River GS 124001B
125013A	Pioneer River at Dumbleton Pump Station	Estimated from Pioneer River at Dumbleton Pump Station Tail Water GS 125016A Historical discharge was estimated using data from Mirani Weir Tail Water GS 125007A where: Discharge $_{\text{Pioneer River Dumbleton Pump Station}}$ = 1.226 x Discharge $_{\text{Mirani Weir Tail Water}}$
1300000	Fitzroy River at Rockhampton#	Estimated from discharge data from The Gap GS 130005A where: Time $_{\text{Rockhampton}}$ = Time $_{\text{The Gap}}$ + 14.5 hours
136014A	Burnett River at Ben Anderson Barrage Head Water#	Estimated from discharge data for Fig Tree GS 136007A, Degilbo GS 136011A and Perry GS 136019A where: Discharge $_{\text{Burnett River at Ben Anderson Barrage Head Water}}$ = Discharge $_{\text{Fig Tree}}$ + Discharge $_{\text{Degilbo}}$ + Discharge $_{\text{Perry}}$ Historical discharge (pre-1988) was estimated from Walla GS 136001A and 136001B where: Discharge $_{\text{Burnett River at Ben Anderson Barrage Head Water}}$ = Discharge $_{\text{Walla}}$
136002D	Burnett River at Mt Lawless#	Historical discharge was estimated using data from Burnett River at Yenda GS 136002A where: Discharge $_{\text{Burnett River at Mt Lawless}}$ = Discharge $_{\text{Yenda}}$
138008A	Tinana Creek at Tinana Barrage Head Water	Estimated from modelled discharge

Sites where discharge was directly applied from another site or calculated by the addition of multiple sites differed in catchment areas by less than four per cent. In all other cases a flow factor was included to account for the effect of catchment area difference on flow.

Where possible, long-term mean annual discharge and historical maximum recorded flow for each monitoring site was calculated using data contained in the Surface Water Database. For four sites, O'Connell River at Caravan Park, Pioneer River at Dumbleton Pump Station, Burnett River at Ben Anderson Barrage Head Water and Burnett River at Mt Lawless, historical discharge was estimated using discharge data from upstream gauging stations as described in Table 2.4. For Mulgrave River at Deeral, Russell River at East Russell and Tinana Creek at Barrage Head Water modelled historic daily flows were used.

The exceedance probability of monitored annual discharge for all sites was calculated using Equation 3. The exceedance probability is the probability that the observed annual discharge will be exceeded in any given year based on the historical flow records available for the monitoring site. See Table 3.1 for the period of flow records used in the calculation of the exceedance probabilities.

The exceedance probability (P_e) of the annual discharge was calculated for each monitored site by:

Equation 3

$$P_e = (1 - \frac{R_i}{N+1}) \times 100$$

where *R* is the rank of the i^{th} total annual (1 July to 30 June) discharge, and *N* is the number of annual discharge observations at the monitoring site.

2.7 Data analysis

2.7.1 Rating of sampling representivity

The suitability of the total suspended solids and nutrients data at each site to calculate loads, between 1 July 2014 and 30 June 2015, was assessed by determining the representivity of the data for total suspended solids and nutrients using the method of Turner et al. (2012), first used in 2009–2010, which was based on elements of the Kroon et al. (2010) and Joo et al. (2012) methods. The sampling representivity rating identifies the sample coverage achieved during the period of maximum discharge at each monitoring site. This method assumes that the majority of the annual total suspended solids and nutrient loads are transported during the highest flow periods, which is generally the case (Joo et al. 2012). In order to reliably calculate the annual pollutant load, the pollutant concentration data should be available for the periods of highest discharge. The rating of sampling representivity was assessed against two criteria:

1. the number of samples collected in the top five per cent of annual monitored flow
2. the ratio between the highest flow rate at which a water sample was collected in the 2014–2015 monitoring year and the maximum flow rate recorded.

The representivity was determined by assigning a score using the system presented in Table 2.5.

Table 2.5 Scores assigned to total suspended solids and nutrients data to determine their representivity.

Number of samples in top 5 per cent of flow	Score	Ratio of highest flow sampled to maximum flow recorded	Score
0 – 9	1	0.00 – 0.19	1
10 – 19	2	0.20 – 0.39	2
20 – 29	3	0.40 – 0.59	3
30 – 39	4	0.60 – 0.79	4
>40	5	>0.80	5

The rating of sample representivity for each analyte was the sum of the scores for the two criteria. Sample representivity for each analyte was rated as "excellent" when the total score was greater than or equal to eight, "good" when the total score was six or seven, "moderate" for total scores of four or five or "indicative" when the score was less than four. Furthermore, hydrographs were visually assessed to verify the representivity rating.

The representivity of pesticide data was not assessed as the Turner et al. (2012) method is not appropriate due to maximum pesticide concentrations often not occurring at the same time as maximum flow. The sample coverage for each monitoring site is presented in the hydrographs provided in Appendix E.

2.7.2 Loads calculation

Loads were calculated using the Loads Tool component of the software Water Quality Analyser 2.1.2.6 (eWater 2015). The total suspended solids and nutrient loads were calculated using concentrations reported in milligrams per litre (mg L^{-1}) and loads for pesticides were calculated using concentrations reported in micrograms per litre (µg L^{-1}).

Annual and daily loads were calculated for total suspended solids and nutrients, including total nitrogen, particulate nitrogen, dissolved organic nitrogen, dissolved inorganic nitrogen (calculated by adding oxidised nitrogen and ammonium nitrogen), oxidised nitrogen, ammonium nitrogen, total phosphorus, particulate phosphorus, dissolved inorganic phosphorus and dissolved organic phosphorus. Annual and daily pesticide loads were also calculated for all pesticides detected above the practical quantitation limit (Table 2.3). Although daily loads have been calculated for all analytes, only annual loads are presented in this report.

One of two methods was used to calculate loads (a decision based on a Great Barrier Reef Catchment Loads Monitoring Program review that identified the need for a repeatable approach that can produce load estimates in a timely manner and that is not subjective (DERM 2011)): the average load (linear interpolation of concentration)[4] or the Beale ratio. Average load (linear interpolation of concentration) is the most accurate and reliable method, provided events are adequately sampled, or at least with reasonably representative sampling including the peak concentration (Joo et al. 2012). For poorly sampled and/or complex events the Beale ratio is one of the recommended methods (Joo et al. 2012). The average load (linear interpolation of concentration) and Beale ratio methods were applied using the following equations:

[4] This method was previously referred to as the 'Linear Interpolation' method in Water Quality Analyser 2.1.1.0 and Turner et al. (2012). The revised name 'average load (linear interpolation of concentration)' is consistent with the load calculation method of Letcher et al. (1999) as referred to in Water Quality Analyser 2.1.2.6.

Average load (linear interpolation of concentration):

Equation 4

$$Load = \sum_{j=1}^{n} \frac{c_j + c_{j+1}}{2} \times q_j$$

where c_j is the j^{th} sample concentration, and q_j is the inter-sample mean flow (eWater 2012).

Beale ratio:

Equation 5

$$Load = Q\left(\frac{\bar{l}}{\bar{q}}\right)\left\{\frac{1+\frac{1}{N}\frac{\rho\sigma L\sigma Q}{\bar{l}\bar{q}}}{1+\frac{1}{N}\frac{\sigma^2 Q}{\bar{q}^2}}\right\}$$

where Q is the total discharge for the period, $\bar{l}$ is the average load for a sample, L is the observed load, $\bar{q}$ is the average of *N* discharge measurements, σ is the standard error of L and ρ is the correlation coefficient for L and Q (eWater 2012).

2.7.2.1 Total suspended solids, nutrients and pesticide loads

The most appropriate method (average load (linear interpolation of concentration) or Beale ratio) to calculate annual pollutant loads was determined for each analyte at each site using the following criteria:

- if the majority of major events were well sampled on both the rise and fall, then the average load (linear interpolation of concentration) method was applied (e.g. Tully River at Euramo, Figure 7.9, Appendix E and Mary River at Home Park, Figure 7.31, Appendix E)
- if the majority of the events were not adequately sampled but the representivity rating was "moderate", "good" or better, the Beale ratio was applied (e.g. Burdekin River at Home Hill, Figure 7.18, Appendix E and Pioneer River at Dumbleton Pump Station, Figure 7.22, Appendix E)
- if the majority of the events were not adequately sampled and the representivity rating was "indicative", then annual loads may be calculated using the Beale ratio method. No indicative loads due to low sampling representivity are reported for the 2014–2015 monitoring year; however, Tinana Creek in the Mary catchment was given an indicative rating as modelled daily flows were used to calculate loads and yields (Figure 7.32). This indicative rating was given as there were no measurements of flow (the dominant factor determining the magnitude of loads). This approach is

consistent with the calculation of loads for the 2013–2014 monitoring year (Garzon-Garcia et al. 2015).

The most appropriate load calculation method varied between sites as the numbers of samples collected and the coverage over the hydrograph varied between events (Appendix E). The availability of concentration data for total suspended solids and each measure of nitrogen and phosphorus, however, were similar within sites. Therefore, the same load calculation method was used for all total suspended solids and nutrient analytes in each site, with the exception of dissolved and particulate nutrients in the Bowen River at Myuna, where the Beale ratio method was applied for these analytes. This was done as sample coverage over the largest event was limited and use of the average load (linear interpolation of concentration) method may have resulted in an underestimate of the load in the 2014–2015 monitoring year.

The load calculation method applied for total suspended solids, nutrients and pesticides at each monitoring site is provided in Table 3.2 to Table 3.6. Once the appropriate loads calculation method was determined, the loads were calculated using the following procedure:

- water quality concentration data with a date and time stamp were imported into Water Quality Analyser (eWater 2012, 2015) for each parameter
- discharge data were imported into Water Quality Analyser (eWater 2012, 2015) on an hourly or daily interpolated time stamp
- for total suspended solids and nutrients, if the concentrations were below the practical quantitation limit specified by the Science Division Chemistry Centre (Table 2.3), the results were adjusted to a value of 50 per cent of the practical quantitation limit
- where pesticide concentrations were below the practical quantitation limit, but other samples in the same event contained the same pesticide, they were replaced by 50 per cent of the practical quantitation limit. In all other cases, where the sample concentration was reported as below the practical quantitation limit, results were adjusted to 0 µg L^{-1} in order to not potentially overestimate the loads
- the water quality concentration data were then aligned to the hourly flow data (nearest time match) or daily flow data where modelled data were used
- the hydrograph and water quality concentration data were checked for relevance and suitability (i.e. trends in relation to hysteresis, visual relationship of water quality concentrations to flow and representativeness)
- the data were then processed by the Loads Tool component of Water Quality Analyser (eWater 2012, 2015) using the appropriate loads calculation method (as outlined above) and annual loads for the period 1 July 2014 to 30 June 2015 period were reported
- all calculated loads were rounded to two significant figures.

At some sites, the average load (linear interpolation of concentration) method was determined to be the most appropriate calculation method, but inadequate ambient sampling points were available to calculate annual loads using Water Quality Analyser (eWater 2012; 2015). For all sites, a calculated data point that was 50 per cent of the lowest reported concentration was inserted into the dataset at 1 July 2014 and the lowest reported concentration was inserted into the dataset at 30 June 2015 to provide tie-down concentrations for calculations (eWater 2012).

The use of average load (linear interpolation of concentration) and Beale ratio loads calculation methods for total suspended solids, nutrients and pesticides is consistent with the previous monitoring years from 2006 to 2014 (Joo et al. 2011; Turner et al. 2012 and 2013; Wallace et al. 2014 and 2015; Garzon-Garcia et al. 2015).

2.7.2.2 Toxicity-based loads (toxic pesticide loads)

As part of our ongoing commitment to improving the Great Barrier Reef Catchment Loads Monitoring Program, the concept of a toxicity-based load (toxic pesticide load) was introduced in the 2013–2014 monitoring year as a more toxicologically relevant measure for pesticides. Photosystem II inhibiting herbicides all have the same toxic mode of action, and therefore, the total toxic pesticide load of ametryn, atrazine, diuron, hexazinone and tebuthiuron could be calculated. A toxic pesticide load is the calculated load of a pesticide weighted by the pesticide’s relative toxicity compared to the toxicity of diuron (Smith et al. 2017b). The toxic pesticide load is therefore expressed as an equivalent mass of diuron, i.e. diuron equivalent kilograms. Following Smith et al. (2017b), the loads of each of the five herbicides were multiplied by the appropriate toxicity equivalency factor (Table 2.6) and then summed. Although the other detected pesticides would contribute to the total toxic pesticide load, the diuron toxicity equivalence factors have not been determined for any other pesticides.

Table 2.6 Toxic equivalency factors for five photosystem II inhibiting herbicides relative to the toxicity of diuron used for the calculation of toxic pesticide loads (adopted from Smith et al. 2017b).

	Ametryn	Atrazine	Diuron	Hexazinone	Tebuthiuron
Diuron equivalency factor	0.65	0.036	1.0	0.21	0.019

2.7.3 Yields

Yields are the load of pollutants (e.g. kilograms, kg, or tonnes, t) that originate from a monitored area of land (e.g. square kilometres, km^2) within a catchment (i.e. t km^{-2} for total suspended solids and kg km^{-2} for nutrients and pesticides). Yields provide a useful means of comparing the rate of pollutant delivery between different monitored areas (e.g. between catchments).

2.7.3.1 Total suspended solids and nutrient catchment yields

Catchment yields of total suspended solids and nutrients were calculated for all end-of-catchment and sub-catchment sites by dividing the monitored annual pollutant load of each analyte by the total monitored catchment area using Equation 6.

Equation 6

$$\textit{Catchment Yield} = \textit{monitored annual load/monitored catchment area}$$

where catchment yield is expressed as t km^{-2} or kg km^{-2}, annual load is expressed as t or kg, and monitored catchment area is expressed as km^2 upstream of the monitoring site.

Total suspended solids and nutrients may originate from all land use types within the monitored area including areas set aside for conservation purposes. The yields of total suspended solids and nutrients are therefore presented as an average rate of pollutant delivery across the total monitored catchment area. Research conducted in the priority reef catchments has demonstrated high variability in the rate of pollutant delivery over varying temporal and spatial scales.

2.7.3.2 Pesticide land use yields

In this report, the methods used to calculate pesticide land use yields (the load divided by the total surface area of land uses where the pesticide is registered for use) are consistent with Wallace et al. (2015), which reported the monitored annual pesticide land use yields for all monitoring years between 2010 and 2014, and Garzon-Garcia et al. (2015), which reported land use yields for the 2013–2014 monitoring year.

Agricultural chemicals, including photosystem II inhibiting herbicides, are registered for specific applications within the agricultural sector by the Australian Pesticides and Veterinary Medicines Authority. The registration of chemicals allows restrictions to be applied to control potential environmental impacts of these chemicals. These restrictions may include the crop type, timing and rate at which registered chemicals may be applied. Although records of agricultural chemical use must be maintained by the user, no centralised reporting of these data is required under current regulations. It is not possible, therefore, to obtain chemical use records for the purpose of calculating land use yields at the scale of the Great Barrier Reef Catchment Loads Monitoring Program. It is possible to use the registered chemical restriction information (e.g. Infopest Database, Growcom 2015) to determine whether the five photosystem II inhibiting herbicides were registered for agricultural production purposes being conducted in specific regions during the 2014–2015 monitoring year. Together with land use data available through the Australian Collaborative Land Use Mapping Program, registered chemical information may be used to calculate the land use yield of photosystem II inhibiting herbicides, or ultimately for all detected pesticides.

In each monitored catchment, the land use data were obtained from the Queensland Land Use Monitoring Program, which is part of the Australian Collaborative Land Use and Management Program (http://www.agriculture.gov.au/abares/aclump/about-aclump) sourced through the Queensland

Government Queensland Spatial Catalogue (DSITI 2016). These land use data were aggregated into eleven categories, with only the aggregated land use area for cropping, forestry, grazing, horticulture and sugarcane used to determine the land use yields (i.e. monitored loads of pesticides were not attributed to the additional six land use categories of urban, mining, conservation, intensive animal production, water and other land uses, although it is acknowledged that photosystem II inhibiting herbicides may be applied in these land use classes). As these land use categories are an aggregation of land use data categories contained in the Queensland Land Use and Management Program dataset, it is acknowledged that these categories may include specific land uses to which the application of registered chemical is not permitted (e.g. ametryn may be applied to pineapples that are included in the horticulture land use category, but may not be applied to bananas that are also included in the horticulture land use category). Aggregated land use categories used in the calculation of land use yields for the photosystem II inhibiting herbicides are presented in Table 2.7 and Table 2.8.

The binary codes (Table 2.7) indicate whether a pesticide is registered for application in an aggregated land use (indicated by a code of 1) or not (indicated by a code of 0) and whether validation criteria relating the allocation of pesticides to particular land uses have been met. The validation criteria applied to the binary coding were:

- the pesticide is registered for a land use contained in the aggregated land use category (e.g. pineapples in horticulture)
- the specific land use (e.g. pineapples) to which the pesticide is registered occurs upstream of the monitoring site.

The pesticide land use yields (LUY) in each catchment were calculated using Equation 7:

Equation 7

$$LUY = \textit{annual monitored pesticide load}/LUA$$

where LUA is the total land use area (km^2) in each catchment based on the aggregated land use categories to which a pesticide may be applied.

The LUA was determined by:

Equation 8

$$LUA = \sum (\textit{binary code (Table 2.7) x surface area of each aggregated land use category (Table 2.8)})$$

The resulting land use yields ($kg\ km^{-2}$) are the yields of pesticides from the monitored area for each aggregated land use category in each catchment.

These are likely underestimates of the actual yields as: (1) not all land to which use of a pesticide is permitted will have had that pesticide applied; (2) pesticides are predominantly transported to waterways when the land to which pesticide is applied receives sufficient rain to cause surface run-off – in this case, agricultural land not receiving rain but registered for a pesticide will not significantly contribute to the load or yield, but this land has been included in the calculation.

The binary coding applied in the calculation of the land use yields in this report was subject to a consultative review undertaken with peak industry bodies in April 2015 (Wallace et al. 2015).

Table 2.7 Binary codes indicating which photosystem II inhibiting herbicides are registered for the aggregated land use categories. A binary code of 1 indicates the pesticide is registered for application in that aggregated land use and the validation criteria are met.

Photosystem II inhibiting herbicides	Cropping	Forestry	Grazing	Horticulture	Sugarcane
Ametryn	0	0	0	0	1
Atrazine	1	1	0	0	1
Diuron	1	0	0	1	1
Hexazinone	0	1	1	0	1
Tebuthiuron	0	0	1	0	0

Table 2.8 Surface area of each aggregated land use category upstream of the monitoring sites (obtained from the Queensland Land Use Monitoring Program) for the 2014–2015 monitoring year. Text in bold relate to end-of-catchment sites and the corresponding data.

Basin	Catchment	River and site name	Monitored area (km^2)	Monitored area of catchment (%)	Cropping (km^2)	Forestry (km^2)	Grazing (km^2)	Horticulture (km^2)	Sugarcane (km^2)
Mulgrave-Russell	Mulgrave	**Mulgrave River at Deeral**	789	98	1.6	5.0	34	1.1	77
	Russell	**Russell River at East Russell**	522	93	0.15	1.7	45	12	85
Johnstone	Johnstone	**North Johnstone River at Old Bruce Highway Bridge (Goondi)***	960	89	6.5	1.0	380	21	11
Tully	Tully	**Tully River at Euramo**	1450	93	0.10	0.0	88	51	160
Herbert	Herbert	**Herbert River at Ingham**	8584	97	25	390	5200	4.2	240
Haughton	Haughton	**Haughton River at Powerline**	1773	87	4.6	33	1500	6.8	20
		Barratta Creek at Northcote	759	62	22	0.0	600	0.99	130
Burdekin	Burdekin	**Burdekin River at Home Hill**	129,930	99	1300	830	120,000	2.7	120
O’Connell	O’Connell	**O’Connell River at Caravan Park**	819	95	0.0	150	520	0.47	50
Pioneer	Pioneer	**Pioneer River at Dumbleton Pump Station**	1466	93	0.0	370	510	0.65	310
Plane	Plane	**Sandy Creek at Homebush**	326	70	0.0	34	100	1.1	160
Fitzroy	Fitzroy	**Fitzroy River at Rockhampton**	139,289	98	9100	9000	110,000	42	3.3
Burnett	Burnett	**Burnett River at Ben Anderson Barrage Head Water**	32,841	99	1200	4100	25,000	84	93
Mary	Mary	**Mary River at Home Park**	6872	75	35	900	4000	42	15
		Tinana Creek at Barrage Head Water	1284	99	3.5	780	210	29	61

*Prior to Garzon-Garcia et al. (2015) land use surface areas for this site were calculated based on the location of the North Johnstone River site at Tung Oil (monitored area of 925 km^2) where discharge was measured.

3 Results and discussion

3.1 Rainfall and river discharge

Annual rainfall and rainfall deciles (with respect to long-term mean rainfall) across the priority reef catchments and natural resource management regions during the 2014–2015 monitoring year are presented in Figure 3.1 and Figure 3.2.

During the 2014–2015 monitoring year the Normanby catchment in the Cape York region received between 500 and 1000 mm of rain, which is below average to very much below average across the majority of the catchment. Rainfall across the monitored catchments of the Wet Tropics region was generally below average to very much below average with catchments in the west receiving between 500 and 1500 mm, increasing to 3000 mm in the upper Mulgrave and Russell catchments. Rainfall in the North Johnstone, South Johnstone, Tully and Herbert catchments was in the range of 500 mm to 2500 mm with the lower rainfall totals occurring in the upper Herbert catchment.

In the Burdekin region, rainfall was very much below average (<500 mm) in the upper Burdekin catchment and average to below average in the western and southern catchment areas (i.e. 500 to 1000 mm). The monitored catchments of the Mackay Whitsunday region received below average rainfall (i.e. 500 to 1000 mm), while much of the Fitzroy region received average rainfall (500 to 1000 mm). An area of the lower-Fitzroy and northern-Burnett catchments received above average to very much above average rainfall owing to Tropical Cyclone Marcia, which crossed the coast north of Rockhampton in late-February 2015. The remainder of the monitored catchments in the Burnett Mary region received from 500 mm up to 1500 mm of rain, which was average. A detailed monthly rainfall summary is presented in Appendix F.

3.1.1 El Niño-Southern Oscillation and Southern Oscillation Index

The El Niño-Southern Oscillation (ENSO) remained neutral during the first half of the 2014–2015 monitoring year. Between late-December and early-March ENSO indicators strengthened to fluctuate at borderline El Niño conditions with the Bureau of Meteorology adjusting the status between 'El Niño alert' and 'El Niño watch' over consecutive months (BoM 2015b; BoM 2016). Early stages of El Niño were confirmed by May 2015 and the El Niño conditions strengthened through until the end of the monitoring year.

3.1.2 River discharge

During the 2014–2015 monitoring year annual discharges in the Herbert River, Haughton River, Barratta Creek, Burdekin River, O'Connell River, Pioneer River and Sandy Creek were less than half the long-term mean annual discharge (Figure 3.3) with exceedance probabilities ranging between 76 per cent in the Pioneer River to 93 per cent in the Haughton River (Table 3.1). In the Barron, Fitzroy and Burnett rivers the proportion of annual discharge was only slightly higher than the above listed catchments, between 51 and 52 per cent, with exceedance probabilities in the range of 27 per cent in the Burnett catchment to 74 per cent in the Barron catchment.

Of the monitored end-of-catchment sites, the Burnett (27 per cent), Mary (41 per cent) and Normanby (44 per cent) rivers had the lowest exceedance probabilities during the 2014–2015 monitoring year.

Discharge in the Russell River equalled the long-term mean (100 per cent) (Figure 3.3 and Table 3.1). The exceedance probability of discharge in the Russell River (89 per cent), however, indicates the low inter-annual variation in discharge in this catchment compared to monitored catchments in other regions.

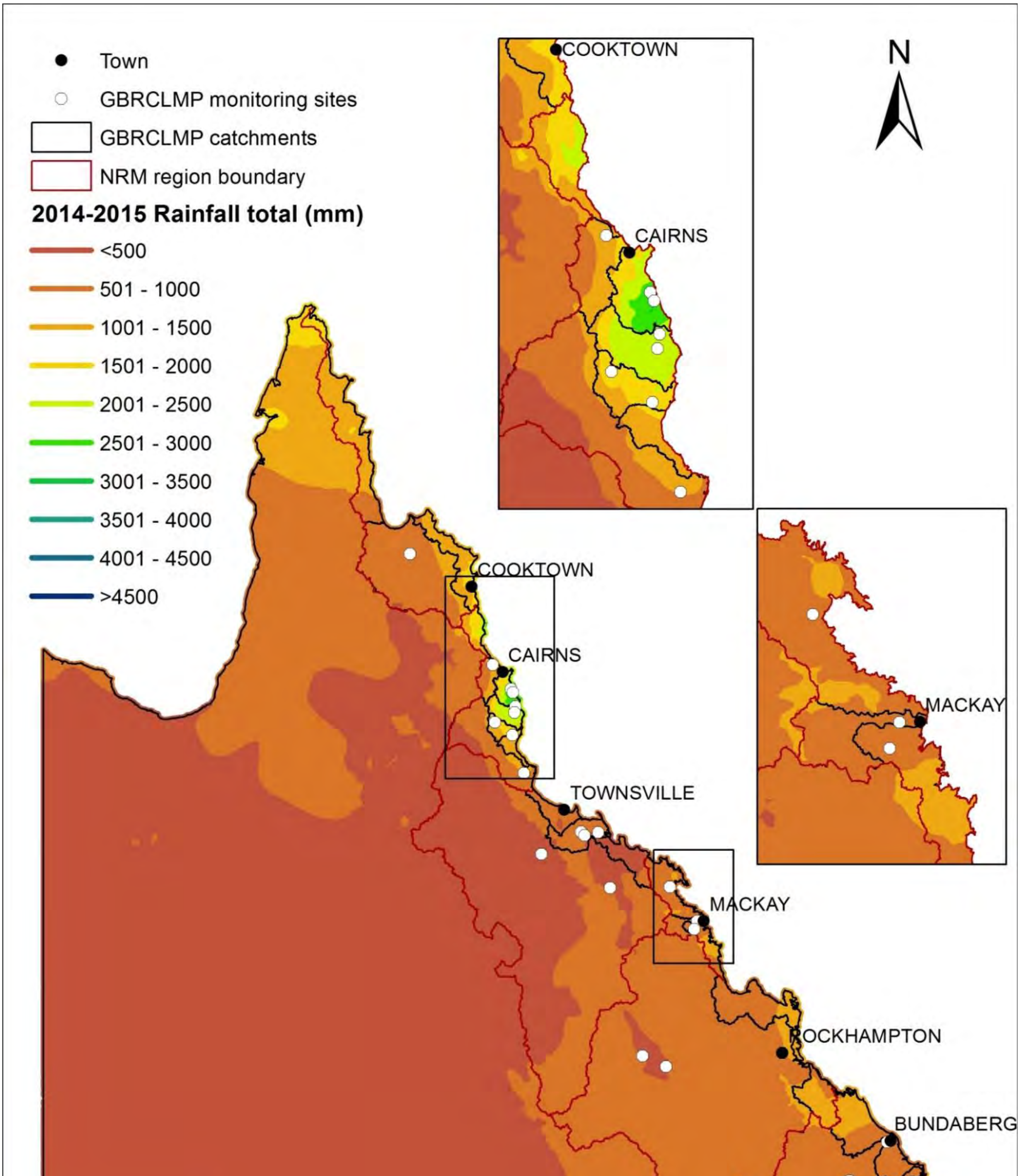


Figure 3.1 Queensland rainfall totals (millimetres) for 1 July 2014 to 30 June 2015, with the natural resource management region, catchments and sites sampled by the Great Barrier Reef Catchment Loads Monitoring Program.

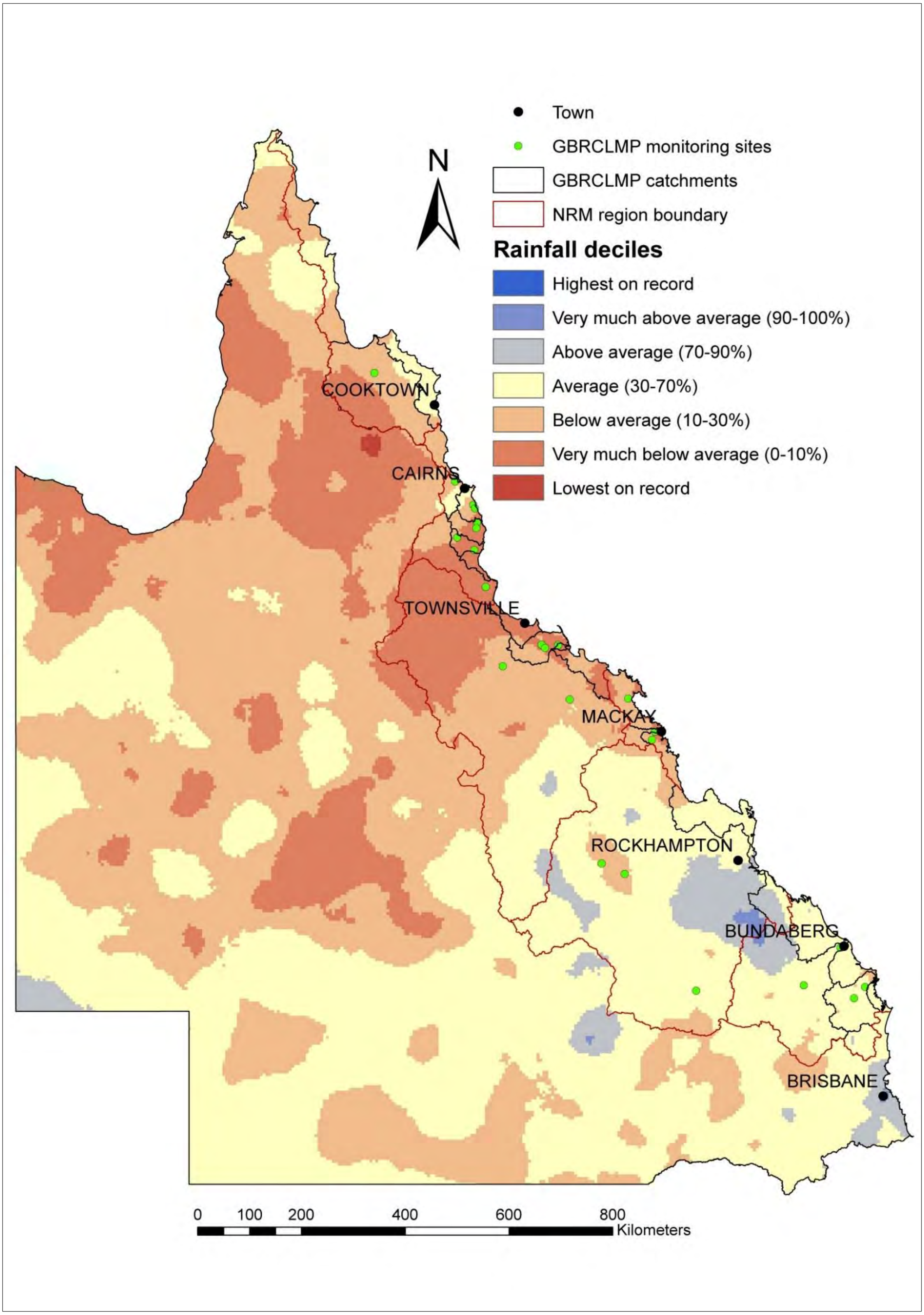


Figure 3.2 Queensland rainfall deciles for 1 July 2014 to 30 June 2015 with respect to long-term mean rainfall, with the natural resource management region, catchments and sites sampled by the Great Barrier Reef Catchment Loads Monitoring Program.

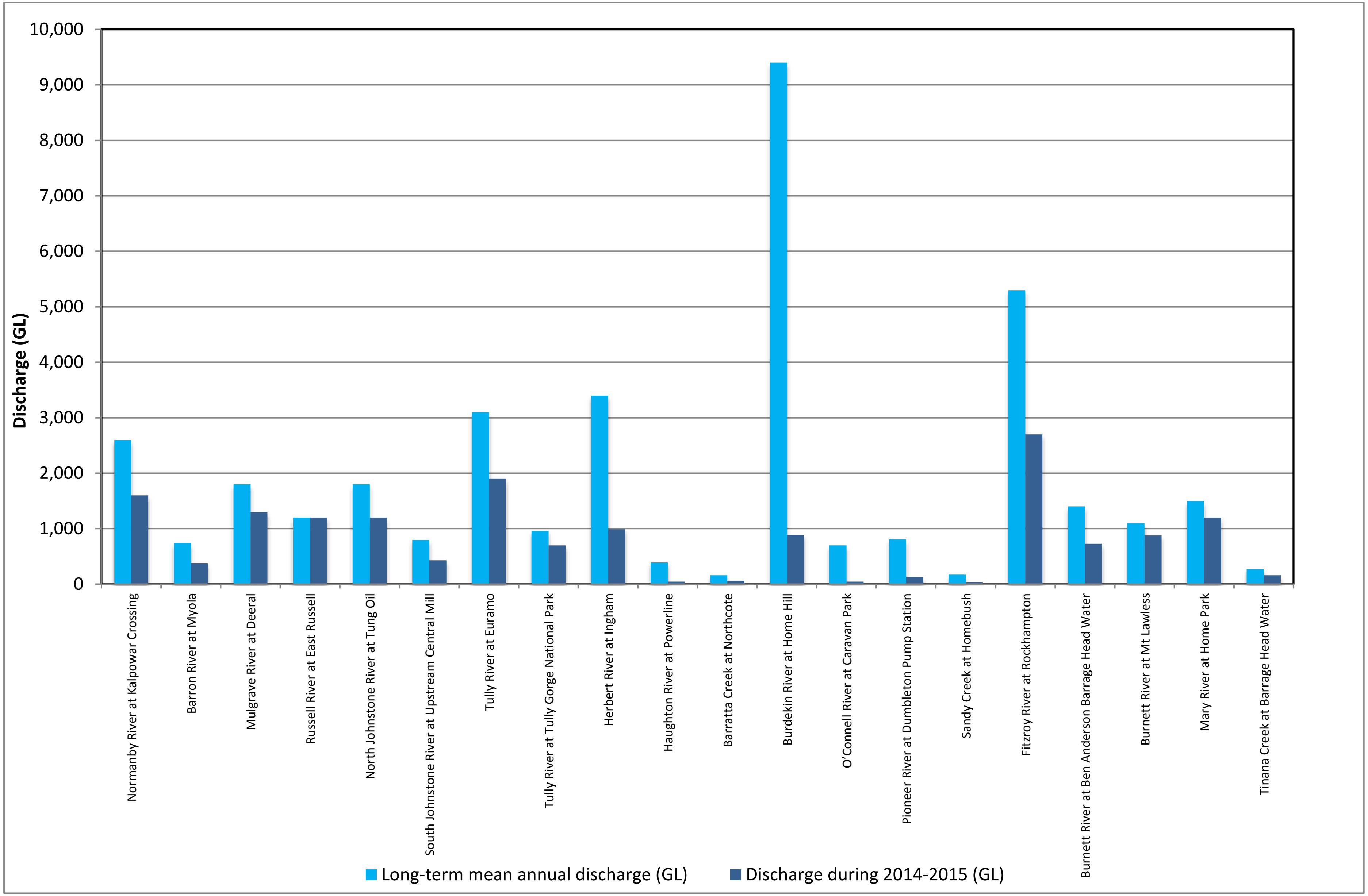


Figure 3.3 Annual discharge for the end-of-catchment sites for the 2014–2015 monitoring year, compared to the long-term mean annual discharge.

Table 3.1 The natural resource management region, basin, catchment and site names, total and monitored area for each catchment and summary discharge and flow statistics for each site sampled in the 2014–2015 monitoring year. Text in bold relate to end-of-catchment sites and the corresponding data; all others relate to sub-catchment sites.

NRM region	Basin	River and site name	Total catchment surface area (km^2)	Monitored surface area (km^2)	Monitored surface area of catchment (%)	Start year of flow records	Long-term mean annual discharge (GL)	Discharge during 2014–2015 (GL)	Exceedance probability (%)	Discharge as a per cent of the long-term mean annual discharge (%)	Historical maximum recorded flow ($m^3 s^{-1}$)	Maximum recorded flow 2014–2015 ($m^3 s^{-1}$)	Per cent of maximum recorded flow observed in 2014–2015 (%)
Cape York	Normanby	**Normanby River at Kalpowar Crossing**	15,030	12,921	86	2005	2600	1600	44	62	2088	1514	73
Wet Tropics	Barron	**Barron River at Myola**	2149	1933	90	1957	740	380	74	51	3076	752	24
	Mulgrave-Russell	**Mulgrave River at Deeral**	804	789	98	1970	1800	1300	59	72	936	464	50
		Russell River at East Russell	561	522	93	1970	1200	1200	89	100	2160	957	44
	Johnstone	**North Johnstone River at Old Bruce Highway Bridge (Goondi)**	1082	960	90	1966	1800	1200	79	67	3051	1394	46
		South Johnstone River at Upstream Central Mill	545	400	73	1974	800	430	87	54	1680	158	9
	Tully	**Tully River at Euramo**	1563	1450	93	1972	3100	1900	86	61	1052	725	69
		Tully River at Tully Gorge National Park		482	31	2009	960	700	83	73	1883	421	22
	Herbert	**Herbert River at Ingham**	8817	8584	97	1915	3400	990	88	29	11,267	750	7
Burdekin	Haughton	**Haughton River at Powerline**	2037	1773	87	1970	390	47	93	12	4454	45	1
		Barratta Creek at Northcote	1226	759	62	1974	160	63	82	39	1695	58	3
	Burdekin	**Burdekin River at Home Hill**	130,120	129,930	100	1973	9400	890	88	9	25,483	988	4
		Burdekin River at Sellheim		36,252	28	1968	4600	260	98	6	24,200	189	1
		Bowen River at Myuna		7107	5.5	1960	950	230	75	24	10,480	764	7
Mackay Whitsunday	O'Connell	**O'Connell River at Caravan Park**	860	819	95	1976	700	44	87	6	6541	257	4
	Pioneer	**Pioneer River at Dumbleton Pump Station**	1570	1466	93	1977	810	130	76	16	4337	382	9
	Plane	**Sandy Creek at Homebush**	465	326	70	1966	170	33	80	19	1314	157	12
Fitzroy	Fitzroy	**Fitzroy River at Rockhampton**	142,553	139,289	98	1964	5300	2700	54	51	14,493	2074	14
		Theresa Creek at Gregory Highway		8485	6	1956	310	92	62	31	4234	219	5
		Comet River at Comet Weir		16,423	12	2002	910	100	75	11	3975	129	3
		Dawson River at Taroom		15,847	11	1911	400	250	45	63	5858	377	6
Burnett Mary	Burnett	**Burnett River at Ben Anderson Barrage Head Water**	33,179	32,841	99	1910	1400	730	27	52	16,902	2191	13
		Burnett River at Mt Lawless		29,356	88	1909	1100	880	18	80	16,646	3045	18
	Mary	**Mary River at Home Park**	9467	6872	75	1982	1500	1200	41	80	12,581	2476	20
		Tinana Creek at Barrage Head Water		1284	14	1970	270	160	50	59	1124	235#	21
Summary end-of-catchment catchment areas (excluding nested sub-catchments)			352,028	342,918	97								

NRM = natural resource management; # = maximum modelled flow in 2014–2015

3.2 Sampling representivity

The sampling representivity rating classified the sample coverage achieved during the period of maximum flow at each monitoring site. The representivity metric was applied because the majority of the annual total suspended solids and nutrient loads are transported during the highest flow periods and in order to reliably calculate the annual pollutant load, it is important that the pollutant concentration data are available for the periods of highest flow. Table 3.2 to Table 3.4 provide a summary of the sampling representivity ratings – indicating those parameters and sites where the representivity is excellent or good, moderate or indicative. Table 7.11 and Table 7.12 in Appendix G provide the representivity rating and the number of samples used to calculate the loads and yields of total suspended solids and nutrients.

No annual loads are reported for the sub-catchment monitoring site Burnett River at Mt Lawless. Although excellent sample coverage was achieved at the Burnett River at Mount Lawless monitoring site, all concentration data were excluded from analysis and reporting due to non-conformance with the sample collection methods. This was due to sediment accretion resulting in the burial of the intake of the automatic sampler below the river bed surface, which impacted the measured concentration of all analytes.

As outlined in Section 2.7.1, the representivity of pesticide data was not assessed as the maximum pesticide concentrations often do not occur at the same time as maximum flow.

3.2.1 Total suspended solids, total nutrients and dissolved nutrients

Good or excellent sampling representivity was achieved at all monitoring sites for all monitored analytes, except in the Haughton River, Theresa Creek and Tinana Creek catchments (Table 3.2).

During the 2014–2015 monitoring year, the Haughton River had very low discharge, which did not permit the application of the sample representivity metric. The average load (linear interpolation of concentration) method was selected as the best load calculation method for this site, taking into consideration that coverage requirements for low flow monitoring are not as stringent as those for high flow (concentrations during low flow do not have such a high variability as those during high flow events).

In the Theresa Creek sub-catchment, sample representivity was moderate for all analytes. This occurred largely due to delayed training of regional staff resulting in few samples being collected during the first and largest event of the year.

The sample coverage during low flow and event flow periods in Tinana Creek in the Mary basin was exceptional with 107 samples collected across the monitoring year, including all major flow events. However, as modelled daily flows were used to calculate annual loads for Tinana Creek, an indicative rating was given because there were no measurements of flow which is known to be the dominant factor determining the magnitude of loads. The same approach was used in the 2013–2014 monitoring year.

3.3 Total suspended solids and nutrient loads and yields

The monitored annual loads and yields of total suspended solids and nutrients were calculated using measured concentration data. The resultant loads are the mass of each analyte transported past the monitoring sites and do not necessarily represent the loads discharged to the Great Barrier Reef lagoon. This occurs because most of the end-of-catchment monitoring sites are not located at the mouth of the river or creek (refer to Section 2.1) and in the unmonitored portion of the catchment or sub-catchment there may be contribution, removal, transformation or degradation of total suspended solids and nutrients. The annual loads discharged to the Great Barrier Reef for all 35 basins are calculated using catchment models and are reported elsewhere in the Paddock to Reef program (DPC 2015).

The monitored annual loads and yields of total suspended solids and nutrients are presented in Table 3.2 to Table 3.4. The relative contribution of each monitored catchment to the total annual load for each parameter is presented in Figure 3.4 to Figure 3.14.

As previously mentioned, daily modelled flow was used to calculate monitored annual loads for Tinana Creek in the Mary basin. Consequently, the calculated monitored annual loads for this site, which are included in the results section, are considered indicative due to the intrinsic limitations of using modelled flow in place of measured flow. Modelled flow was also used in the calculation of monitored annual loads in the Mulgrave and Russell catchments, but these were considered to be of excellent representivity as modelled flow was only used for periods of low discharge.

3.3.1 Total suspended solids

3.3.1.1 Total suspended solid loads

The combined monitored annual load of total suspended solids for the priority catchments during the 2014–2015 monitoring year was 2.4 Mt (Table 3.2), of which, 68 per cent was derived from the Fitzroy (0.90 Mt; 38 per cent) and Burdekin (0.70 Mt; 30 per cent) catchments (Table 3.2 and Figure 3.4). Moderate loads were also derived from the Mary (0.23 Mt; 9.6 per cent) and North Johnstone (0.18 Mt; 7.4 per cent) catchments. The remaining monitored catchments each contributed less than five per cent of the combined monitored annual total suspended solids load. The lowest monitored annual total suspended solids load during the 2014–2015 monitoring year was in the Haughton catchment (0.00062 Mt; 0.026 per cent).

The Burdekin and Fitzroy catchments typically contribute the majority of the monitored total suspended solids annual loads (between 52 per cent in 2012–2013 and 92 per cent in 2007–2008); however, in the 2013–2014 monitoring year these catchments produced only 20 per cent of the total monitored annual load because the annual discharge was very much below average (Garzon-Garcia et al. 2015). The high proportion of the monitored loads from these two catchments during the 2014–2015 monitoring year, relative to the mass load of other catchments, is explained by the low discharge across most monitored catchments during the 2014–2015 monitoring year relative to historic discharge.

In the Wet Tropics region, the Russell (0.020 Mt; 0.83 per cent), Mulgrave (0.018 Mt; 0.77 per cent) and South Johnstone (0.028 Mt; 1.2 per cent) catchments produced low loads of total suspended solids compared to other sites monitored by the Great Barrier Reef Catchment Loads Monitoring Program. The load of total suspended solids monitored at the North Johnstone catchment (0.18 Mt; 7.4 per cent) was the highest of all monitored catchments in the Wet Tropics region, being approximately three and four times greater than the Herbert (0.059 Mt) and Barron (0.047 Mt) catchments, respectively, and six times greater than the Tully (0.029 Mt) catchment.

In the Burdekin catchment, the highest monitored annual sub-catchment load occurred in the Bowen River (monitored at Myuna, 0.43 Mt), with a much lower monitored annual load of total suspended solids in the upper Burdekin River (monitored at Sellheim, 0.056 Mt) (Table 3.2). The monitored annual load of total suspended solids in the Burdekin River at Sellheim was the lowest reported for this sub-catchment since the Great Barrier Reef Catchment Loads Monitoring Program commenced in 2006. The low monitored annual load of total suspended solids in the upper Burdekin sub-catchment is explained by the very low rainfall (very much below average) and discharge in this sub-catchment during the 2014–2015 monitoring year.

Since the Great Barrier Reef Catchment Loads Monitoring Program commenced in 2006, the 2014–2015 monitoring year provided the first opportunity to present loads for all three monitored sub-catchments in the Fitzroy basin – sampling representivity was moderate to good at all sites during the 2014–2015 monitoring year. In previous years, loads were not reported for some sites due to low sampling coverage and inadequate sampling representivity. The improved sampling during the 2014–2015 monitoring year was achieved through enhanced engagement, provision of training to regional personnel and implementation of formal contracts with regional organisations to implement sample collection.

The Dawson River and Comet River sub-catchments produced similar monitored annual loads of total suspended solids during the 2014–2015 monitoring year (0.13 Mt and 0.12 Mt, respectively). A lower load of total suspended solids was derived from the Theresa Creek sub-catchment (0.081 Mt), which has a monitored area approximately half the size of the other monitored sub-catchment.

In the Mary basin the monitored load of total suspended solids from the Mary River monitored at Home Park (0.23 Mt) was 55 times larger than the monitored load of total suspended solids derived from Tinana Creek (0.0041 Mt) despite the fact that the monitored area of the Mary River catchment is only 5.4 times larger than the monitored area of the Tinana Creek catchment.

No monitored annual loads of total suspended solids are reportable for the Burnett River at Mt Lawless monitoring site during 2014 – 2015. This occurred as a review of data quality for this site determined that there was non-conformance of the sample collection methods against existing quality management systems. All data reported for the Burnett River at Mt Lawless during previous years are unaffected.

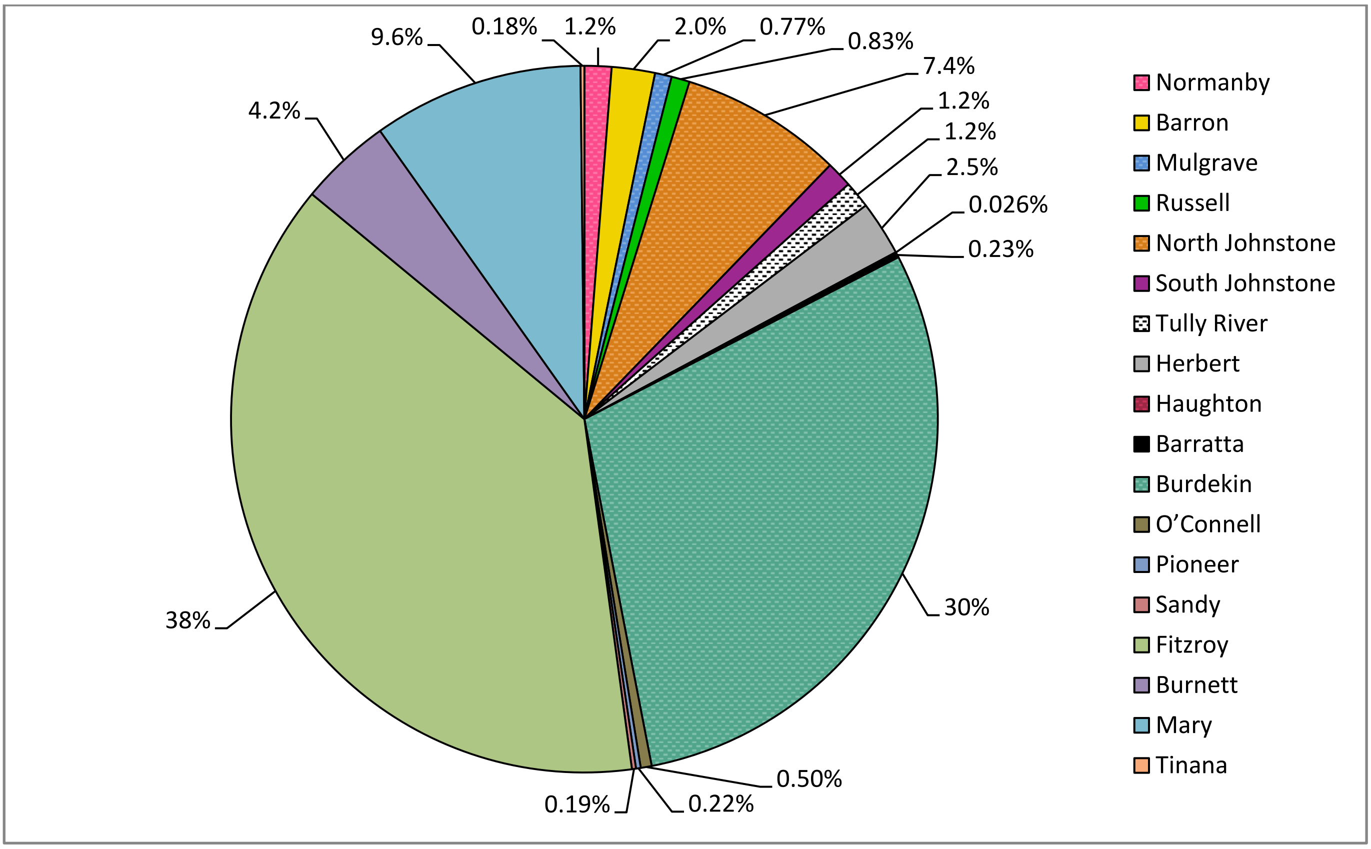


Figure 3.4 Per cent contribution of each catchment to the combined monitored annual total suspended solids load during the 2014–2015 monitoring year.

3.3.1.2 Total suspended solids yields

The highest yield of total suspended solids during the 2014–2015 monitoring year was derived from the North Johnstone catchment (180 t km^{-2}) (Table 3.3). Moderate yields of total suspended solids were monitored in the South Johnstone (70 t km^{-2}), Russell (38 t km^{-2}), Mary (33 t km^{-2}), Barron (24 t km^{-2}), Mulgrave (23 t km^{-2}) and Tully (20 t km^{-2}) catchments (Table 3.3). All of these catchments, except the Mary, are located in the Wet Tropics natural resource management region. The moderate yield of total suspended solids derived from the Mary catchment was driven by the moderate flood event during February 2015 – the maximum flow rate during this event exceeded the flow rate in all other events at all end-of-catchment sites monitored by the Great Barrier Reef Catchment Loads Monitoring Program during the 2014–2015 monitoring year (Table 3.1).

Catchments in the Wet Tropics region have consistently produced high yields of total suspended solids during previous monitoring years relative to other monitored catchments (Garzon-Garcia et al. 2015). This is the first year that annualised yields are reported for the Russell and Mulgrave catchments. The yield of total suspended solids in these catchments was similar to other catchments in this region.

The lowest monitored annual yield of total suspended solids during the 2014–2015 monitoring year occurred in the Haughton catchment (0.35 t km^{-2}). The larger catchments (i.e. surface areas greater than 8000 km^{2}) , including the Normanby (2.3 t km^{-2}), Herbert (6.9 t km^{-2}), Burdekin (5.4 t km^{-2}), Fitzroy (6.5 t km^{-2}) and

Burnett (3.0 t km^{-2}), generally have low yields of total suspended solids compared to the small coastal catchments (i.e. surface areas less than 1000 km^{2}) of the Mackay Whitsunday (range, 13–14 t km^{-2}) and Wet Tropics regions (range, 23–180 t km^{-2}). During the 2014–2015 monitoring year, however, low discharge in catchments of the Mackay Whitsunday region contributed to lower loads of total suspended solids over the monitoring period. The yield of total suspended solids in the Pioneer catchment (2.5 t km^{-2}) was very low compared to previous monitoring years – 24 t km^{-2} in 2013–2014, 89 t km^{-2} in 2012–2013, 140 t km^{-2} in 2011–2012, and 550 t km^{-2} in 2010–2011 (see Wallace et al. 2015, Garzon-Garcia et al. 2015).

The yield of total suspended solids was similar between the two monitoring sites in the Tully catchment despite substantial differences in upstream land use – Tully River at Tully Gorge National Park (18 t km^{-2}) and the Tully River end-of-catchment monitoring site at Euramo (20 t km^{-2}). Upstream of the Tully River at Tully Gorge National Park sub-catchment monitoring site, 96 per cent of the catchment is contained in conservation and protected areas, with a small area of grazing on the plateau that represents less than one per cent of the catchment area. Upstream of the Tully River at Euramo end-of-catchment site, over 75 per cent of the catchment is contained in conservation and protected area; however, the catchment also includes intensive land uses including sugarcane production, horticulture (primarily banana production) and grazing that, together, account for a further 20 per cent of the land use upstream of the Tully River at Euramo end-of-catchment monitoring site.

In the monitored sub-catchments of the Burdekin River, the yield of total suspended solids at upper Burdekin River monitored at Sellheim was 1.5 t km^{-2}, which was exceptionally low compared to the yield reported for all years since 2006, including the previously reported low yield in 2013–2014 of 57 t km^{-2}. The low yield of total suspended solids from the upper Burdekin is likely due to the exceptionally low discharge from this sub-catchment during the monitoring year, which was only six per cent of the long-term annual average (Table 3.1). In the Bowen River sub-catchment the yield of total suspended solids was 61 t km^{-2}, twice the yield of total suspended solids during the previous monitoring year (Garzon-Garcia et al. 2015). The increase in yield is despite discharge during the 2014–2015 being approximately half the discharge observed during the previous monitoring year. This likely reflects the reduced ground cover following sequential years of very much below average rainfall and an increased risk of sediment mobilisation during rainfall runoff events.

During the 2014–2015 monitoring year, the yield of total suspended solids was similar among the monitored sub-catchments in the Fitzroy basin – Theresa Creek (9.5 t km^{-2}), Dawson River (8.0 t km^{-2}) and Comet River (7.0t km^{-2}).

3.3.2 Nitrogen

3.3.2.1 Nitrogen load

During the 2014–2015 monitoring year, the combined monitored annual load of total nitrogen was 12 kt (Table 3.2); equal to the monitored load of total nitrogen in the 2013–2014 monitoring year (Garzon-Garcia et al. 2015). The Fitzroy (3.2 kt; 27 per cent) catchment produced the largest monitored annual load of total nitrogen with moderate loads also derived from the Mary (1.4 kt; 12 per cent), North Johnstone (1.2 kt; 9.9 per cent), Burdekin (1.0 kt; 8.5 per cent) and Burnett (0.84 kt; 7.2 per cent) (Table 3.2 and Figure 3.5) catchments. All other monitored catchments each contributed less than six per cent of the combined monitored load of total nitrogen during the 2014–2015 monitoring year with the lowest loads derived from the O'Connell (0.077 kt; 0.65 per cent), Sandy Creek (0.062 kt; 0.53 per cent) and Haughton (0.017 kt; 0.14 per cent) catchments.

During the 2014–2015 monitoring year, the combined monitored annual load of particulate nitrogen was 5.4 kt (Table 3.2). Consistent with the observed trend of total suspended solids loads, the largest monitored annual loads of particulate nitrogen during the 2014–2015 monitoring year were derived from the Fitzroy (1.6 kt; 30 per cent), North Johnstone (0.82 kt; 15 per cent), Burdekin (0.62 kt: 12 per cent) and Mary (0.62 kt; 11 per cent) catchments. The remaining catchments each contributed less than seven per cent of the combined monitored load (Figure 3.9), with the lowest end-of-catchment load monitored in the Haughton catchment (0.0041 kt; 0.076 per cent) (Table 3.2 and Figure 3.9).

The combined monitored annual load of dissolved inorganic nitrogen was 2.6 kt (Table 3.2). The largest monitored annual loads of dissolved inorganic nitrogen was derived from the Fitzroy catchment (0.47 kt; 18 per cent) with moderate loads from the Tully (0.38 kt; 15 per cent), Mary (0.31 kt; 12 per cent) and Russell (0.27 kt; 10 per cent) catchments. The remaining catchments each contributed less than eight per cent of the combined monitored dissolved inorganic nitrogen load, with the lowest monitored loads occurring in the O'Connell (0.0082 kt; 0.31 per cent) and Haughton (0.0026 kt; 0.097 per cent) catchments.

Oxidised nitrogen accounted for 87 per cent of the combined monitored dissolved inorganic nitrogen load during the 2014–2015 monitoring year (Table 3.2). The largest monitored annual loads of oxidised nitrogen were derived from the Fitzroy (0.40 kt; 17 per cent), Tully (0.36 kt; 16 per cent), Mary (0.28 kt; 12 per cent) and Russell (0.24 kt; 10 per cent) catchments that, together, accounted for 56 per cent of the combined monitored end-of-catchment load. The remaining catchments each contributed less than approximately eight per cent of the total monitored oxidised nitrogen load, with the lowest annual load of oxidised nitrogen load monitored in the Haughton catchment (0.0022 kt; 0.094 per cent).

During the 2014–2015 monitoring year, the total monitored annual load of ammonium nitrogen was 0.34 kt (Table 3.2). The Fitzroy (0.077 kt; 22 per cent), Burnett (0.069 kt; 20 per cent) and Russell (0.030 kt; 8.9 per cent) catchments contribute over half of the total ammonium nitrogen load with moderate loads also monitored in the Mary (0.027 kt; 7.8 per cent), Tully (0.025 kt; 7.2 per cent), Normanby (0.019 kt; 5.6 per cent) and Mulgrave (0.018 t; 5.4 per cent) catchments. All remaining catchments each contributed five per cent or less of the monitored ammonium nitrogen load, with the lowest monitored annual loads occurring in the Haughton catchment (0.00040 kt; 0.12 per cent).

The ratio of the monitored annual oxidised nitrogen load to the ammonium nitrogen load varied greatly amongst catchments. In the Sandy Creek, North Johnstone, South Johnstone and Tully catchments the ratio was high (15:1). In all other catchments the ratio was in the range 5:1 to 11:1, except in the Pioneer, Tinana, Burnett, O'Connell and Normanby catchments where the ratio was less than 3:1. The Normanby catchment was the only monitored catchment where the load of ammonium nitrogen was larger than the monitored annual load of oxidised nitrogen – this is consistent with previous monitoring years where the ratio was less than 1:1 (e.g. Wallace et al. 2015; Garzon-Garcia et al. 2015).

Within the Mary basin, the ratio of the monitored annual oxidised nitrogen load to the ammonium nitrogen load in the Mary River catchment (11:1) was approximately five times higher compared to Tinana Creek catchment (2:1). The ratio of oxidised nitrogen to ammonium load was similar between the Dawson and Comet rivers (11:1 and 14:1, respectively) in the Fitzroy basin, which were approximately twice the ratio observed in Theresa Creek (5.5:1), also in the Fitzroy basin. In the upper Burdekin River sub-catchment (monitored at Sellheim) the ratio of oxidised nitrogen to ammonium nitrogen was four times higher than in the Bowen River sub-catchment (8:1 and 2:1, respectively).

The combined monitored annual load of dissolved organic nitrogen during the 2014–2015 monitoring year was 3.7 kt (Table 3.2) – approximately one third of the combined total nitrogen load. The largest monitored annual loads of dissolved organic nitrogen were derived from the Fitzroy (1.1 kt; 31 per cent), Mary (0.46 kt; 12 per cent) and Normanby (0.38 kt; 10 per cent) catchments that, together, accounted for over half the combined monitored annual end-of-catchment load during the 2014–2015 monitoring year. Moderate loads were also monitored in the Burnett (0.30 kt; 8.1 per cent), Burdekin (0.23 kt; 6.1 per cent) and Herbert (0.21 kt; 5.7 per cent) catchments (Table 3.2 and Figure 3.10). The remaining catchments each contributed less than five per cent of the combined monitored load of dissolved organic nitrogen (Figure 3.10), with the lowest loads monitored in the O'Connell (0.023 kt;0.61 per cent), Sandy Creek (0.022 kt; 0.58 per cent) and Haughton (0.010 kt; 0.28 per cent) catchments.

3.3.2.2 Nitrogen yields

During the 2014–2015 monitoring year the yield of total nitrogen derived from the North Johnstone catchment (1200 kg km^{-2}) was very high relative to all other monitored catchments across the Great Barrier Reef. High yields were also derived from all other coastal catchments in the Wet Tropics region including the Russell (980 kg km^{-2}), South Johnstone (900 kg km^{-2}), Mulgrave (600 kg km^{-2}) and Tully (470 kg km^{-2}) catchments (Table 3.3). Moderate yields of total nitrogen were also derived from Barratta Creek (200 kg km^{-2}), Mary (200 kg km^{-2}) and Sandy Creek (190 kg km^{-2}) catchments. The lowest monitored annual yields of total nitrogen were derived from the larger inland catchments in which a dominant land use is dry land grazing, including the Burnett (26 kg km^{-2}), Fitzroy (23 kg km^{-2}) and Burdekin (7.7 kg km^{-2}) catchments, which is consistent with previous monitoring years between 2006–2014 (Garzon-Garcia et al. 2015).

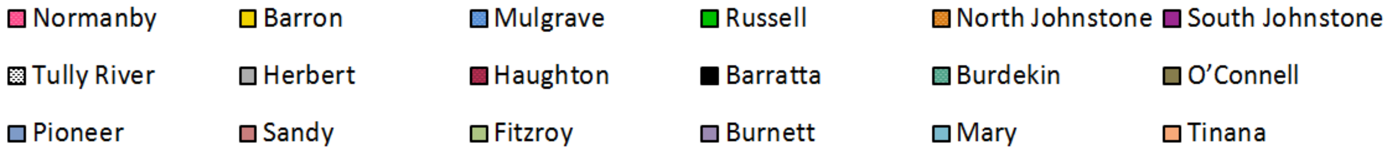
The North Johnstone and South Johnstone catchments generated the highest yield of particulate nitrogen during the 2014–2015 monitoring year with 860 kg km^{-2} and 680 kg km^{-2}, respectively (Table 3.3). Moderate yields of particulate nitrogen were derived from the Russell (210 kg km^{-2}), Mulgrave (140 kg km^{-2}) and Tully (90 kg km^{-2}) catchments, which are all in the Wet Tropics region. The yield of particulate nitrogen in the Mary catchment (90 kg km^{-2}) was also notably high relative to other catchments in the southern and central natural resource management regions, including the Burnett (11 kg km^{-2}), Fitzroy (12 kg km^{-2}) and Pioneer (24 kg km^{-2}) catchments. The lowest yields of particulate nitrogen during the 2014–2015 monitoring year were derived from the Burdekin (4.8 kg km^{-2}) and Haughton (2.3 kg km^{-2}) catchments.

The yield of dissolved inorganic nitrogen in the Russell (520 kg km^{-2}) catchment was exceptionally high relative to all other catchments monitored during the 2014–2015 monitoring year. The yield of dissolved inorganic nitrogen in the Russell catchment was twice the yield of dissolved inorganic nitrogen in the Tully catchment (260 kg km^{-2}), which during previous monitoring years consistently produced amongst the highest yields. The yield of dissolved inorganic nitrogen in the Mulgrave catchment was also high (260 kg km^{-2}) relative to other monitored catchments. As the 2014–2015 monitoring year was the first year that annual loads and yields are reported for the Russell and Mulgrave catchments, no comparison with previous monitoring years is possible and the reason for such high yields is not clear at this stage. Moderate yields of dissolved inorganic nitrogen were also derived from the North Johnstone (200 kg km^{-2}), South Johnstone (110 kg km^{-2}) and Barratta Creek (110 kg km^{-2}) catchments. The Burdekin and Haughton catchments produced the lowest monitored yields of dissolved inorganic nitrogen over the 2014–2015 monitoring year (1.2 kg km^{-2} and 1.4 kg km^{-2}).

The yield of oxidised nitrogen was high across the smaller monitored coastal catchments in the Wet Tropics region (e.g. Russell River 460 kg km^{-2}, Tully River 250 kg km^{-2}, Mulgrave River 240 kg km^{-2}) with comparatively lower yields in the larger Barron and Herbert catchments (20 kg km^{-2} and 17 kg km^{-2}, respectively), which are also in the Wet Tropics region. Outside of the Wet Tropics region, Barratta Creek (99 kg km^{-2}), Sandy Creek (63 kg km^{-2}) and the Mary (41 kg km^{-2}) catchments also produced high yields of oxidised nitrogen relative to other monitored catchments. The lowest yields of oxidised nitrogen during the 2014–2015 monitoring year were in the Haughton (1.2 kg km^{-2}), Normanby (1.2 kg km^{-2}) and Burdekin (1.1 kg km^{-2}) catchments.

The largest yields of ammonium nitrogen were also in the smaller coastal catchments of the Wet Tropics region, with the Russell (58 kg km^{-2}), Mulgrave (23 kg km^{-2}), Tully (17 kg km^{-2}) and North Johnstone (12 kg km^{-2}) catchments generating yields higher than in all other monitored catchments. Barratta Creek (11 kg km^{-2}) and the Pioneer (7.5 kg km^{-2}) catchments also produced moderate yields of ammonium nitrogen, with the lowest yields derived from the Fitzroy (0.55 kg km^{-2}), Haughton (0.23 kg km^{-2}) and Burdekin (0.11 kg km^{-2}) catchments.

The monitored annual yield of dissolved organic nitrogen during the 2014–2015 monitoring year were high in the smaller coastal catchments of the Wet Tropics region, with the highest yields occurring in the Russell (260 kg km^{-2}) and Mulgrave (210 kg km^{-2}) catchments. Moderate yields were derived from the Tully (120 kg km^{-2}), Tinana Creek (77 kg km^{-2}), Mary (67 kg km^{-2}), Sandy Creek (66 kg km^{-2}), Barratta Creek (56 kg km^{-2}) and Barron (50 kg km^{-2}) catchments. The lowest yields of dissolved organic nitrogen during the 2014–2015 monitoring year were derived from the Fitzroy (8.2 kg km^{-2}), Haughton (5.8 kg km^{-2}) and Burdekin (1.7 kg km^{-2}) catchments.



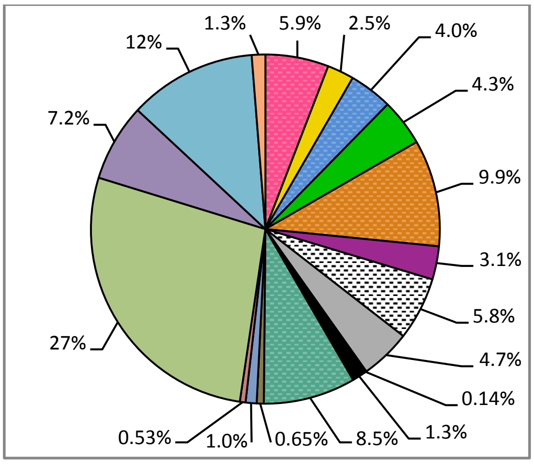


Figure 3.5 Per cent contribution of each catchment to the combined monitored annual total nitrogen load during the 2014–2015 monitoring year.

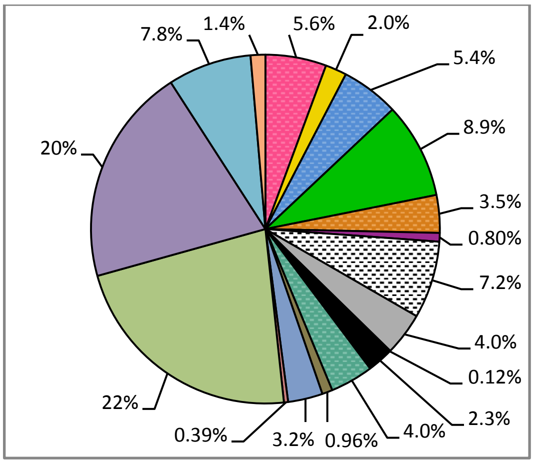


Figure 3.8 Per cent contribution of each catchment to the combined monitored annual ammonium nitrogen load during the 2014–2015 monitoring year.

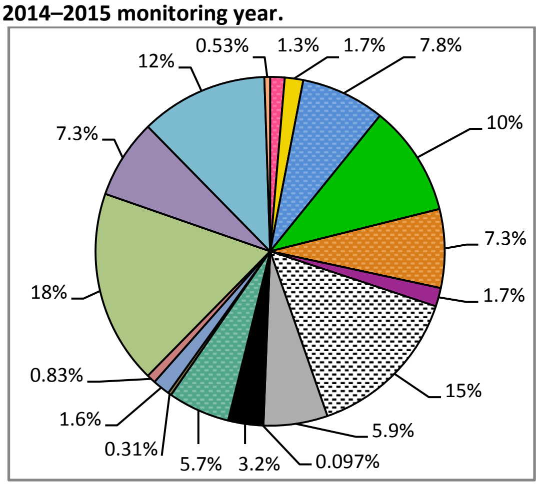


Figure 3.6 Per cent contribution of each catchment to the combined monitored annual dissolved inorganic nitrogen load during the 2014–2015 monitoring year.

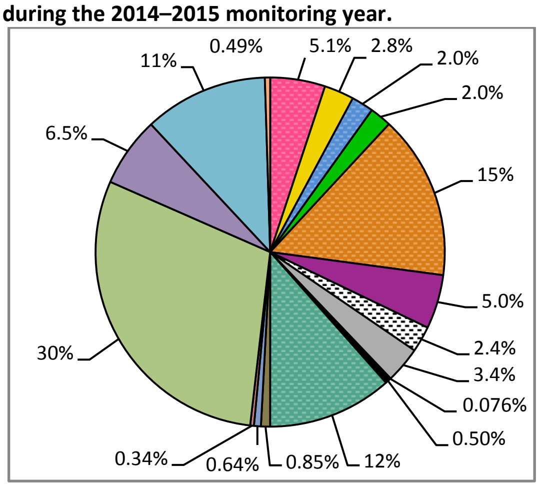


Figure 3.9 Per cent contribution of each catchment to the combined monitored annual particulate nitrogen load during the 2014–2015 monitoring year.

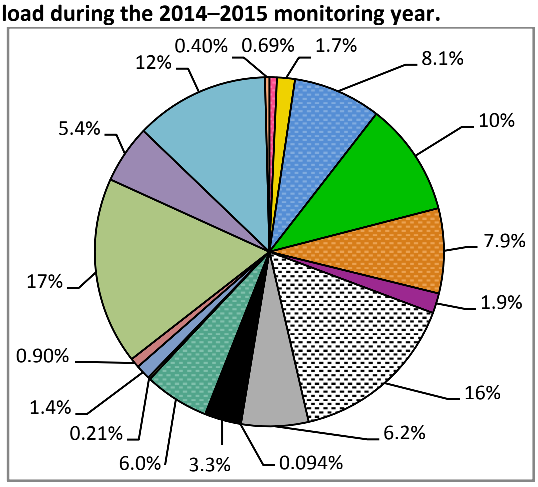


Figure 3.7 Per cent contribution of each catchment to the combined monitored annual oxidised nitrogen load during the 2014–2015 monitoring year.

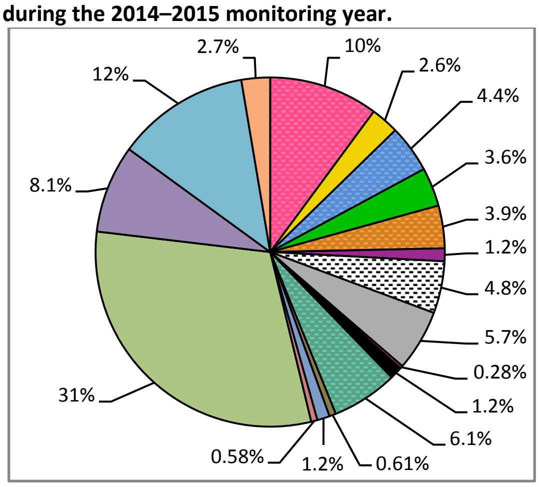


Figure 3.10 Per cent contribution of each catchment to the combined monitored annual dissolved organic nitrogen load during the 2014–2015 monitoring year.

3.3.3 Phosphorus

3.3.3.1 Phosphorus load

The combined monitored annual load of total phosphorus during the 2014–2015 monitoring year was 2.9 kt (Table 3.2), of which 44 per cent was derived from the Fitzroy (1.3 kt; 44 per cent) catchment. Moderate loads were also derived from the Burdekin (0.41kt; 14 per cent), North Johnstone (0.39 kt; 14 per cent), Mary (0.26 kt; 9.0 per cent) and Burnett (0.15 kt; 5.0 per cent) catchments. All remaining catchments contributed less than three per cent of the combined monitored annual load of total phosphorus, with the lowest monitored total phosphorus load derived from in the Haughton catchment (0.0022 kt; 0.075 per cent).

During the 2014–2015 monitoring year, the combined monitored annual load of dissolved inorganic phosphorus was 360 t (Table 3.2). The largest monitored annual load of dissolved inorganic phosphorus was derived from the Fitzroy (240 t) catchment which accounted for 67 per cent of the combined monitored annual load. The proportionally high contribution of the Fitzroy catchment is consistent with previous years between 2009 and 2013 (range 56 to 74 per cent). In the 2013–2014 monitoring year, however, low discharge reduced the proportional contribution of the Fitzroy catchment to 26 per cent of the monitored dissolved inorganic phosphorus load. In the 2014–2015 monitoring year, all other catchments each contributed less than seven per cent of the combined monitored annual dissolved inorganic phosphorus load (Figure 3.12), with the lowest load occurring in the Haughton catchment (0.43 t; 0.12 per cent).

The combined monitored annual load of particulate phosphorus was 2.4 kt (Table 3.2), which accounted for 83 per cent of the total phosphorus monitored annual load (2.9 kt). Similar to total suspended solids and particulate nitrogen loads, the largest monitored annual loads of particulate phosphorus were derived from the Fitzroy (0.96 kt; 40 per cent), Burdekin (0.38 kt; 16 per cent), North Johnstone (0.38 kt; 16 per cent) and Mary (0.23 kt; 9.5 per cent) catchments. The remaining catchments each produced less than five per cent of the combined monitored annual load with the lowest monitored annual load derived from the Haughton catchment (0.0016 kt; 0.066 per cent)

During the 2014–2015 monitoring year the combined monitored annual load of dissolved organic phosphorus was 180 t (Table 3.2). The largest monitored annual loads of dissolved organic phosphorus were derived from the Fitzroy catchment (50 t; 28 per cent). Moderate loads of dissolved organic phosphorus were also monitored in the Tully (19 t; 11 per cent), Normanby (17 t; 9.4 per cent), Mary (14 t; 7.8 per cent) and North Johnstone (13 t; 7.0 per cent) catchments. The remaining catchments each contributed less than seven per cent of the combined monitored load (Figure 3.14), with the lowest load from end-of-catchment sites occurring in the Haughton catchment (0.47 t; 0.25 per cent).

3.3.3.2 Phosphorus yields

During the 2014–2015 monitoring year, the yield of total phosphorus from the North Johnstone catchment (410 kg km^{-2}) (Table 3.4) was more than double the yield from the South Johnstone catchment (190 kg km^{-2}) and five times greater than the Russell catchment (79 kg km^{-2}). Moderate yields of total phosphorus were also derived from the Mulgrave (57 kg km^{-2}), Mary (38 kg km^{-2}), Sandy Creek (38 kg km^{-2}) and Tully

(32 kg km^{-2}) catchments. The lowest monitored annual yield of total phosphorus was derived from the Haughton catchment (1.2 kg km^{-2}), with low yields also occurring in the Burdekin (3.2 kg km^{-2}), Burnett (4.5 kg km^{-2}), Herbert (4.8 kg km^{-2}), Normanby (6.2 kg km^{-2}) and Fitzroy (9.1 kg km^{-2}) catchments. Excluding the Haughton catchment, which produced exceptionally low yields in the 2014–2015 monitoring year due to very low discharge relative to the long-term mean, the latter catchments have consistently produced comparative low yields since commencement of the Great Barrier Reef Catchment Loads Monitoring Program in 2006 (Garzon-Garcia et al. 2015).

Sandy Creek catchment (18 kg km^{-2}) had the highest yield of dissolved inorganic phosphorus compared to all other monitored catchments during the 2014–2015 monitoring year and is consistent with previous monitoring years (Garzon-Garcia et al. 2015). High yields of dissolved inorganic phosphorus were also derived from the Mulgrave (12 kg km^{-2}), South Johnstone (11 kg km^{-2}), Russell (7.4 kg km^{-2}) and North Johnstone (7.1 kg km^{-2}) catchments. The lowest monitored annual yields of dissolved inorganic phosphorus were derived from the Normanby (0.29 kg km^{-2}), Haughton (0.24 kg km^{-2}) and Burdekin (0.19 kg km^{-2}) catchments (Table 3.4).

The highest yields of particulate phosphorus during the 2014–2015 monitoring year were in the North Johnstone (400 kg km^{-2}) and South Johnstone (180 kg km^{-2}) catchments. The yield of particulate phosphorus in all other catchments was comparatively low, with the lowest monitored annual yields derived from the Haughton (0.90 kg km^{-2}) catchment with low yields also occurring in the Herbert (3.9 kg km^{-2}), Burnett (3.6 kg km^{-2}) and Burdekin (2.9 kg km^{-2}) catchments (Table 3.4).

The Russell and Mulgrave catchments generated the highest yields of dissolved organic phosphorus during the 2014–2015 monitoring year (24 kg km^{-2} and 16 kg km^{-2}, respectively). The yield of dissolved organic phosphorus was also high in the other catchments of the Wet Tropics region; North Johnstone (13 kg km^{-2}), Tully (13 kg km^{-2}) and South Johnstone (11 kg km^{-2}) relative to monitored catchments in all other regions. The lowest yields of dissolved organic phosphorus were derived from the Burdekin (0.073 kg km^{-2}), Burnett (0.25 kg km^{-2}) and Haughton (0.26 kg km^{-2}) catchments (Table 3.4).

Normanby | Barron | Mulgrave | Russell | North Johnstone | South Johnstone
Tully River | Herbert | Haughton | Barratta | Burdekin | O'Connell
Pioneer | Sandy | Fitzroy | Burnett | Mary | Tinana

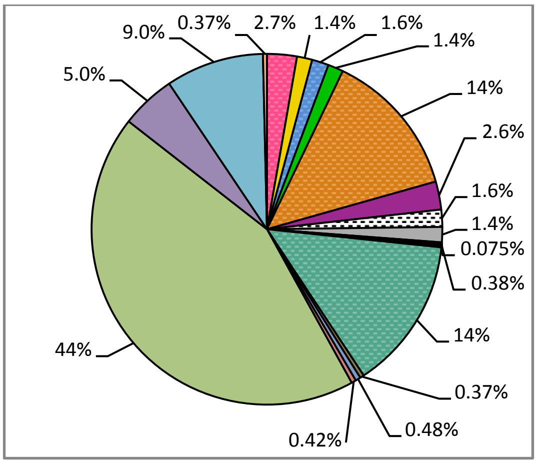


Figure 3.11 Per cent contribution of each catchment to the combined monitored annual total phosphorus load during the 2014–2015 monitoring year.

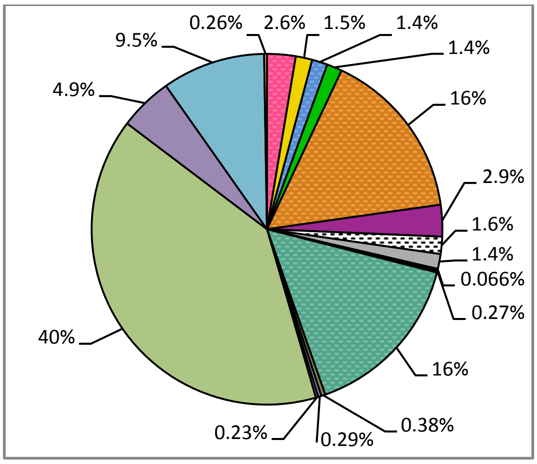


Figure 3.13 Per cent contribution of each catchment to the combined monitored annual particulate phosphorus load during the 2014–2015 monitoring year.

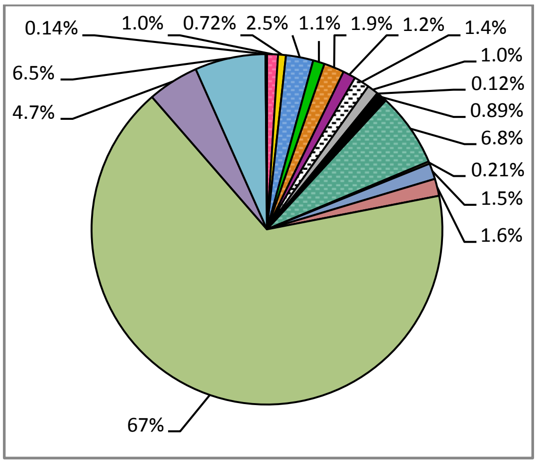


Figure 3.12 Per cent contribution of each catchment to the combined monitored annual dissolved inorganic phosphorus load during the 2014–2015 monitoring year.

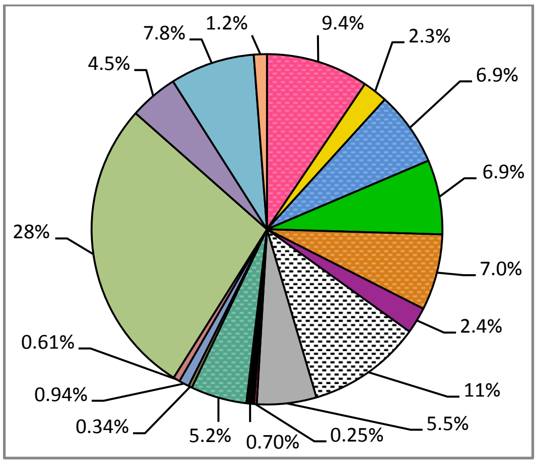


Figure 3.14 Per cent contribution of each catchment to the combined monitored annual dissolved organic phosphorus load during the 2014–2015 monitoring year.

Table 3.2 Monitored annual total suspended solids and nutrient loads for the 2014–2015 monitoring year. Text in bold relate to end-of-catchment sites and the corresponding data, all others relate to sub-catchment sites. Green shading = excellent or good representivity rating; orange shading = moderate representivity; red shading = indicative representivity and grey shading = no representivity calculated.

NRM region	Basin	Catchment	River and site name	Method	TSS (t)	TN (t)	PN (t)	NO_x-N (t)	NH_4-N (t)	DIN (t)	DON (t)	TP (t)	DIP (t)	PP (t)	DOP (t)
Cape York	Normanby	**Normanby River**	**Normanby River at Kalpowar Crossing**	L	29,000	690	280	16	19	35	380	80	3.7	64	17
Wet Tropics	Barron	**Barron River**	**Barron River at Myola**	L	47,000	290	150	38	6.8	45	96	41	2.6	37	4.2
	Mulgrave-Russell	**Mulgrave River**	**Mulgrave River at Deeral**	L	18,000	470	110	190	18	200	160	45	9.2	35	13
		Russell River	**Russell River at East Russell**	L	20,000	510	110	240	30	270	130	41	3.9	34	13
	Johnstone	**North Johnstone River**	**North Johnstone River at Old Bruce Highway Bridge (Goondi)**	B	180,000	1200	820	180	12	190	150	390	6.8	380	13
		South Johnstone River	**South Johnstone River at Upstream Central Mill**	B	28,000	360	270	42	2.8	45	44	76	4.3	71	4.4
	Tully	**Tully River**	**Tully River at Euramo**	L	29,000	690	130	360	25	380	180	46	5.2	38	19
		Tully River	Tully River at Tully Gorge National Park	L	8500	170	64	45	8.8	54	56	14	0.73	12	7.1
	Herbert	**Herbert River**	**Herbert River at Ingham**	B	59,000	550	180	140	14	160	210	41	3.8	33	10
Burdekin	Haughton	**Haughton River**	**Haughton River at Powerline**	L	620	17	4.1	2.2	0.40	2.6	10	2.2	0.43	1.6	0.47
		Barratta Creek	**Barratta Creek at Northcote**	L	5500	150	27	75	8.0	83	43	11	3.3	6.6	1.3
	Burdekin	**Burdekin River**	**Burdekin River at Home Hill**	B	700,000	1000	620	140	14	150	230	410	25	380	9.4
		Burdekin River	Burdekin River at Sellheim	L	56,000	97	30	17	2.1	19	48	22	2.3	15	5.8
		Bowen River	Bowen River at Myuna	L/B	430,000[L]	630[L]	790[B]	35[B]	18[B]	52[B]	72[B]	270[L]	15[B]	390[B]	2.6[B]
Mackay Whitsunday	O'Connell	**O'Connell River**	**O'Connell River at Caravan Park**	B	12,000	77	46	4.9	3.3	8.2	23	11	0.78	9.2	0.61
	Pioneer	**Pioneer River**	**Pioneer River at Dumbleton Pump Station**	L	3600	120	35	31	11	42	43	14	5.3	7.1	1.7
	Plane	**Sandy Creek**	**Sandy Creek at Homebush**	L	4400	62	19	21	1.3	22	22	12	5.8	5.5	1.1
Fitzroy	Fitzroy	**Fitzroy River**	**Fitzroy River at Rockhampton**	B	900,000	3200	1600	400	77	470	1100	1300	240	960	50
		Theresa Creek	Dawson River at Taroom	L	130,000	440	250	57	5.1	62	130	140	40	93	11
		Comet River	Comet River at Comet Weir	B	120,000	210	140	20	1.5	22	46	130	18	110	3.7
		Dawson River	Theresa Creek At Gregory Highway	B	81,000	140	96	5.6	1.0	6.6	37	63	11	48	3.4
Burnett Mary	Burnett	**Burnett River**	**Burnett River at Ben Anderson Barrage Head Water**	B	99,000	840	350	120	69	190	300	150	17	120	8.2
	Mary	**Mary River**	**Mary River at Home Park**	L	230,000	1400	620	280	27	310	460	260	24	230	14
		Tinana Creek	**Tinana Creek at Barrage Head Water**	L	4100	150	26	9.2	4.7	14	98	11	0.50	6.3	2.2
Total combined monitored load (excluding nested sub-catchment sites)					2,400,000	12,000	5400	2300	340	2600	3700	2900	360	2400	180

The number of concentration data points used in the calculation of loads for all analytes is presented in Appendix G. TSS = total suspended solids; TN = total nitrogen; PN = particulate nitrogen; NOx-N = oxidised nitrogen as N; NH_4-N = ammonium nitrogen as N; DIN = dissolved inorganic nitrogen (DIN = (NOx-N) + (NH_4-N)); DON = dissolved organic nitrogen; TP = total phosphorus; DIP = dissolved inorganic phosphorus; PP = particulate phosphorus; DOP = dissolved organic phosphorus; B = Beale ratio method used to calculate loads; L = average load (linear interpolation of concentration) method used to calculate loads.

Table 3.3 Total suspended solids and nitrogen yields calculated for the 2014–2015 monitoring year. Text in bold relate to end-of-catchment sites and the corresponding data, all others relate to sub-catchment sites. Green shading = excellent or good representivity rating; orange shading = moderate representivity; red shading = indicative representivity and grey shading = no representivity calculated.

NRM region	Basin	Catchment	River and site name	Method	TSS (t km^{-2})	TN (kg km^{-2})	PN (kg km^{-2})	NOx-N (kg km^{-2})	NH_4-N (kg km^{-2})	DIN (kg km^{-2})	DON (kg km^{-2})
Cape York	Normanby	**Normanby River**	**Normanby River at Kalpowar Crossing**	L	2.3	53	21	1.2	1.5	2.7	29
Wet Tropics	Barron	**Barron River**	**Barron River at Myola**	L	24	150	77	20	3.5	23	50
	Mulgrave-Russell	**Mulgrave River**	**Mulgrave River at Deeral**	L	23	600	140	240	23	260	210
		Russell River	**Russell River at East Russell**	L	38	980	210	460	58	520	260
	Johnstone	**North Johnstone River**	**North Johnstone River at Old Bruce Highway Bridge (Goondi)**	B	180	1200	860	190	12	200	150
		South Johnstone River	**South Johnstone River at Upstream Central Mill**	B	70	900	680	110	6.9	110	110
	Tully	**Tully River**	**Tully River at Euramo**	L	20	470	90	250	17	260	120
		Tully River	Tully River at Tully Gorge National Park	L	18	350	130	93	18	110	120
	Herbert	**Herbert River**	**Herbert River at Ingham**	B	6.9	65	21	17	1.6	18	24
Burdekin	Haughton	**Haughton River**	**Haughton River at Powerline**	L	0.35	9.4	2.3	1.2	0.23	1.4	5.8
		Barratta Creek	**Barratta Creek at Northcote**	L	7.2	200	35	99	11	110	56
	Burdekin	**Burdekin River**	**Burdekin River at Home Hill**	B	5.4	7.7	4.8	1.1	0.11	1.2	1.7
		Burdekin River	Burdekin River at Sellheim	L	1.5	2.7	0.83	0.47	0.057	0.53	1.3
		Bowen River	Bowen River at Myuna	L/B	61	89	110	4.9	2.5	7.4	10
Mackay Whitsunday	O'Connell	**O'Connell River**	**O'Connell River at Caravan Park**	B	14	94	56	6.0	4.0	10	28
	Pioneer	**Pioneer River**	**Pioneer River at Dumbleton Pump Station**	L	2.5	82	24	21	7.5	29	29
	Plane	**Sandy Creek**	**Sandy Creek at Homebush**	L	13	190	57	63	4.1	67	66
Fitzroy	Fitzroy	**Fitzroy River**	**Fitzroy River at Rockhampton**	B	6.5	23	12	2.8	0.55	3.4	8.2
		Theresa Creek	Dawson River at Taroom	L	8.0	28	16	3.6	0.32	3.9	8.2
		Comet River	Comet River at Comet Weir	B	7.0	13	8.7	1.2	0.09	1.3	2.8
		Dawson River	Theresa Creek At Gregory Highway	B	9.5	16	11	0.66	0.12	0.78	4.3
Burnett Mary	Burnett	**Burnett River**	**Burnett River at Ben Anderson Barrage Head**	B	3.0	26	11	3.7	2.1	5.9	9.2
	Mary	**Mary River**	**Mary River at Home Park**	L	33	200	90	41	3.9	45	67
		Tinana Creek	**Tinana Creek at Barrage Head Water**	L*	3.2	120	21	7.2	3.6	11	77

The number of concentration data points used in the calculation of loads for all analytes is presented in Appendix G. TSS = total suspended solids; TN = total nitrogen; PN = particulate nitrogen; NOx-N = oxidised nitrogen as N; NH_4-N = ammonium nitrogen as N; DIN = dissolved inorganic nitrogen (DIN = (NOx-N) + (NH_4-N)); DON = dissolved organic nitrogen; B = Beale ratio method used to calculate loads; L = average load (linear interpolation of concentration) method used to calculate loads; *Yields for Tinana Creek at Barrage Head Water are indicative considering modelled daily flow was used for load calculations.

Table 3.4 Phosphorus yields calculated for the 2014–2015 monitoring year. Text in bold relate to end-of-catchment sites and the corresponding data, all others relate to sub-catchment sites. Green shading = excellent or good representivity rating; orange shading = moderate representivity; red shading = indicative representivity and grey shading = no representivity calculated.

NRM region	Basin	Catchment	River and site name	Method	TP (kg km^{-2})	DIP (kg km^{-2})	PP (kg km^{-2})	DOP (kg km^{-2})
Cape York	Normanby	**Normanby River**	**Normanby River at Kalpowar Crossing**	L	6.2	0.29	4.9	1.3
Wet Tropics	Barron	**Barron River**	**Barron River at Myola**	L	21	1.4	19	2.2
	Mulgrave-Russell	**Mulgrave River**	**Mulgrave River at Deeral**	L	57	12	44	16
		Russell River	**Russell River at East Russell**	L	79	7.4	65	24
	Johnstone	**North Johnstone River**	**North Johnstone River at Old Bruce Highway Bridge (Goondi)**	B	410	7.1	400	13
		South Johnstone River	**South Johnstone River at Upstream Central Mill**	B	190	11	180	11
	Tully	**Tully River**	**Tully River at Euramo**	L	32	3.6	27	13
		Tully River	Tully River at Tully Gorge National Park	L	30	1.5	26	15
	Herbert	**Herbert River**	**Herbert River at Ingham**	B	4.8	0.44	3.9	1.2
Burdekin	Haughton	**Haughton River**	**Haughton River at Powerline**	L	1.2	0.24	0.90	0.26
		Barratta Creek	**Barratta Creek at Northcote**	L	15	4.3	8.6	1.7
	Burdekin	**Burdekin River**	**Burdekin River at Home Hill**	B	3.2	0.19	2.9	0.073
		Burdekin River	Burdekin River at Sellheim	L	0.62	0.065	0.4	0.16
		Bowen River	Bowen River at Myuna	L/B	39	2.1	55	0.36
Mackay Whitsunday	O'Connell	**O'Connell River**	**O'Connell River at Caravan Park**	B	13	0.95	11	0.75
	Pioneer	**Pioneer River**	**Pioneer River at Dumbleton Pump Station**	L	9.6	3.6	4.8	1.2
	Plane	**Sandy Creek**	**Sandy Creek at Homebush**	L	38	18	17	3.4
Fitzroy	Fitzroy	**Fitzroy River**	**Fitzroy River at Rockhampton**	B	9.1	1.7	6.9	0.36
		Theresa Creek	Dawson River at Taroom	L	9.0	2.5	5.9	0.67
		Comet River	Comet River at Comet Weir	B	7.9	1.1	6.6	0.23
		Dawson River	Theresa Creek At Gregory Highway	B	7.4	1.4	5.7	0.40
Burnett Mary	Burnett	**Burnett River**	**Burnett River at Ben Anderson Barrage Head Water**	B	4.5	0.52	3.6	0.25
	Mary	**Mary River**	**Mary River at Home Park**	L	38	3.5	34	2.1
		Tinana Creek	**Tinana Creek at Barrage Head Water**	L*	8.3	0.39	4.9	1.7

The number of concentration data points used in the calculation of loads for all analytes is presented in Appendix G. TP = total phosphorus; DIP = dissolved inorganic phosphorus; PP = particulate phosphorus; DOP = dissolved organic phosphorus; B = Beale ratio method used to calculate loads; L = average load (linear interpolation of concentration) method used to calculate loads; *Yields for Tinana Creek at Barrage Head Water are indicative considering modelled daily flow was used for load calculations.

3.4 Pesticide loads, toxicity-based loads (toxic pesticide loads) and yields

In this section, the monitored loads and yields of five photosystem II inhibiting herbicides are presented. In addition, the toxicity-based loads (toxic pesticide load) (refer to Section 2.7.2.2) at the 16 monitoring sites (Table 3.5) during the 2014–2015 monitoring year are also presented. The toxic pesticide load is the sum of the monitored annual loads of the five photosystem II inhibiting herbicides (i.e. ametryn, total atrazine, total diuron, hexazinone and tebuthiuron) following conversion to diuron equivalent loads using diuron equivalency factors (Table 2.6).

3.4.1.1 Pesticide loads

The monitored annual loads of photosystem II inhibiting herbicides ametryn, total atrazine, total diuron, hexazinone and tebuthiuron were calculated for 15 end-of-catchment sites and 1 nested sub-catchment site across 12 basins. The loads of the other pesticides detected by analysis funded by the Queensland Department of Environment and Heritage Protection (Reef Water Quality Unit) under project RP57C are presented in Appendix A.

This is the first year that annual loads of photosystem II inhibiting herbicides are reported for the Mulgrave and Russell catchments; event loads were reported during the 2013–2014 monitoring year as these sites were only installed and commissioned during 2014 (Garzon-Garcia et al. 2015).

The total monitored annual load of the five photosystem II inhibiting herbicides exported past the monitoring sites were (from largest to smallest): 1400 kg of total atrazine; 810 kg of total diuron; 410 kg of tebuthiuron; 280 kg of hexazinone; and 7.7 kg of ametryn (Table 3.5). The contribution of each monitored catchment to the total monitored annual loads of these five photosystem II inhibiting herbicides is presented in Figure 3.15 to Figure 3.19.

Total atrazine and total diuron were the only photosystem II inhibiting herbicides detected at all monitored catchments (Table 3.5). Hexazinone was detected in all catchments except the Haughton and Burdekin catchments (Table 3.5). Ametryn was only detected in the Russell, Barratta, Pioneer and Sandy catchments. Tebuthiuron was detected at only five catchments; Barratta, Burdekin, O'Connell, Sandy and Fitzroy catchments (Table 3.5).

Ametryn was detected above the analytical limit of reporting in only four of the monitored catchments with the largest monitored annual loads of ametryn derived from Barratta Creek (4.2 kg; 55 per cent) and Pioneer River (1.9 kg; 25 per cent) catchments, which together accounted for 80 per cent of the total monitored annual ametryn load (7.7 kg) (Table 3.5, Figure 3.15). The remaining two sites contributed comparatively small loads of ametryn, with 0.85 kg (11 per cent) and 0.72 kg (9.4 per cent) derived from the Russell River and Sandy Creek catchments, respectively (Table 3.5, Figure 3.15). The monitored load of ametryn was similar to the previous monitoring year (11 kg) (Garzon-Garcia et al. 2015) and low compared to the monitored annual loads reported for the period 2009–2013 (range 48 kg to 120 kg) despite the increase in the number of monitored catchments and total monitored area.

The Fitzroy River and Barratta Creek contributed over half of the combined monitored total atrazine load (1400 kg) with 520 kg (38 per cent) and 260 kg (19 per cent), respectively. Substantial loads of total atrazine were also detected in the Pioneer (140 kg; 10 per cent), Tully (130 kg; 9.2 per cent) and Sandy Creek (89 kg; 6.4 per cent) catchments (Table 3.5, Figure 3.16). The remaining catchments each contributed less than five per cent of the total monitored annual load of total atrazine, with the lowest reported load coming from the North Johnstone catchment (0.14 kg; 0.0099 per cent). The monitored annual load of total atrazine in the Comet River sub-catchment (250 kg) was approximately half the load monitored at the Fitzroy basin end-of-catchment site and high compared to all other monitored sites.

During the 2014–2015 monitoring year, over half of the monitored annual total diuron load (810 kg) was derived from the Russell (200 kg; 25 per cent), Tully (140 kg; 17 per cent) and Pioneer (100 kg; 13 per cent) catchments (Table 3.5 and Figure 3.17). Moderate monitored annual loads of total diuron were also derived from Mulgrave (78 kg; 9.7 per cent), Sandy Creek (73 kg; 9.0 per cent) and Herbert (70 kg; 8.7 per cent) catchments (Table 3.5, Figure 3.17). All other catchments each contributed less than five per cent of the total monitored annual total diuron load, with the lowest reportable load monitored in the Haughton catchment (0.76 kg; 0.094 per cent). The monitored annual load of total diuron in the Comet River sub-catchment was low (0.58 kg), accounting for approximately two per cent of the total diuron load monitored at the Fitzroy River end-of-catchment site (29 kg).

Hexazinone was detected at 14 of the 16 monitored sites with the largest loads of hexazinone derived from the Tully (73 kg; 27 per cent) and Russell (61 kg; 22 per cent) catchments. Moderate loads were also derived from the Herbert (24 kg; 8.8 per cent), Pioneer (22 kg; 8.1 per cent), Fitzroy (18 kg; 6.7 per cent), Sandy Creek (17 kg; 6.3 per cent) and Mulgrave (17 kg; 6.3 per cent) catchments (Table 3.5, Figure 3.18). The monitored load of hexazinone in all other catchments was less than five per cent of the total monitored annual hexazinone load with the smallest calculable load occurring in the Barratta Creek catchment (1.5 kg; 0.53 per cent) (Table 3.5, Figure 3.18).

Consistent with all monitoring years since 2009, the largest monitored annual load of tebuthiuron was derived from the Fitzroy catchment (390 kg), which accounted for 97 per cent of the total monitored tebuthiuron load (410 kg) (Table 3.5, Figure 3.19). The load of tebuthiuron at the other four catchments, where tebuthiuron was detected above the analytical limit of reporting, ranged from 9.4 kg in the Burdekin catchment (2.3 per cent) to 0.15 kg in the Sandy Creek catchment (0.037 per cent) (Table 3.5, Figure 3.19).

3.4.1.2 Toxic pesticide load

During the 2014–2015 monitoring year, the combined toxic pesticide load of all monitored sites (excluding the nested sub-catchment monitoring site at Comet River), was 930 kg TEq_{diuron} (Table 3.5). The pesticide that contributed most to the total annual toxic pesticide load was total diuron, accounting for 86 per cent of the combined toxic pesticide load. Consistent with previous monitoring years, catchments with high total diuron loads were the main contributors to the annual toxic pesticide loads due to the high weighted toxicity of diuron in the calculation of the toxic pesticide loads.

In the 2014–2015 monitoring year the highest toxic pesticide load was derived from the Russell catchment (220 kg TEq_{diuron}; 23 per cent) (Figure 3.20). This was the first year that annual loads are reported for the Russell and Mulgrave catchments as only event loads were reported in the 2013–2014 monitoring year. Comparatively high toxic pesticide loads were also monitored in the Tully (160 kg TEq_{diuron}; 17 per cent), Pioneer (110 kg TEq_{diuron}; 12 per cent), Mulgrave (84 kg TEq_{diuron}; 9.0 per cent), Sandy Creek (80 kg TEq_{diuron}; 8.5 per cent) and Herbert (76 kg TEq_{diuron}; 8.1 per cent) catchments (Table 3.5). The 2014–2015 toxic pesticide loads are approximately half the toxic pesticide loads reported for some sites in the previous monitoring year (Garzon-Garcia et al. 2015). The calculated annual toxic pesticide load at all remaining sites was less than six per cent of the total calculated annual toxic pesticide load with the lowest toxic pesticide load occurring in the Haughton catchment (0.97 kg TEq_{diuron}; 0.10 per cent) (Table 3.5).

3.4.1.3 Pesticide land use yields

Pesticide land use yields of five photosystem II inhibiting herbicides (ametryn, total atrazine, total diuron, hexazinone and tebuthiuron) were calculated for 15 sites monitored during 2014–2015. This is the first year that land use yields have been reported for the Mulgrave and Russell catchments, as only event loads were calculated during the previous monitoring year. The land use yields for each monitored catchment are presented in Table 3.6.

No land use yields are reportable for sites where the concentration of the pesticide was below the analytical limit of reporting and the mass load of the chemical was not calculated.

As identified in Section 2.7.3.2, land use yields were calculated by dividing the monitored annual load by the total land use area where the pesticide is registered for use. This approach averages the contribution across the total land use area for which the pesticide is permitted for use. In the absence of formal chemical use records across all monitored areas, this approach provides a comparison of the rate of pesticide loss, between catchments and catchments between years.

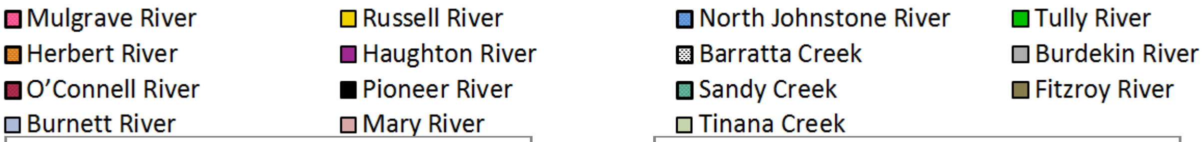
Ametryn was only detected above the analytical limit of reporting in four catchments with the highest land use yield occurring in Barratta Creek catchment (0.032 kg km $^{-2}$), which was three times and five times greater than the land use yield in the Russell and Pioneer catchments, respectively (Table 3.6). The lowest calculable land use yield occurred in the Sandy Creek catchment (0.0047 kg km^{-2}).

The land use yield of total atrazine in Barratta Creek catchment (1.7 kg km^{2}) was very high relative to all other monitored catchments including being twice the yield observed in the Tully catchment which had the highest land use yield in the 2014–2015 monitoring year at 1.3 kg km^{-2}. The land use yield of total atrazine in the Tully catchment was lower in the current monitoring year at 0.80 kg km^{-2} with moderate yields also observed in the Mulgrave (0.65 kg km^{-2}), Sandy Creek (0.47 kg km^{2}), Russell (0.27 kg km^{-2}) and Pioneer (0.21 kg km^{-2}) catchments. The land use yields in all other catchments were low, with the lowest monitored land use yield of total atrazine occurring in the Burnett catchment (0.0048 kg km^{-2}) (Table 3.6).

The highest monitored land use yields of total diuron occurred in the Russell catchment (2.1 kg km^{-2}), which was more than twice the land use yield from the Mulgrave catchment (0.98 kg km^{-2}) and more than three times higher than in the Tully (0.67 kg km^{-2}) and North Johnstone (0.66 kg km^{-2}) catchments. Moderate land use yields were also determined for Sandy Creek (0.46 kg km^{-2}), Pioneer (0.33 kg km^{-2}), O'Connell (0.26 kg km^{-2}), and Barratta Creek (0.23 kg km^{-2}) catchments (Table 3.6). The lowest calculable land use yields of total diuron were in the Fitzroy (0.0032 kg km^{-2}) and Burdekin (0.0049 kg km^{-2}) catchments.

The land use yield of hexazinone in the Russell catchment (0.46 kg km^{-2}) was high relative to all other catchments; specifically 1.5 times greater than the land use yield in the Tully catchment (0.30 kg km^{-2}) and three times higher than the Mulgrave catchment (0.15 kg km^{-2}). The land use yield of hexazinone in all other catchments was comparatively low, with the lowest calculable land use yield occurring in the Fitzroy catchment (0.00015 kg km^{-2}) (Table 3.6).

The highest calculable land use yields of tebuthiuron during the 2014–2015 monitoring year were in the O'Connell (0.0048 kg km^{-2}) and Fitzroy (0.0035 kg km^{-2}) catchments – these catchments have also produced the highest land use yield of tebuthiuron in previous years (Wallace et al. 2015; Garzon-Garcia et al. 2015). During the 2014–2015 monitoring year, tebuthiuron was only detected in two other catchments; specifically the Burdekin River and Barratta Creek, and the land use yield in both of these catchments was low (Table 3.6).



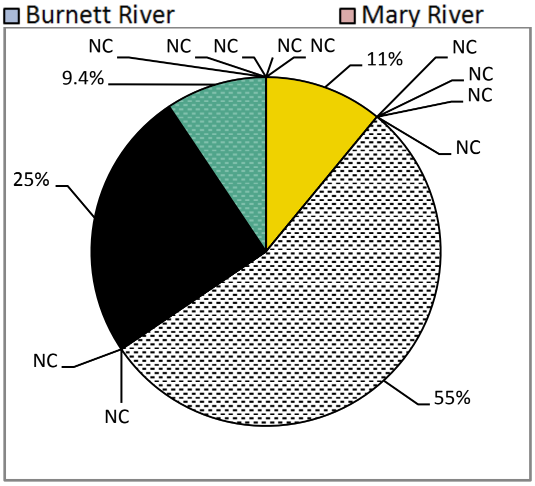


Figure 3.15 Per cent contribution of all sites monitored for pesticides to the combined monitored annual ametryn load during the 2014–2015 monitoring year (NC = load not calculable).

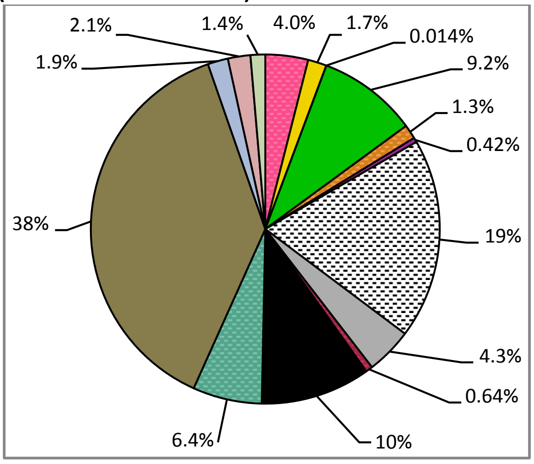


Figure 3.16 Per cent contribution of all sites monitored for pesticides to the combined monitored annual total atrazine load during the 2014–2015 monitoring year.

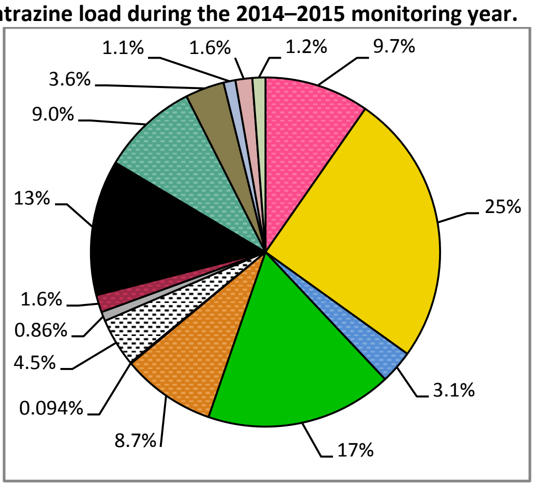


Figure 3.17 Per cent contribution of all sites monitored for pesticides to the combined monitored annual total diuron load during the 2014–2015 monitoring year.

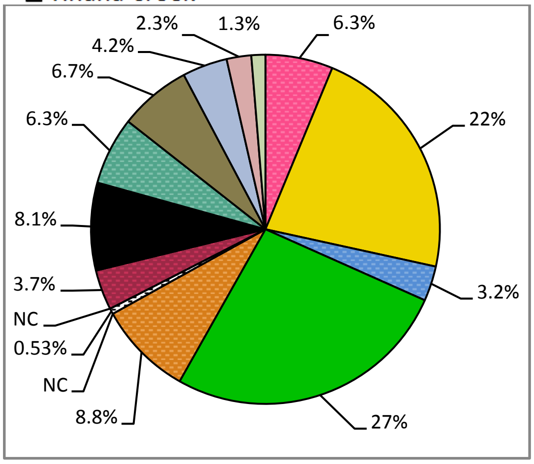


Figure 3.18 Per cent contribution of all sites monitored for pesticides to the combined monitored annual hexazinone load during the 2014–2015 monitoring year (NC = load not calculable).

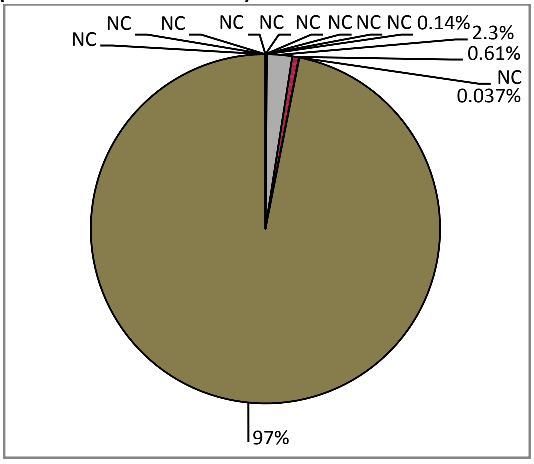


Figure 3.19 Per cent contribution of all sites monitored for pesticides to the combined monitored annual tebuthiuron load during the 2014–2015 monitoring year (NC = load not calculable).

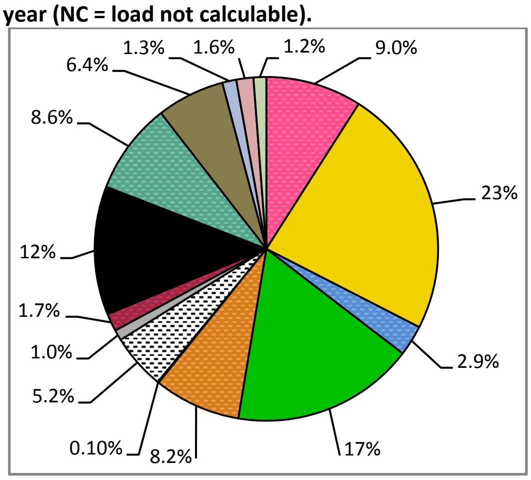


Figure 3.20 Per cent contribution of all sites monitored for pesticides to the combined monitored annual toxic pesticide load during the 2014–2015 monitoring year.

Table 3.5 Monitored annual loads and total toxic pesticide loads for the 2014-2015 monitoring year calculated for five photosystem II inhibiting herbicides: ametryn, total atrazine, total diuron, hexazinone and tebuthiuron. Text in bold relate to end-of-catchment sites and the corresponding data, all other relate to sub-catchment sites.

NRM region	Basin	Catchment	River and site name	n	Method	Ametryn load (kg)	Total Atrazine load (kg)	Total Diuron load (kg)	Hexazinone load (kg)	Tebuthiuron load (kg)	Total Toxic pesticide load (diuron-equivalent kg)
Wet Tropics	Mulgrave-Russell	**Mulgrave River**	**Mulgrave River at Deeral**	74	L	NC	55	78	17	NC	84
		Russell River	**Russell River at East Russell**	86	L	0.85	24	200	61	NC	220
	Johnstone	**North Johnstone River**	**North Johnstone River at Old Bruce Highway Bridge (Goondi)**	36	B	NC	0.14	25	8.9	NC	26
	Tully	**Tully River**	**Tully River at Euramo**	110	L	NC	130	140	73	NC	160
	Herbert	**Herbert River**	**Herbert River at Ingham**	39	B	NC	18	70	24	NC	76
Burdekin	Haughton	**Haughton River**	**Haughton River at Powerline**	15	L	NC	5.8	0.76	NC	NC	0.97
		Barratta Creek	**Barratta Creek at Northcote**	60	L	4.2	260	36	1.5	0.55	49
	Burdekin	**Burdekin River**	**Burdekin River at Home Hill**	22	L	NC	59	7.0	NC	9.4	9.3
Mackay Whitsunday	O'Connell	**O'Connell River**	**O'Connell River at Caravan Park**	19	B	NC	8.9	13	10	2.5	16
	Pioneer	**Pioneer River**	**Pioneer River at Dumbleton Pump Station**	23	L	1.9	140	100	22	NC	110
	Plane	**Sandy Creek**	**Sandy Creek at Homebush**	38	L	0.72	89	73	17	0.15	80
Fitzroy	Fitzroy	**Fitzroy River**	**Fitzroy River at Rockhampton**	39	B	NC	520	29	18	390	59
		Comet River	Comet River at Comet Weir	16	B	NC	250	0.58	0.95	3.9	10
Burnett Mary	Burnett	**Burnett River**	**Burnett River at Ben Anderson Barrage Head Water**	31	L	NC	26	8.9	11	NC	12
	Mary	**Mary River**	**Mary River at Home Park**	111	L	NC	29	13	6.3	NC	15
		Tinana Creek	**Tinana Creek at Barrage Head Water**	111	L*	NC	19	9.8	3.6	NC	11
Total monitored annual load (excluding Comet River)				814		7.7	1400	810	280	410	930

n = the number of grab samples used to calculate loads; NC = a load was not calculated as all the concentrations for all samples collected were below the practical quantitation limit or there were insufficient samples collected over the year to calculate a load; B = Beale ratio method used to calculate loads; L = average load (linear interpolation of concentration) method used to calculate loads; *Loads for Tinana Creek at Barrage are indicative considering modelled daily flow was used for load calculations.

Table 3.6 The monitored annual yields calculated for five photosystem II inhibiting herbicides: ametryn, total atrazine, total diuron, hexazinone and tebuthiuron for the 2014–2015 monitoring year.

PSII herbicide	Registered land use	River and site name	Method	Land use yield (kg km^{-2})
Ametryn	Sugarcane	Mulgrave River at Deeral	L	NC
		Russell River at East Russell	L	0.0099
		North Johnstone River at Old Bruce Highway Bridge (Goondi)	B	NC
		Tully River at Euramo	L	NC
		Herbert River at Ingham	B	NC
		Haughton River at Powerline	L	NC
		Barratta Creek at Northcote	L	0.032
		Burdekin River at Home Hill	L	NC
		O'Connell River at Caravan Park	B	NC
		Pioneer River at Dumbleton Pump Station	L	0.0063
		Sandy Creek at Homebush	L	0.0047
		Fitzroy River at Rockhampton	B	NC
		Burnett River at Ben Anderson Barrage Head Water	L	NC
		Mary River at Home Park	L	NC
		Tinana Creek at Tinana Barrage Head Water	L	NC
Total atrazine	Cropping, forestry, and sugarcane	Mulgrave River at Deeral	L	0.65
		Russell River at East Russell	L	0.27
		North Johnstone River at Old Bruce Highway Bridge (Goondi)	B	0.0075
		Tully River at Euramo	L	0.80
		Herbert River at Ingham	B	0.028
		Haughton River at Powerline	L	0.10
		Barratta Creek at Northcote	L	1.7
		Burdekin River at Home Hill	L	0.026
		O'Connell River at Caravan Park	B	0.045
		Pioneer River at Dumbleton Pump Station	L	0.21
		Sandy Creek at Homebush	L	0.47
		Fitzroy River at Rockhampton	B	0.029
		Burnett River at Ben Anderson Barrage Head Water	L	0.0048
		Mary River at Home Park	L	0.030
		Tinana Creek at Tinana Barrage Head Water	L	0.022
Total diuron	Cropping, horticulture and sugarcane	Mulgrave River at Deeral	L	0.98
		Russell River at East Russell	L	2.1
		North Johnstone River at Old Bruce Highway Bridge (Goondi)	B	0.66
		Tully River at Euramo	L	0.67
		Herbert River at Ingham	B	0.27
		Haughton River at Powerline	L	0.024
		Barratta Creek at Northcote	L	0.23
		Burdekin River at Home Hill	L	0.0049
		O'Connell River at Caravan Park	B	0.26
		Pioneer River at Dumbleton Pump Station	L	0.33
		Sandy Creek at Homebush	L	0.46
		Fitzroy River at Rockhampton	B	0.0032
		Burnett River at Ben Anderson Barrage Head Water	L	0.0064
		Mary River at Home Park	L	0.14
		Tinana Creek at Tinana Barrage Head Water	L	0.10
Hexazinone	Forestry, grazing and sugarcane	Mulgrave River at Deeral	L	0.15
		Russell River at East Russell	L	0.46
		North Johnstone River at Old Bruce Highway Bridge (Goondi)	B	0.023
		Tully River at Euramo	L	0.30
		Herbert River at Ingham	B	0.0042
		Haughton River at Powerline	L	NC
		Barratta Creek at Northcote	L	0.0020
		Burdekin River at Home Hill	L	NC
		O'Connell River at Caravan Park	B	0.014
		Pioneer River at Dumbleton Pump Station	L	0.019
		Sandy Creek at Homebush	L	0.059
		Fitzroy River at Rockhampton	B	0.00015
		Burnett River at Ben Anderson Barrage Head Water	L	0.00039
		Mary River at Home Park	L	0.0013
		Tinana Creek at Tinana Barrage Head Water	L	0.0034
Tebuthiuron	Grazing	Mulgrave River at Deeral	L	NC
		Russell River at East Russell	L	NC
		North Johnstone River at Old Bruce Highway Bridge (Goondi)	B	NC
		Tully River at Euramo	L	NC
		Herbert River at Ingham	B	NC
		Haughton River at Powerline	L	NC
		Barratta Creek at Northcote	L	0.00092
		Burdekin River at Home Hill	L	0.000079
		O'Connell River at Caravan Park	B	0.0048
		Pioneer River at Dumbleton Pump Station	L	NC
		Sandy Creek at Homebush	L	0.0014
		Fitzroy River at Rockhampton	B	0.0035
		Burnett River at Ben Anderson Barrage Head Water	L	NC
		Mary River at Home Park	L	NC
		Tinana Creek at Tinana Barrage Head Water	L	NC

NC = not calculable; B = Beale ratio method used to calculate loads; L = average load (linear interpolation of concentration) method used to calculate loads; Loads for Tinana Creek at Barrage are indicative considering modelled daily flow was used for load calculations.

4 Conclusions

During 2014–2015, the Great Barrier Reef Catchment Loads Monitoring Program calculated the monitored annual loads and yields of total suspended solids and ten forms of nitrogen and phosphorus for 18 end-of-catchment sites and seven nested sub-catchment sites across 14 priority basins. The monitored annual loads, toxic pesticides loads and yields of five photosystem II inhibiting herbicides were also calculated for 15 end-of-catchment sites and one nested sub-catchment site across 12 priority basins. During the 2014–2015 monitoring year:

- Monitored reef catchments generally received below average to very much below average rainfall in the Cape York, Wet Tropics, Burdekin and Mackay Whitsunday regions, and average rainfall in the Fitzroy and Burnett Mary regions.
- Severe Tropical Cyclone Marcia crossed the coast in late February 2015 as a Category 5 system north of Rockhampton in the Fitzroy region. Isolated rainfall in the south-east of the Fitzroy catchment and northern section of the Burnett catchment contributed to above average annual rainfall in isolated sections of these catchments. Rainfall associated with this system also resulted in minor to moderate flooding in some monitored priority reef catchments in these regions.
- River discharge was less than half the long-term mean in all monitored catchments in the Burdekin and Mackay Whitsunday regions and in the Herbert catchment in the Wet Tropics region – discharge in the Burdekin was only nine per cent of the long-term mean. In the Barron, Fitzroy and Burnett rivers, discharge was approximately equal to half the long-term mean. Discharge in the Mary River was 80 per cent of the long-term mean, and in the Russell River discharge was equal to the long-term mean.
- Good to excellent sampling representivity was achieved at all monitoring sites for total suspended solids, total nutrients and dissolved nutrients, except in Theresa Creek where moderate representivity was achieved and Haughton River which was not assessed due to low discharge. Loads for Tinana Creek catchment are indicative considering modelled daily flow was used for load calculations.
- Sample representivity and coverage was the best achieved by the program since commencement in 2006. The representivity of sampling for the calculation of pesticide loads was not assessed in the current report.
- No data were reported for the Burnett River at Mt Lawless due to non-conformance of sample collection methods which resulted from sediment accretion over the auto-sampler intake which impacted on the measured concentration for all analytes.
- This is the first year in which annual loads were reported for the Mulgrave and Russell rivers. These rivers are major contributors to the total monitored annual loads of dissolved inorganic nitrogen and pesticide toxic pesticide loads, which are both high risk pollutants in the Wet Tropics region (Brodie et al. 2013a).
- The monitored catchments generated approximately 2.4 million tonnes of total suspended solids, 12,000 tonnes of nitrogen and 2900 tonnes of phosphorus.

- The Fitzroy catchment generated the largest loads of total suspended solids and all measures of nutrients; 38 per cent of the combined total suspended solids load; 27 per cent of the combined total nitrogen load; and 44 per cent of the combined total phosphorus load. The Burdekin catchment contributed 30 per cent of the combined total suspended solids load and 14 per cent of the total phosphorus load despite the discharge only being nine per cent of the long-term mean. The monitored catchments in the Johnstone basin generated substantial contributions of total nitrogen and particulate nitrogen, and the Tully and Russell catchments generated substantial contributions of dissolved inorganic nitrogen. Overall, 49 per cent of the combined dissolved inorganic nitrogen load was derived from the Wet Tropics region.
- The Haughton catchment generally produced the lowest loads of total suspended solids and other nutrients analytes, which was driven by very low discharge relative to the long-term mean.
- The highest monitored yields of total suspended solids, total nitrogen, particulate nitrogen, total phosphorus and particulate phosphorus occurred in the North Johnstone catchment which is consistent with findings from previous years. The Russell, Mulgrave, South Johnstone and Tully catchments produced high yields of total and particulate nitrogen and dissolved inorganic nitrogen and dissolved organic nitrogen. The North Johnstone and South Johnstone contributed the highest yields of total and particulate phosphorus. The highest yield of dissolved inorganic phosphorus was derived from the Fitzroy catchment and dissolved organic phosphorus from the Russell catchment.
- The Haughton catchment produced the lowest yields of most analytes owing in part to the exceptionally low discharge during the 2014–2015 monitoring year.
- The total monitored annual photosystem II inhibiting herbicide loads were, in descending order: 1400 kg of total atrazine; 810 kg of total diuron; 410 kg of tebuthiuron; 280 kg of hexazinone; and 7.7 kg of ametryn
- The photosystem II inhibiting herbicides total atrazine and total diuron were detected at all monitored sites.
- The largest monitored annual loads of ametryn were in the Barratta Creek and Pioneer catchments. The Fitzroy catchment produced the largest load of total atrazine, with substantial loads also monitored in Barratta Creek catchment. A very high load of total diuron was monitored in the Russell catchment with high loads also derived from the Tully and Pioneer catchments. The Tully catchment produced the largest monitored annual loads of hexazinone. The Fitzroy catchment produced the largest monitored annual load of tebuthiuron, which is consistent with all monitoring years since 2009 when monitoring of pesticides was first implemented.
- The combined toxic pesticide load of all monitored sites was 930 kg $TEq_{diuron,}$ with total diuron accounting for 86 per cent or 810 kg TEq_{diuron}. The Russell catchment produced the highest toxic pesticide load, 220 kg TEq_{diuron}, accounting for 23 per cent of the combined monitored toxic pesticide load.
- The highest land use yield of ametryn and total atrazine were in Barratta Creek catchment, with the yield of total atrazine more than double the yield in all other monitored catchments. The highest monitored land use yields of total diuron and hexazinone were derived from the Russell catchment, with the yield of total diuron very high relative to all other monitored catchments. The highest land use yield of tebuthiuron was in the O'Connell catchment.

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7 Appendices

Appendix A Loads of other pesticides detected by the Great Barrier Reef Catchment Loads Monitoring Program

Funding provided by the Queensland Department of Environment and Heritage Protection, Reef Quality Protection Unit, allowed the continued analysis of water samples for a broader suite of pesticides, including alternate and emerging chemicals that were not previously monitored by the Great Barrier Reef Catchment Loads Monitoring Program. The analysis of water samples for the extended suite of chemicals was initiated in 2012 under Project RP57C. A detailed analysis of the concentration data for the 2012–2013 monitoring year was reported in Smith et al. (2014). The mass loads of these additional chemicals were reported for the 2013–2014 monitoring year in Garzon-Garcia et al. (2015).

Through the EHP funded extension to RP57C, all water samples collected from all sites during the 2014–2015 monitoring year were analysed via LC-MS as described in Section 2.5 for the extended suite of chemicals. The LC-MS analytical suite is capable of detecting more than 40 pesticides and their breakdown products (i.e. in addition to the five photosystem II inhibiting herbicides presented in the body of the report) (See Table 7.1). The monitored annual loads of the additional pesticides were calculated using the methods previously described in Section 2.7.2.

Water samples from the North Johnstone River, Tully River, Herbert River, Haughton River, Barratta Creek, O'Connell River, Pioneer River and Sandy Creek (Figure 2.1) were also analysed by HPLC-MS/MS for total glyphosate (glyphosate plus the metabolite AMPA). The analysis of samples by HPLC-MS/MS only commenced in January 2014, which was prior to all notable flow events at each of these sites. The concentration of glyphosate during low flow periods prior to the commencement of analysis, however, is unknown and the contribution of this unmonitored period cannot be calculated. The monitored load of total glyphosate and the metabolites reported below are for the monitored part of the year, commencing on the day the first samples were collected (Table 7.7).

The results presented in this section of the report are the monitored annual loads of these detected additional pesticides, including 2,4-D, aciflurofen, AMPA, bromacil, clothiandin, fluroxypyr, glyphosate, haloxyfop, imazapyr, imazethapyr, imidacloprid, imidacloprid metabolites, isoxaflutole, MCPA, metolachlor, metribuzin, metsulfuron-methyl, prometryn, propazine-2-hydroxy (a metabolite of the herbicide propazine), simazine, terbuthylazine, total imazapic, triclopyr and 3,4-dichloroaniline (a metabolite of the herbicide diuron).

The monitored annual loads of atrazine and its metabolites, desethyl atrazine and desisopropyl atrazine, are also presented, although they will not be discussed further as the total atrazine load is already considered in Section 3.4. Similarly, the monitored annual loads of diuron and its metabolite 3,4-dichloroaniline will not be discussed as the loads of total diuron have been presented in Section 3.4.

The total monitored annual loads of other pesticides detected by the LC-MS analysis suite was approximately 1800 kg. Total load of individual pesticides ranged from 0.14 kg of imidacloprid metabolites and 0.26 kg of propazin-2-hydroxy to 570 kg of metolachlor, which was detected broadly across all regions. These loads are comparable to those of the five photosystem II inhibiting herbicides reported in Section 3.4 of 2900 kg, indicating it is essential to continue monitoring and calculating the loads of these pesticides.

Barratta Creek had the highest number of additional pesticides detected (17 chemicals) (including metabolites), followed by Sandy Creek (13 chemicals). The Pioneer River and Tinana Creek also ranked highly with 12 additional chemicals detected in each catchment. By contrast, only three additional chemicals were detected in the Herbert catchment (see Table 7.3 to Table 7.5)

The herbicide 2,4-D was the only additional chemical detected in all monitored catchments. The largest loads of 2,4-D occurred in the Fitzroy (50 kg; 16 per cent), Tully (40 kg; 13 per cent), Herbert (36 kg; 12 per cent) and Barratta Creek (31 kg; 10 per cent) catchments, together, accounting for approximately half of the combined annual load of all monitored catchments (Table 7.3). The smallest monitored annual loads of 2,4-D were monitored in the Haughton (0.68 kg; 0.23 per cent) and Tinana Creek (5.6 kg; 1.8 per cent) catchments.

Clothiandin, prometryn and propazin-2-hydroxy were each detected above the analytical limit of reporting in one end-of-catchment site; prometryn and propazin-2-hydroxy were also detected in the Comet River nested sub-catchment (Table 7.3 and Table 7.5). The monitored annual load of clothiandin in the North Johnstone catchment was 4.6 kg. A lower load of prometryn, 3.9 kg, was monitored in the Fitzroy catchment with an equal load of 3.9 kg also monitored at the Comet River nested sub-catchment. Small monitored annual loads of propazin-2-hydroxy were detected in Barratta Creek (0.26 kg) and the nested Comet River sub-catchment in the Fitzroy basin with a monitored annual load of 3.0 kg. Propazin-2-hydroxy was not detected at the Fitzroy River end-of-catchment monitoring site above the analytical limit of reporting.

Aciflurofen was only detected in two catchments, with more than 98 per cent of the monitored annual load (17 kg) derived from the Fitzroy catchment and a small load monitored in Barratta Creek catchment (0.32 kg; 1.8 per cent) (Table 7.3).

Bromacil was only detected in three catchments, with 98 per cent of the monitored annual load (9.2 kg) derived from the Fitzroy (6.8 kg; 74 per cent) and Tinana Creek (2.2 kg; 23 per cent) catchments, and only a small load monitored in Barratta creek catchment (0.23 kg; 2.5 per cent) (Table 7.3).

Fluometuron was not detected above the analytical limit of reporting at any catchment during the 2014–2015 monitoring year. In contrast a small load of 12 kg was derived from the Tully catchment in the 2013–2014 monitoring year (Garzon-Garcia et al. 2015).

Fluroxypyr was detected above the analytical limit of reporting in all monitored catchments except the North Johnstone and Burdekin catchments. The combined monitored annual load of fluroxypyr was 250 kg with the largest load derived from the Fitzroy catchment (110 kg; 42 per cent) (Table 7.3). The Herbert (56 kg; 23 per cent) and Russell (21 kg; 8.3 per cent) also contributed moderate loads. The smallest monitored annual load of fluroxypyr occurred in the O'Connell catchment (0.35 kg; 0.14 per cent).

During the 2014–2015 monitoring year the total monitored annual load of haloxyfop (48 kg) was approximately ten times greater than the monitored load of haloxyfop in the 2013–2014 monitoring year

(5.0 kg). In 2014–2015, approximately two-thirds of the monitored annual load was derived from the Fitzroy catchment (31 kg; 64 per cent) – notably, haloxyfop was not detected above the analytical limit of reporting in this catchment during the previous monitoring year. Comparatively moderate loads of haloxyfop were also detected in the Mulgrave (6.1 kg; 13 per cent), Tully (5.9 kg;12 per cent) and Russell (4.1 kg; 8.7 per cent) catchments, which together with the Fitzroy catchment accounted for 98 per cent of the total monitored haloxyfop load (Table 7.3). The smallest load of haloxyfop was monitored in Tinana Creek catchment (0.076 kg; 0.16 per cent),

Imazethapyr was only detected above the analytical limit of reporting at three catchments, which together produced a monitored annual load of 1.9 kg (Table 7.3). The largest load of imazethapyr was derived from Barratta Creek catchment (1.2 kg), which accounted for 61 per cent of the total monitored load. The Pioneer (0.34 kg; 18 per cent) and Tinana Creek (0.40 kg; 21 per cent) catchments contributed the remaining monitored load of this chemical.

Imidacloprid was detected at all monitored sites in all regions except the Fitzroy. The total monitored annual load of imidacloprid during the 2014–2015 monitoring year was 310 kg, more than double the monitored annual load of the previous monitoring year in 2013–2014 (Garzon-Garcia et al. 2015). During the 2014–2015 monitoring year 76 per cent of the combined imdicaloprid load was derived from the five Wet Tropics catchments where pesticide monitoring was conducted (Table 7.4). The largest monitored annual loads of imidacloprid were in the Tully (120 kg; 38 per cent), North Johnstone (51 kg; 17 per cent) and Russell (45 kg; 14 per cent) catchments. The lowest monitored annual loads of imidacloprid, where this pesticide was detected above the analytical limit of reporting, were in the Mary (0.64 kg; 0.21 per cent) and Haughton (0.70 kg; 0.23 per cent) catchments. The analytical suite undertaken by Queensland Health Forensic Scientific Services also quantifies metabolites of imidacloprid; however, in the 2014–2015 monitoring year they were only detected above the analytical limit of reporting at two catchments, Barratta Creek (0.091 kg) and Sandy Creek (0.044 kg) catchments.

Isoxaflutole was detected above the analytical limit of reporting at seven end-of-catchment sites across the Wet Tropics, Burdekin and Mackay Whitsunday regions (Table 7.4). The total monitored annual load of isoxaflutole (22 kg) was equal to the previous year (22 kg) (Garzon-Garcia et al. 2015). The monitored annual load of isoxaflutole was similar between the Tully (6.5 kg; 30 per cent) and Barratta Creek (6.1 kg; 28 per cent) catchments, which together accounted for more than half of the total monitored annual isoxaflutole load. The smallest load of isoxaflutole was monitored in the Burdekin catchment (1.0 kg; 4.6 per cent). Isoxaflutole was also detected above the analytical limit of reporting at the Comet River sub-catchment in the Fitzroy basin, with a monitored annual load of 0.67 kg. Notably, isoxaflutole was not detected above the limit of reporting at the Fitzroy basin end-of-catchment monitoring site Fitzroy River at Rockhampton.

MCPA was detected at all sites in the Burdekin region with the combined load from these three sites (Barratta Creek, 10 kg; Burdekin River, 1.5 kg; and Haughton River 0.45 kg) accounting for 44 per cent of the total monitored annual load of MCPA (27 kg) during the 2014–2015 monitoring year (Table 7.4). MCPA was also detected above the analytical limit of reporting at two sites in each of the Wet Tropics, Mackay

Whitsunday and Burnett Mary regions with moderate loads monitored in the Russell River (4.8 kg; 18 per cent) and Sandy Creek (3.9 kg; 14 per cent) catchments. The lowest calculable load occurred in the Haughton catchment, which accounted for 1.7 per cent of the total MCPA load.

The combined monitored load of metolachlor was the highest mass load of all the monitored additional chemicals (570 kg) with 78 per cent derived from the Fitzroy catchment (440 kg) (Table 7.4). The monitored load of metolachlor in the Comet River sub-catchment was 78 kg – higher than all other monitored end-of-catchment sites. A moderate load of metolachlor was also derived from Barratta Creek catchment (52 kg; 9.2 per cent), with the monitored load in all other catchments each contributing less than four per cent of the total monitored metolachlor load in the 2014–2015 monitoring year.

Metribuzin (combined monitored annual load of 63 kg) was widely detected across all regions other than the Fitzroy. The largest monitored annual load occurred in Barratta Creek catchment (19 kg; 30 per cent) (Table 7.4). The monitored annual load of metribuzin was similar in the Sandy Creek catchment (12 kg; 19 per cent). Moderate loads were also monitored in the Tully (9.7 kg; 15 per cent) and Mulgrave (7.4 kg; 12 per cent) catchments – this was the first year that monitoring for the additional chemicals was undertaken in the Mulgrave catchment. The smallest calculable monitored annual load of metribuzin was in the Haughton catchment (0.11 kg; 0.17 per cent). In the Mary basin, metribuzin was only detected above the analytical limit of reporting in the Tinana Creek catchment where the annual monitored load was 0.61 kg (0.97 per cent) (Table 7.4).

The total monitored annual load of metsulfuron-methyl was 17 kg, with the majority of this load occurring in the Mulgrave (6.8 kg; 41 per cent) and Tully (4.5 kg; 27 per cent) catchments (Table 7.4). The smallest calculable monitored annual load of metsulfuron-methyl occurred in the Tinana Creek catchment (0.037 kg; 0.22 per cent).

The total monitored annual load of simazine was 4.9 kg, with the largest load occurring in the Fitzroy catchment (4.0 kg), which accounted for 81 per cent of the total monitored load of simazine during the 2014–2015 monitoring year (Table 7.5). Small loads of simazine were also monitored in Barratta Creek (0.37 kg; 7.5 per cent), Pioneer (0.33 kg; 6.8 per cent) and Sandy Creek (0.22 kg; 4.4 per cent) catchments.

Terbuthylazine was detected above the analytical limit of reporting at only two catchments with the majority of the combined monitored annual load (100 kg) derived from the Fitzroy catchment (97 kg; 95 per cent) and a comparatively small load also detected in the Burnett catchment (4.9 kg; 4.8 per cent) (Table 7.5). The total monitored annual load of terbuthylazine during the 2014–2015 is substantially greater than the load monitored during the 2013–2014 monitoring year when terbuthylazine was only detected in the Fitzroy catchment with a load of 12 kg (Garzon-Garcia et al. 2015).

During the 2014–2015 monitoring year, total imazapic was detected in the Wet Tropics, Burdekin and Mackay Whitsunday and Burnett Mary regions with the largest monitored load of total imazapic derived from the Russell catchment (14 kg; 40 per cent) (Table 7.5). The combined monitored loads of the three monitored catchments in the Mackay Whitsunday region accounted for approximately 40 per cent of the total monitored annual load. Outside of the Wet Tropics and Mackay Whitsunday regions, total imazapic was also detected in Tinana Creek (3.4 kg; 9.8 per cent) and Barratta Creek (3.2 kg; 9.2 per cent) catchments.

Triclopyr was detected in all regions with a total monitored annual load of 46 kg. The largest monitored annual loads occurred in the Mary (14 kg; 30 per cent), Fitzroy (11 kg; 24 per cent) and Tully (8.5 kg; 18 per cent) catchments (Table 7.5). The smallest calculable loads of triclopyr occurred in the Haughton and Sandy Creek catchments with the each catchment producing 0.14 kg (0.30 per cent) of triclopyr.

During the 2014–2015 monitoring year additional samples were collected for analysis of total glyphosate (glyphosate plus the metabolite AMPA) at six catchments – North Johnstone, Tully, Herbert, Barratta Creek, Pioneer and Sandy Creek. The collection of samples at these sites did not commence until early January; therefore, the loads reported are for the monitored portion of the year only. Total glyphosate was detected (analytical limit of reporting 0.7 μgL^{-1}) at three catchments with the largest monitored annual load occurring in the Tully catchment (480 kg; 67 per cent) with a moderate load also derived from Barratta Creek catchment (220 kg; 32 per cent). The load of total glyphosate in the Sandy Creek catchment in the Plane basin was comparatively small at 5.4 kg (0.77 per cent) (Table 7.7).

The glyphosate metabolite, AMPA was only detected in Barratta Creek (93 kg; 90 per cent) and Sandy Creek (9.8 kg; 9.6 per cent) catchments. Further information regarding the number of samples is presented in Table 7.7.

Table 7.1 Pesticides analysed for by the Great Barrier Catchment Loads Monitoring Program using the liquid chromatography-mass spectrometry method.

Pesticide	Limit of Reporting (μg L^{-1})	Pesticide	Reporting Limit (μg L^{-1})
2,4-D	0.01	MCPA	0.01
2,4-DB	0.01	MCPB	0.01
3,4-dichloroaniline	0.04	Mecoprop	0.01
Acifluorfen	0.01	Mesosulfuron methyl	0.01
Ametryn	0.01	Metolachlor	0.01
Atrazine	0.01	Metribuzin	0.01
AMPA	0.7	Metsulfuron methyl	0.01
Bromacil	0.01	Napropamide	0.01
Clomazone	0.01	Prometryn	0.01
Clothianidin	0.01	Propachlor	0.01
Cyanazine	0.01	Propazin-2-hydroxy	0.02
Desethyl atrazine	0.01	Sethoxydim (including Clethodim)	0.02
Desisopropyl atrazine	0.01	Simazine	0.01
Diuron	0.01	Sulfosulfuron	0.01
Ethametsulfuron methyl	0.01	Tebuthiuron	0.01
Fluometuron	0.01	Terbuthylazine	0.01
Fluroxypyr	0.03	Terbuthylazine desethyl	0.01
Flusilazole	0.01	Terbutryn	0.01
Haloxyfop (acid)	0.01	Thiamethoxam	0.02
Glyphosate	0.7	Total Diuron	0.08
Hexazinone	0.01	Total Glyphsosate	1.8
Imazapyr	0.01	Total Imazapic	0.07
Imazethapyr	0.01	Total Imidacloprid	0.03
Imidacloprid	0.01	Triclopyr	0.02
Imidacloprid metabolites	0.01	Trifloxysulfuron	0.01
Isoxaflutole[£]	0.01		

£ Measured as diketonitrile metabolite which is the active species of isoxaflutole

Table 7.2 Mode of action, octonal-water partiton coefficient (log KoW) and type of pesticide for all pesticides detected during the 2014-2015 monitoring year.

Mode of Action	Pesticide	Log KoW	Log KoC	Type
Priority PSII Herbicides				
PSII Herbicides	Ametryn	2.63 @ pH 7, temperature of 20°C[1] 2.63 @ pH 7, temperature of 20°C[2]	2.49[2]	Herbicide
	Atrazine	2.7 @ pH 7, temperature of 20°C[1] 2.7 @ pH 7, temperature of 20°C[2]	2[2]	
	Diuron	2.87 @ pH 7, temperature of 20°C[1] 2.87 @ pH 7, temperature of 20°C[2]	2.91[2]	
	Hexazinone	1.17 @ pH 7, temperature of 20°C[1] 1.17 @ pH 7, temperature of 20°C[2]	1.73[2]	
	Tebuthiuron	1.79 @ pH 7, temperature of 20°C[1] 1.79 @ pH 7, temperature of 20°C[2]	1.9[2]	
Alternate Pesticides				
Amino acid inhibitor	Imazapic	0.393 @ pH 4, 5, 6 (buffer), temperature of 25°C[1] 2.47 @ pH 7, temperature of 20°C[2]	2.14[2]	Herbicide
	Imazapyr	0.11 @ pH not stated, temperature of 22°C[1] 0.11 @ pH 7, temperature of 20°C[2]	Not stated	
	Imazethapyr	1.04 @ pH 5, 1.49 @ pH 7, 1.20 @ pH 9, temperature of 25°C[1] 1.49 @ pH 7, temperature at 20°C[2]	2.18[2]	
	Metsulfuron-methyl	-1.87 @ pH 7, temperature of 20°C[1] -1.87 @ pH 7, temperature of 20°C[2]	Not stated	
Auxin growth regulators	2,4-D	2.58-2.83 @ pH 1, 0.04-0.33 @ pH 5, -0.75 @ pH 7, temperature not stated[1] -0.82 @ pH 7, temperature of 20°C[2]	1.59[2]	
	Fluroxypyr	-1.24[a] @ pH not stated, temperature not stated[1] 0.04 @ pH 7, temperature of 20°C[2]	Not stated	
	MCPA	2.75 @ pH 1, 0.59 @ pH 5, -0.71 @ pH 7, temperature of 25°C[1] -0.81 @ pH 7, temperature of 20°C[2]	Not stated	
	Triclopyr	0.42 @ pH 5, -0.45 @ pH 7, -0.96 @ pH 9, temperature not stated[1] 4.62 @ pH 7, temperature of 20°C[2]	1.43[2]	
Cell membrane disruptor	Acifluorfen	1.19 @ pH 5, temperature of 25°C[1] 1.18 @ pH 7, temperature of 20°C[2]	2.05[2]	
Inhibitor of enzyme EPSP synthase	Glyphosate	<-3.2 @ pH 5-9, temperature of 20°C[1] -3.2 @ pH 7, temperature of 20°c[2]	3.15[2]	
Inhibitor of meristematic tissue growth	Haloxyfop	Not stated	1.88[2]	
Inhibitor of carotenoid biosynthesis	Isoxaflutole	2.34 @ pH 5.5, temperature of 20°C[1] 2.34 @ pH 7, temperature of 20°C[2]	2.16[2]	
PSII inhibitors	Bromacil	1.88 @ pH 5, temperature not stated[1] 1.88 @ pH 7, temperature of 20°C[2]	1.5[2]	
	Metribuzin	1.6 @ pH 5.6, temperature of 20°C[1] 1.65 @ pH 7, temperature of 20°C[2]	Not stated	
	Prometryn	3.1 @ pH not stated, temperature of 25°C (unionised)[1] 3.34 @ pH 7, temperature of 20°C[2]	2.6[2]	
	Propazine-2-hydroxy	2.51 @ pH 7, temperature of 20°C[3]	0	
	Simazine	2.1 @ pH not stated, temperature of 25°C (unionised)[1] 2.3 @ pH 7, temperature of 20°C[2]	2.11[2]	

Mode of Action	Pesticide	Log KoW	Log KoC	Type
	Terbuthy-lazine	3.4 @ pH not stated, temperature of 25ºC[1] 3.4 @ pH 7, temperature of 20ºC[2]	Not stated	
Inhibitor of long-chain fatty acids	Metolachlor	2.9 @ pH not stated, temperature of 25ºC[1] 3.4 @ pH 7, temperature of 20ºC[2]	2.08[2]	
Nicotinic acetylcholine receptor (nAChR) competitive modulators (neonicotinoid)	Clothianidin	0.7 @ pH not stated, temperature of 25ºC[1] 0.905 @ pH 7, temperature of 20ºC[2]	2.09[2]	Insecticide
	Imidacloprid	0.57 @ pH not stated, temperature of 21ºC[1] 0.57 @ pH 7, temperature of 20ºC[2]	Not stated	

[1] BCPC (British Crop Production Council) (2012). A world compendium. The Pesticide Manual. Sixteenth Edition. MacBean (Ed), BCPC, Alton, United Kingdom.

[2] University of Hertfordshire (2013). The Pesticide Properties DataBase (PPDB) developed by the Agriculture & Environment Research Unit (AERU), University of Hertfordshire, 2006–2013. Available from: http://sitem.herts.ac.uk/aeru/ppdb/en/>, Accessed: August, 2016.

[3] International Union of Pure and Applied Chemistry (IUPAC) (2015). The Pesticide Properties DataBase (PPDB) developed by the Agriculture & Environment Research Unit (AERU), University of Hertfordshire, 2006–2013. Available from: http://sitem.herts.ac.uk/aeru/iupac/Reports/925.htm, Accessed August 2016.

Table 7.3 The monitored annual loads calculated for the additional pesticides: 2,4-D, acifluorfen, bromacil, clothiandin, fluroxypyr, haloxyfop and imazethapyr. Text in bold refer to end-of-catchment sites and the corresponding data, all others refer to sub-catchment sites.

NRM region	Basin	Gauging station	River and site name	n	2,4-D (kg)	Acifluorfen (kg)	Bromacil (kg)	Clothiandin (kg)	Fluroxypyr (kg)	Haloxyfop (kg)	Imazethapyr (kg)
Wet Tropics	Mulgrave-Russell	**Mulgrave River**	**Mulgrave River at Deeral**	74	13	NC	NC	NC	11	6.1	NC
		Russell River	**Russell River at East Russell**	86	22	NC	NC	NC	21	4.1	NC
	Johnstone	**North Johnstone River**	**North Johnstone River at Old Bruce Highway Bridge (Goondi)**	36	16	NC	NC	4.6	NC	NC	NC
	Tully	**Tully River**	**Tully River at Euramo**	110	40	NC	NC	NC	14	5.9	NC
	Herbert	**Herbert River**	**Herbert River at Ingham**	39	36	NC	NC	NC	56	NC	NC
Burdekin	Haughton	**Haughton River**	**Haughton River at Powerline**	15	0.68	NC	NC	NC	0.62	NC	NC
		Barratta Creek	**Barratta Creek at Northcote**	60	31	0.32	0.23	NC	7.6	0.54	1.2
	Burdekin	**Burdekin River**	**Burdekin River at Home Hill**	22	9.0	NC	NC	NC	NC	NC	NC
Mackay Whitsunday	O'Connell	**O'Connell River**	**O'Connell River at Caravan Park**	19	8.7	NC	NC	NC	0.35	NC	NC
	Pioneer	**Pioneer River**	**Pioneer River at Dumbleton Pump Station**	23	17	NC	NC	NC	8.4	NC	0.34
	Plane	**Sandy Creek**	**Sandy Creek at Homebush**	38	18	NC	NC	NC	5.3	0.16	NC
Fitzroy	Fitzroy	**Fitzroy River**	**Fitzroy River at Rockhampton**	39	50	17	6.8	NC	110	31	NC
		Comet River	Comet River at Comet Weir	16	6.8	1.1	NC	NC	25	NC	NC
Burnett Mary	Burnett	**Burnett River**	**Burnett River at Ben Anderson Barrage Head Water**	31	14	NC	NC	NC	7.6	NC	NC
	Mary	**Mary River**	**Mary River at Home Park**	111	23	NC	NC	NC	3.7	NC	NC
		Tinana Creek	**Tinana Creek at Barrage Head Water**	111	5.6	NC	2.2	NC	7.1	0.076	0.40
Total monitored load (excluding Comet River at Comet Weir#)				814	300	17	9.2	4.6	250	48	1.9

n = the number of grab samples used to calculate loads; NC = a load was not calculated as all the concentrations were below the practical quantitation limit or there were insufficient samples collected over the year to calculate a load; L = average load (linear interpolation of concentration) method used to calculate loads; B = Beale ratio method used to calculate loads.

Comet River at Comet Weir is a nested sub-catchment monitoring site located upstream of the Fitzroy River at Rockhampton monitoring site and has therefore not been included in the calculation of total monitored load.

Table 7.4 The monitored annual loads calculated for the additional pesticides: imidacloprid, imidacloprid metabolites, isoxaflutole, MCPA, metolachlor, metribuzin and metsulfuron-methyl. Text in bold refer to end-of-catchment sites and the corresponding data, all others refer to sub-catchment sites.

NRM region	Basin	Catchment	River and site name	n	Method	Imidacloprid (kg)	Imidacloprid metabolites (kg)	Isoxaflutole[£] (kg)	MCPA (kg)	Metolachlor (kg)	Metribuzin (kg)	Metsulfuron-methyl (kg)
Wet Tropics	Mulgrave-Russell	**Mulgrave River**	**Mulgrave River at Deeral**	74	L	19	NC	2.0	4.8	1.4	7.4	6.8
		Russell River	**Russell River at East Russell**	86	L	45	NC	NC	2.0	2.2	2.3	NC
	Johnstone	**North Johnstone River**	**North Johnstone River at Old Bruce Highway Bridge (Goondi)**	36	B	51	NC	NC	NC	NC	NC	2.4
	Tully	**Tully River**	**Tully River at Euramo**	110	L	120	NC	6.5	NC	18	9.7	4.5
	Herbert	**Herbert River**	**Herbert River at Ingham**	39	B	19	NC	NC	NC	NC	NC	NC
Burdekin	Haughton	**Haughton River**	**Haughton River at Powerline**	15	L	0.70	NC	NC	0.45	0.42	0.11	NC
		Barratta Creek	**Barratta Creek at Northcote**	60	L	3.3	0.091	6.1	10	52	19	0.077
	Burdekin	**Burdekin River**	**Burdekin River at Home Hill**	22	L	9.6	NC	1.0	1.5	2.0	NC	NC
Mackay Whitsunday	O'Connell	**O'Connell River**	**O'Connell River at Caravan Park**	19	B	5.5	NC	1.1	NC	NC	6.0	NC
	Pioneer	**Pioneer River**	**Pioneer River at Dumbleton Pump Station**	23	L	17	NC	2.5	1.5	1.9	5.8	0.54
	Plane	**Sandy Creek**	**Sandy Creek at Homebush**	38	L	11	0.044	2.3	3.9	14	12	0.15
Fitzroy	Fitzroy	**Fitzroy River**	**Fitzroy River at Rockhampton**	39	B	NC	NC	NC	NC	440	NC	NC
		Comet River	Comet River at Comet Weir	16	B	NC	NC	0.67	NC	78	NC	0.63
Burnett Mary	Burnett	**Burnett River**	**Burnett River at Ben Anderson Barrage Head Water**	31	L	11	NC	NC	NC	23	NC	NC
	Mary	**Mary River**	**Mary River at Home Park**	111	L	0.64	NC	NC	2.2	7.0	NC	2.1
		Tinana Creek	**Tinana Creek at Barrage Head Water**	111	L	0.84	NC	NC	0.76	4.3	0.61	0.037
Total monitored load (excluding Comet River at Comet Weir[#])				814		310	0.14	22	27	570	63	17

n = the number of grab samples used to calculate loads; NC = a load was not calculated as all the concentrations were below the practical quantitation limit or there were insufficient samples collected over the year to calculate a load; L = average load (linear interpolation of concentration) method used to calculate loads; B = Beale ratio method used to calculate loads.

Comet River at Comet Weir is a nested sub-catchment monitoring site located upstream of the Fitzroy River at Rockhampton monitoring site and has therefore not been included in the calculation of total monitored load.
£ Measured as diketonitrile metabolite which is the active species of isoxaflutole

Table 7.5 The monitored annual loads calculated for the additional pesticides: prometryn, propazin-2-hydroxy, simazine, terbuthylazine, triclopyr, total imazapic. Text in bold refer to end-of-catchment sites and the corresponding data, all others refer to sub-catchment sites.

NRM region	Basin	Catchment	River and site name	N	Method	Prometryn (kg)	Propazin-2-hydroxy (kg)	Simazine (kg)	Terbuthy-lazine (kg)	Total Imazapic (kg)	Triclopyr (kg)
Wet Tropics	Mulgrave-Russell	**Mulgrave River**	**Mulgrave River at Deeral**	74	L	NC	NC	NC	NC	NC	NC
		Russell River	**Russell River at East Russell**	86	L	NC	NC	NC	NC	14	NC
	Johnstone	**North Johnstone River**	**North Johnstone River at Old Bruce Highway Bridge (Goondi)**	36	B	NC	NC	NC	NC	NC	3.8
	Tully	**Tully River**	**Tully River at Euramo**	110	L	NC	NC	NC	NC	NC	8.5
	Herbert	**Herbert River**	**Herbert River at Ingham**	39	B	NC	NC	NC	NC	NC	NC
Burdekin	Haughton	**Haughton River**	**Haughton River at Powerline**	15	L	NC	NC	NC	NC	NC	0.14
		Barratta Creek	**Barratta Creek at Northcote**	60	L	NC	0.26	0.37	NC	3.2	0.16
	Burdekin	**Burdekin River**	**Burdekin River at Home Hill**	22	L	NC	NC	NC	NC	NC	NC
Mackay Whitsunday	O'Connell	**O'Connell River**	**O'Connell River at Caravan Park**	19	B	NC	NC	NC	NC	1.0	NC
	Pioneer	**Pioneer River**	**Pioneer River at Dumbleton Pump Station**	23	L	NC	NC	0.33	NC	4.4	0.33
	Plane	**Sandy Creek**	**Sandy Creek at Homebush**	38	L	NC	NC	0.22	NC	8.4	0.14
Fitzroy	Fitzroy	**Fitzroy River**	**Fitzroy River at Rockhampton**	39	B	3.9	NC	4.0	97	NC	11
		Comet River	Comet River at Comet Weir	16	B	3.9	3.0	2.6	NC	NC	NC
Burnett Mary	Burnett	**Burnett River**	**Burnett River at Ben Anderson Barrage Head Water**	31	L	NC	NC	NC	4.9	NC	4.2
	Mary	**Mary River**	**Mary River at Home Park**	111	L	NC	NC	NC	NC	NC	14
		Tinana Creek	**Tinana Creek at Barrage Head Water**	111	L	NC	NC	NC	NC	3.4	4.1
Total monitored load (excluding Comet River at Comet Weir[#])				814		3.9	0.26	4.9	100	34	46

n = the number of grab samples used to calculate loads; NC = a load was not calculated as all the concentrations were below the practical quantitation limit or there were insufficient samples collected over the year to calculate a load; L = average load (linear interpolation of concentration) method used to calculate loads; B = Beale ratio method used to calculate loads.

Comet River at Comet Weir is a nested sub-catchment monitoring site located upstream of the Fitzroy River at Rockhampton monitoring site and has therefore not been included in the calculation of total monitored load.

Table 7.6 The monitored annual loads calculated for the additional pesticides: terbuthylazine, triclopyr, total imazapic, total atrazine and its metabolites atrazine, desethylatrazine and desisopropylatrazine, and total diuron including its metabolites diuron and 3,4-dichloroaniline. Text in bold refer to end-of-catchment sites and the corresponding data, all others refer to sub-catchment sites.

NRM region	Basin	Catchment	River and site name	n	Method	Total atrazine (kg)			Total diuron (kg)	
						Atrazine (kg)	Desethyl-atrazine (kg)	Desisop-ropylatra-zine (kg)	Diuron (kg)	3,4 dichl-oroaniline (kg)
Wet Tropics	Mulgrave-Russell	**Mulgrave River**	**Mulgrave River at Deeral**	76	L	49	4.8	NC	78	NC
		Russell River	**Russell River at East Russell**	88	L	20	3	NC	200	NC
	Johnstone	**North Johnstone River**	**North Johnstone River at Old Bruce Highway Bridge (Goondi)**	38	B	0.14	NC	NC	25	NC
	Tully	**Tully River**	**Tully River at Euramo**	112	L	100	15	5.4	140	NC
	Herbert	**Herbert River**	**Herbert River at Ingham**	41	B	17	1.4	NC	70	NC
Burdekin	Haughton	**Haughton River**	**Haughton River at Powerline**	17	L	4.2	0.97	0.36	0.76	NC
		Barratta Creek	**Barratta Creek at Northcote**	62	L	220	24	8.5	36	0.32
	Burdekin	**Burdekin River**	**Burdekin River at Home Hill**	24	L	50	5.0	3.0	7.0	NC
Mackay Whitsunday	O'Connell	**O'Connell River**	**O'Connell River at Caravan Park**	21	B	6.9	1.2	0.49	13	NC
	Pioneer	**Pioneer River**	**Pioneer River at Dumbleton Pump Station**	25	L	110	15	6.9	100	NC
	Plane	**Sandy Creek**	**Sandy Creek at Homebush**	40	L	74	8.2	4.2	72	0.81
Fitzroy	Fitzroy	**Fitzroy River**	**Fitzroy River at Rockhampton**	41	B	430	49	30	29	NC
		Comet River	Comet River at Comet Weir	18	B	230	9.9	7.1	0.58	NC
Burnett Mary	Burnett	**Burnett River**	**Burnett River at Ben Anderson Barrage Head Water**	33	L	25	1.2	NC	8.9	NC
	Mary	**Mary River**	**Mary River at Home Park**	113	L	24	3.9	NC	13	NC
		Tinana Creek	**Tinana Creek at Barrage Head Water**	130	L	16	1.8	0.62	9.8	NC
Total monitored load (excluding Comet River at Comet Weir#)				879		1100	130	59	800	1.1

Data shaded blue (atrazine, desethylatrazine,desisopropylatrazine and diuron and 3,4-dichloroaniline) have already been incorporated in the calculation of total atrazine and total diuron and have been presented in the main body of this report. n = the number of grab samples used to calculate loads; NC = a load was not calculated as all the concentrations were below the practical quantitation limit or there were insufficient samples collected over the year to calculate a load; L = average load (linear interpolation of concentration) method used to calculate loads; B = Beale ratio method used to calculate loads.

Comet River at Comet Weir is a nested sub-catchment monitoring site located upstream of the Fitzroy River at Rockhampton monitoring site and has therefore not been included in the calculation of total monitored load.

Table 7.7 The monitored loads calculated for the additional pesticide total glyphosate, glyphosate and AMPA. Sampling collection for the analysis of glyphosate only commenced in January 2015 and loads are calculated for the monitored period only. Text in bold refer to end-of-catchment sites and the corresponding data.

NRM region	Basin	Catchment	River and site name	n	Method	Start date	End date	Number of days monitored	Total Glyphosate (kg)	Glyphosate (kg)	AMPA (kg)
Wet Tropics	Tully	**Tully River**	**Tully River at Euramo**	72	L	**09/01/2016**	**30/06/2015**	**172**	**480**	**220**	**NC**
Burdekin	Haughton	**Barratta Creek**	**Barratta Creek at Northcote**	40	L	**04/01/2016**	**30/06/2015**	**177**	**220**	**100**	**93**
Mackay Whitsunday	Plane	**Sandy Creek**	**Sandy Creek at Homebush**	24	L	**06/01/2016**	**30/06/2015**	**175**	**5.4**	**1.7**	**9.8**

n = the number of samples used to calculate loads; L = average load (linear interpolation of concentration) method used to calculate loads.

Appendix B Calculation of discharge

At monitoring sites located at Queensland Department of Natural Resources and Mines gauging stations, discharge was calculated using an area velocity method. During the 2014–2015 monitoring year, river gauge height was recorded by gauging stations using a float or a pressure sensor at intervals of approximately 15 minutes. Discharge is calculated for sub-sectional areas of the river channel and summed to determine the discharge across the whole cross-sectional area. Sub-sectional areas were calculated from a known width multiplied by the river gauge height at time t. Flow velocity was determined for each cross-sectional area at time t using a current meter.

Discharge as extracted from the Queensland Government surface water database is calculated following the equation:

Equation 9

$$q = va$$

where, q is the discharge ($m^3 s^{-1}$), v = average velocity of the flow in the cross-sectional area (ms^{-1}) and a = the cross-sectional area of the river (m^2).

Flow records were extracted for from the Queensland Government electronic data management system (Hydstra).

Appendix C Discharge data quality

The total period (hours) during the 2014–2015 monitoring year for which discharge was calculated from interpolated height data is provided in Table 7.8. Discharge that was calculated from interpolated height data were assigned a quality code of 59 or 60 (refer to Table 7.8).

Table 7.8 Per cent of annual discharge period calculated using interpolated discharge. Text in bold relate to end-of-catchment sites and gauging stations and the corresponding data, all others relate to sub-catchment sites.

Basin	Gauging station	River and site name	Time period (hours)	Quality code[1]	Per cent of annual discharge calculated using interpolated discharge
Normanby	**105107A**	**Normanby River at Kalpowar Crossing**			
Barron	**110001D**	**Barron River at Myola**			
Mulgrave-Russell	**1110056**	**Mulgrave River at Deeral[$]**	NA	NA	NA
	1111019	**Russell River at East Russell[$]**	NA	NA	NA
Johnstone	**1120049**	**North Johnstone River at Old Bruce Highway Bridge (Goondi)**	105	60	1
	112101B	**South Johnstone River at Upstream Central Mill**			
Tully	**113006A**	**Tully River at Euramo**	7521	60	86
	113015A	Tully River at Tully Gorge National Park			
Herbert	**116001F**	**Herbert River at Ingham**	3721	60	42
Haughton	**119003A**	**Haughton River at Powerline**	152	60	2
	119101A	**Barratta Creek at Northcote**	43	60	<1
Burdekin	**120001A**	**Burdekin River at Home Hill**			
	120002C	Burdekin River at Sellheim	132	130	2
	120205A	Bowen River at Myuna			
O'Connell	**1240062**	**O'Connell River at Caravan Park**			
Pioneer	**125013A**	**Pioneer River at Dumbleton Pump Station**	252	60	3
Plane	**126001A**	**Sandy Creek at Homebush**			
Fitzroy	**1300000**	**Fitzroy River at Rockhampton**			
	130206A	Theresa Creek at Gregory Highway			
	130302A	Dawson River at Taroom			
	130504B	Comet River at Comet Weir			
Burnett	**136014A**	**Burnett River at Ben Anderson Barrage Head Water**			
	136002D	**Burnett River at Mt Lawless**	140	60	2
Mary	**138014A**	**Mary River at Home Park**			
	138008A	**Tinana Creek at Barrage Head Water[#]**	NA	NA	NA

1 Quality codes are explained in Table 7.9; # modelled discharge was used in the calculation of loads for this site; and $ modelled and measured flow were used in the calculation of loads at these sites; NA = not applicable as discharge was calculated using flow measured flow and modelled discharge.

Table 7.9 Description of discharge data quality codes (DNRM 2015).

Discharge data quality code	Description
10	Good
15	No flow
20	Fair
30	Poor
59	CITEC – Derived height
60	Estimate
160	Suspect

Appendix D Calculation of discharge in the Mulgrave River and Russell River

New monitoring sites were installed in the Mulgrave River and Russell River by the Great Barrier Reef Catchment Loads Monitoring Program in early 2015. Installation of these sites was made possible through partnership funding provided by Terrain Natural Resource Management and Department of Science, Information Technology and Innovation.

Measured flow by Horizontal Acoustic Doppler Current Profiler

Flow during flood events at the Russell River and Mulgrave River monitoring sites were measured by Horizontal Acoustic Doppler Current Profilers. These sites are heavily affected by tidal flows and flow measurement at such locations was not possible prior to the development and installation of Horizontal Acoustic Doppler Current Profilers at these sites.

The Horizontal Acoustic Doppler Current Profilers units are mounted at the side of the river and only measure the velocity in a fixed horizontal slice of the river. Therefore, it is necessary to calibrate the measurements against the values for the whole river. This is achieved by measuring the flow of the entire river in a range of flow conditions to develop the Index Velocity relationship between the average velocity of the slice of water that the Horizontal Acoustic Doppler Current Profilers are measuring and the average velocity of the total river. Data from more than 200 measurements, collected across a wide range of flow conditions, have been used to develop these relationships at the Russell River and Mulgrave River monitoring sites.

Although the Horizontal Acoustic Doppler Current Profilers are able to measure during almost all flow conditions, at these sites their mounting positions are above the low tide water level in low-flow conditions. As a consequence, a small portion of the total flows at these sites remains unmeasured and modelled flows have been used for daily flow calculations during low-flow periods. This approach also avoids the complication of filtering the tidal 'noise' from the fresh water flows at these sites. During high flow conditions the Horizontal Acoustic Doppler Current Profilers units are able to measure the flows continuously and the effect of the tide is also significantly attenuated. Use of these measured data enables significantly more precise load calculations during flood events (when compared to using only modelled flow), as sample concentrations can be applied to accurate flow data, rather than a modelled daily figure.

Mulgrave River at Deeral

The entire record of velocity data has been adjusted to reflect the Velocity Index relationship found between the average velocity recorded by the Horizontal Acoustic Doppler Current Profilers at this site and the average velocity (Q/area) of the whole river measured by a River Ray Acoustic Doppler Current Profilers during 118 sections gauged over the period 11/02/15 and 11/02/16.

- Measured flows ranged from -129 to 159 m^3s^{-1}.
- Measured average velocities ranged from -0.432 to 0.752 ms^{-1}.

The relationship between the gauged velocities (x) and the Horizontal Acoustic Doppler Current Profilers velocities (y) in these measurements is described by:

Equation 10 $y = 0.185x^2 + 0.9449x - 0.0146$ ($R^2 = 0.9843$)

Russell River at East Russell

The record of velocity data has been adjusted to reflect the Velocity Index relationship found from 88 sections gauged over the period 11/02/15 and 10/02/16.

- Measured flows ranged from -70.1 to 232 m^3s^{-1}.
- Measured average velocities ranged from -0.18 to 0.72 ms^{-1}.

The relationship between the gauged velocities (x) and the Horizontal Acoustic Doppler Current Profilers velocities (y) in these measurements is described by:

Equation 11 $y = 0.7578x + 0.0091$ ($R^2 = 0.9729$)

Modelled river discharge

Daily discharge for the Mulgrave River and Russell River were simulated and calibrated by the Department of Natural Resources and Mines using the Source Catchments platform Sacramento rainfall runoff model coupled with the Parameter Estimation Software Tool (PEST) for the period 1 July 1970 to 30 June 2015, following the approach detailed in Zhang et al. (2014). Zhang et al. (2014) demonstrated that the Sacramento model provides better performance in reproducing long-term daily discharge and high flow event scenarios than the Source Catchments platform alternate models Simhyd and GR4J.

The hydrology statistics used to calibrate the Mulgrave and Russell catchments (based on three upstream gauging stations) are provided in Table 7.10 (Zhang 2015b). The calibration site at the Mulgrave River at Peets Bridge is the lowest gauged site within the catchment. Similarly within the Russell catchment, Russell River at Bucklands and Babinda Creek at Babinda are the two lowest gauges on the primary tributaries in the Russell catchment.

Table 7.10 Summary hydrology statistics used to calibrate the Sacramento rainfall runoff model in the Mulgrave and Russell basin for the period 1 July 1970 to 30 June 2015.

Gauging station	River and site name	R^2	NSE*	Bias of total flow	Bias of high flow
111007A	Mulgrave River at Peets Bridge	0.91	0.83	0.0%	-0.2%
111101D	Russell River at Bucklands	0.94	0.89	-2.5%	-3.3%
111102B	Babinda Creek at Babinda	0.90	0.81	-6.2%	-4.5%

*Nash-Sutcliffe coefficient of efficiency for daily simulated flow versus observed on a 1:1 line.

Appendix E Hydrograph plots of discharge and sample collection points

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

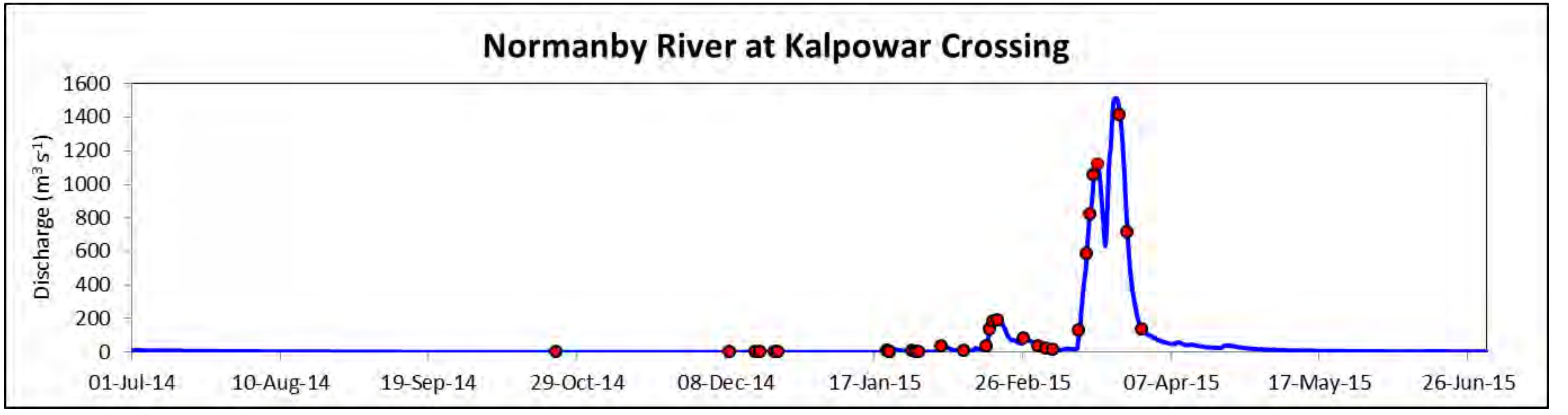

Figure 7.1 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Normanby River at Kalpowar Crossing between 1 July 2014 and 30 June 2015. Representivity rating was good for all analytes.

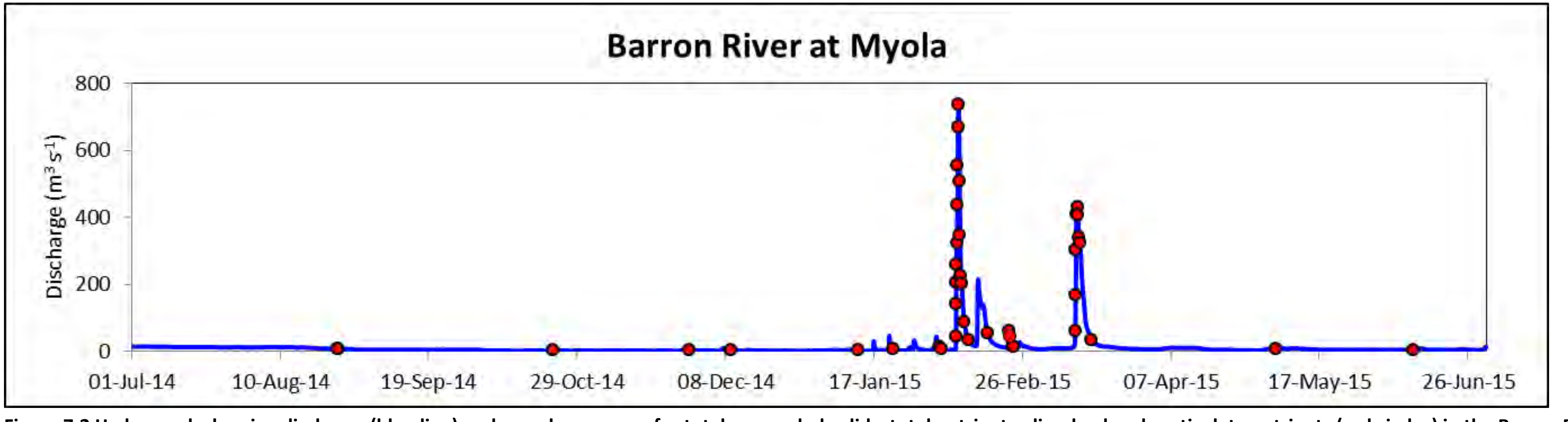

Figure 7.2 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Barron River at Myola between 1 July 2014 and 30 June 2015. Representivity rating was excellent for all analytes.

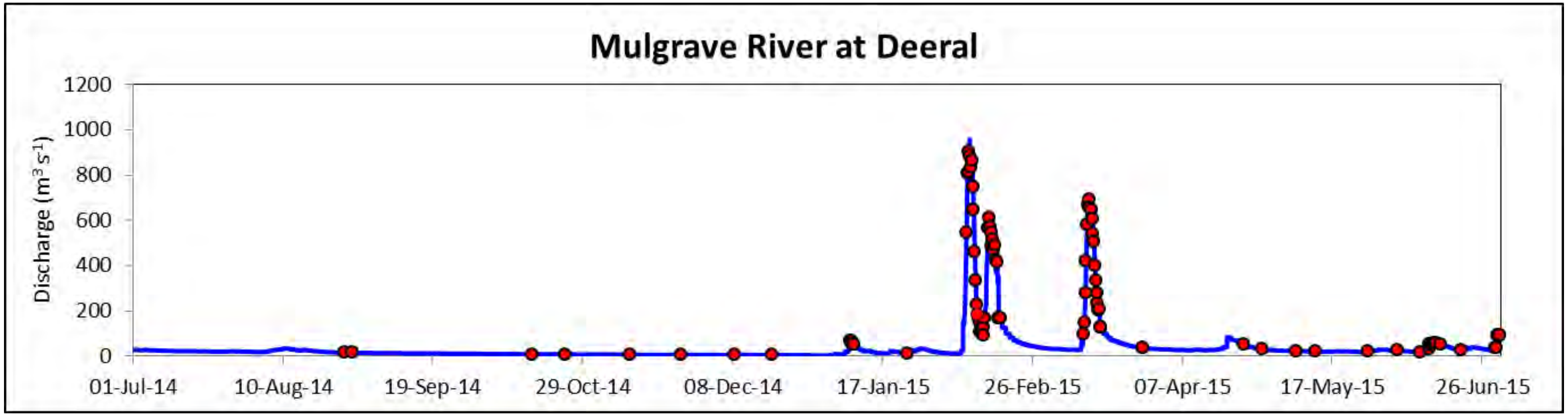

Figure 7.3 Hydrograph showing measured and modelled discharge (blue line) (Appendix D) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Mulgrave River at Deeral between 1 July 2014 and 30 June 2015. Representivity rating was excellent for all analytes.

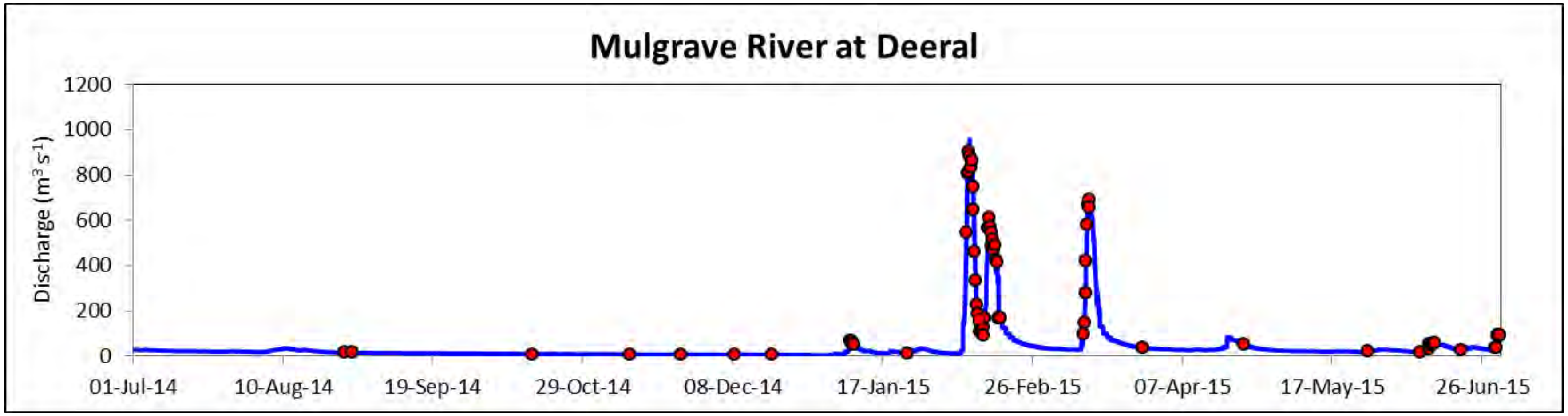

Figure 7.4 Hydrograph showing measured and modelled discharge (blue line) (Appendix D) and sample coverage for photosystem II inhibiting herbicides (red circles) in the Mulgrave River at Deeral between 1 July 2014 and 30 June 2015. Sample representivity was not assessed for pesticides.

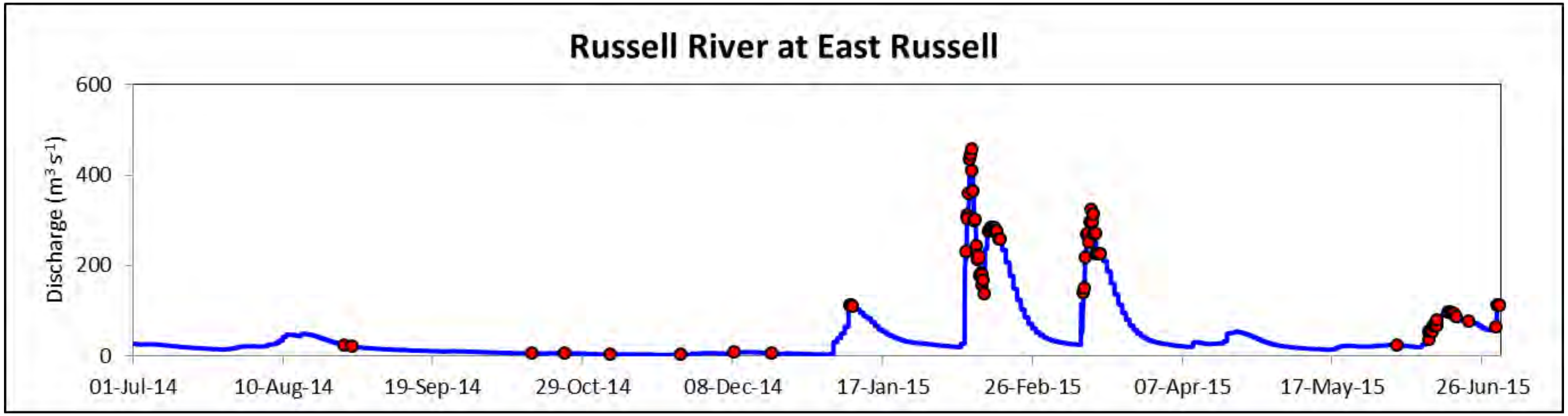

Figure 7.5 Hydrograph showing measured and modelled discharge (blue line) (Appendix D) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Russell River at East Russell between 1 July 2014 and 30 June 2015. Representivity rating was excellent for all analytes.

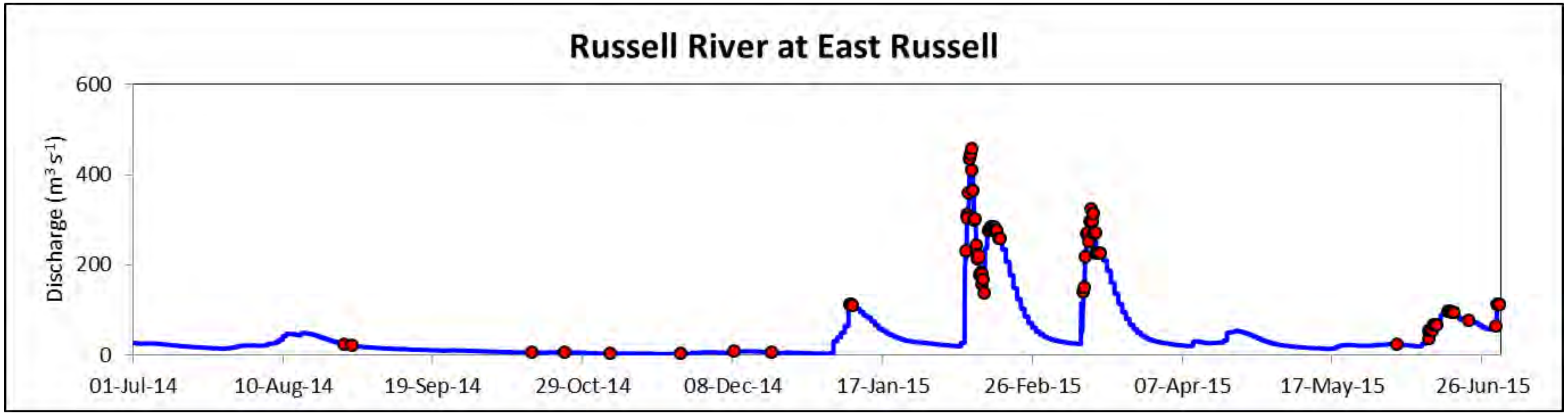

Figure 7.6 Hydrograph showing measured and modelled discharge (blue line) (Appendix D) and sample coverage for photosystem II inhibiting herbicides (red circles) in the Russell River at East Russell between 1 July 2014 and 30 June 2015. Sample representivity was not assessed for pesticides.

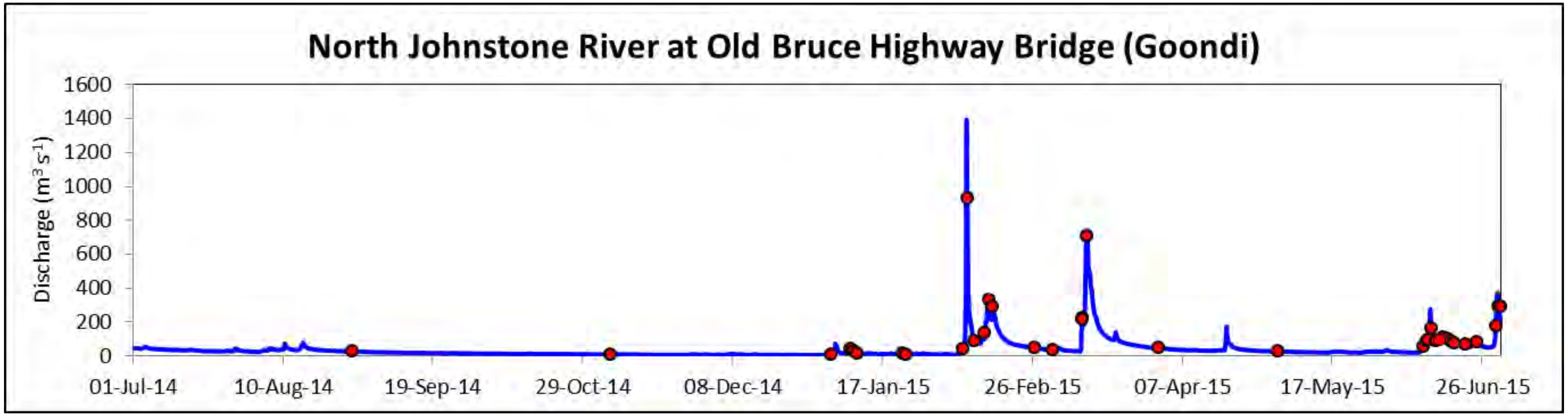

Figure 7.7 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved, particulate nutrients and for photosystem II inhibiting herbicides (red circles) in the North Johnstone River at Old Bruce Highway Bridge (Goondi) between 1 July 2014 and 30 June 2015. Representivity rating was good for all analytes. Sample representivity was not assessed for pesticides.

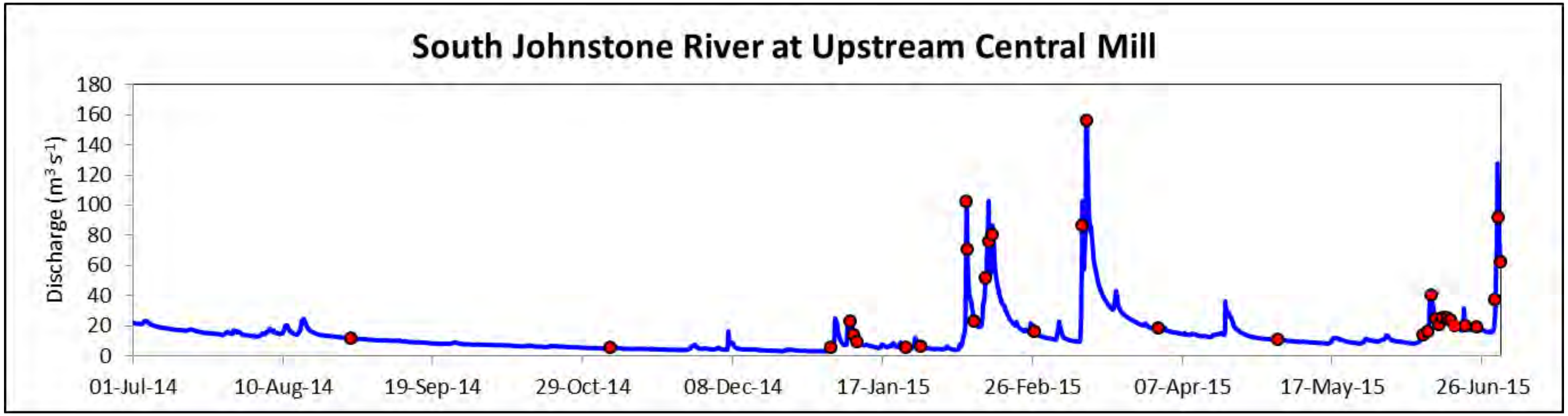

Figure 7.8 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the South Johnstone River at Upstream Central Mill between 1 July 2014 and 30 June 2015. Representivity rating was good for all analytes.

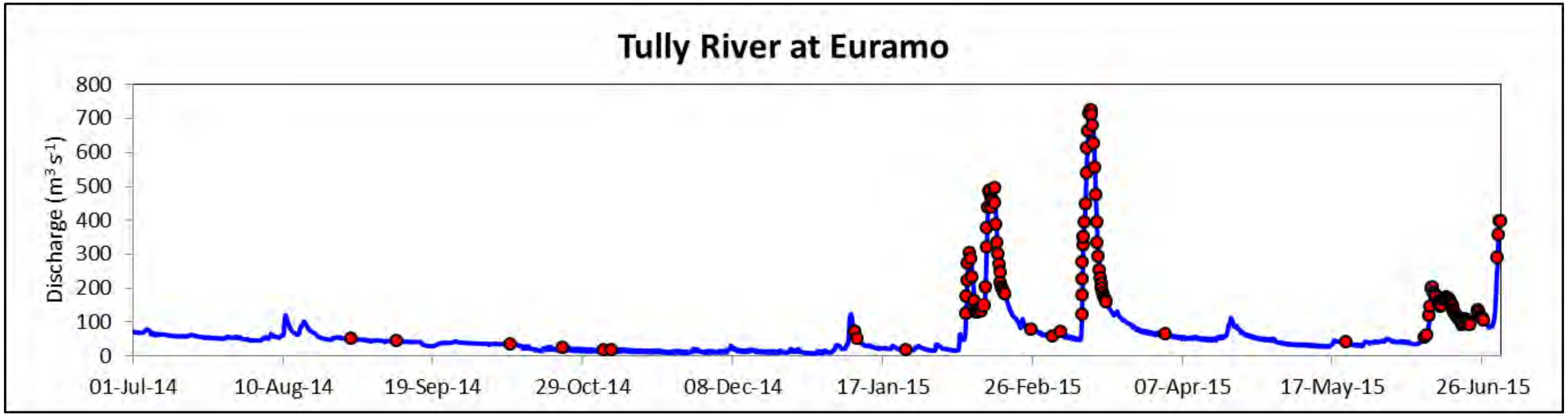

Figure 7.9 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Tully River at Euramo between 1 July 2014 and 30 June 2015. Representivity rating was excellent for all analytes.

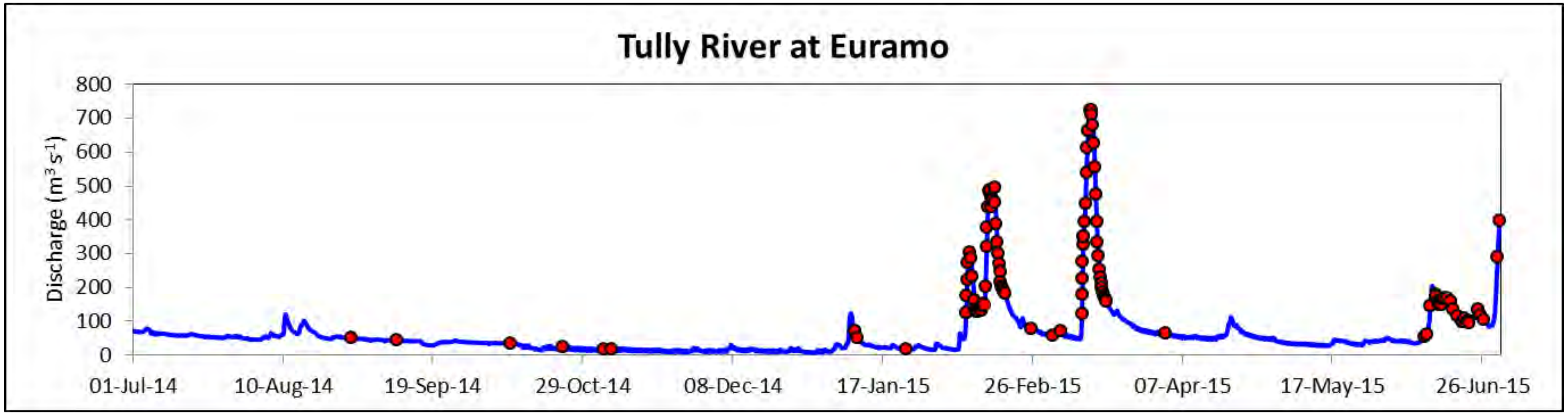

Figure 7.10 Hydrograph showing discharge (blue line) and sample coverage for photosysterm II inhibiting herbicides (red circles) in the Tully River at Euramo between 1 July 2014 and 30 June 2015. Sample representivity was not assessed for pesticides.

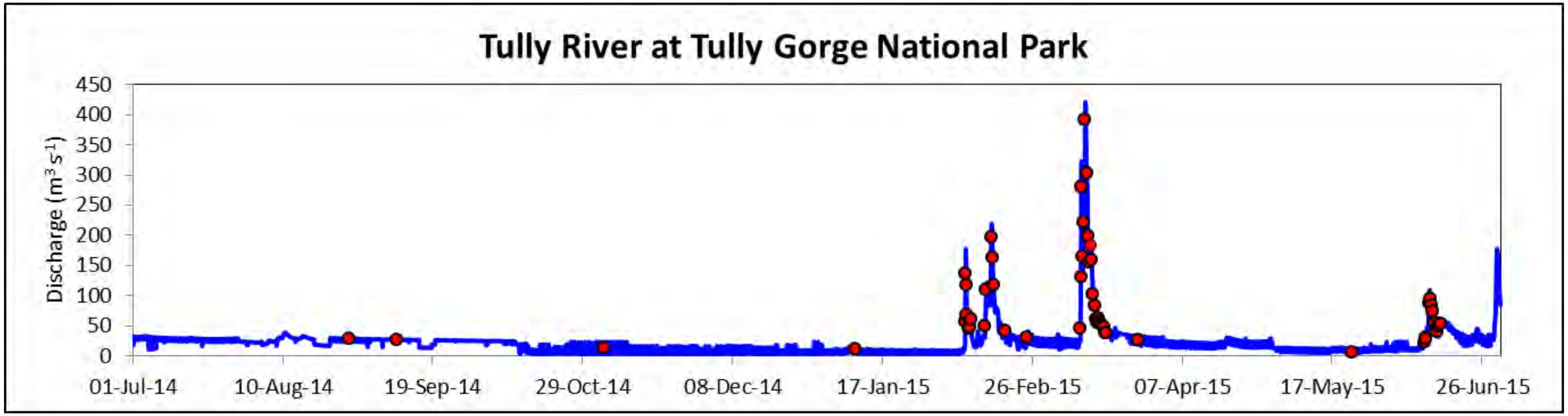

Figure 7.11 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Tully River at Tully Gorge National Park between 1 July 2014 and 30 June 2015. Sample representivity was not assessed for pesticides.

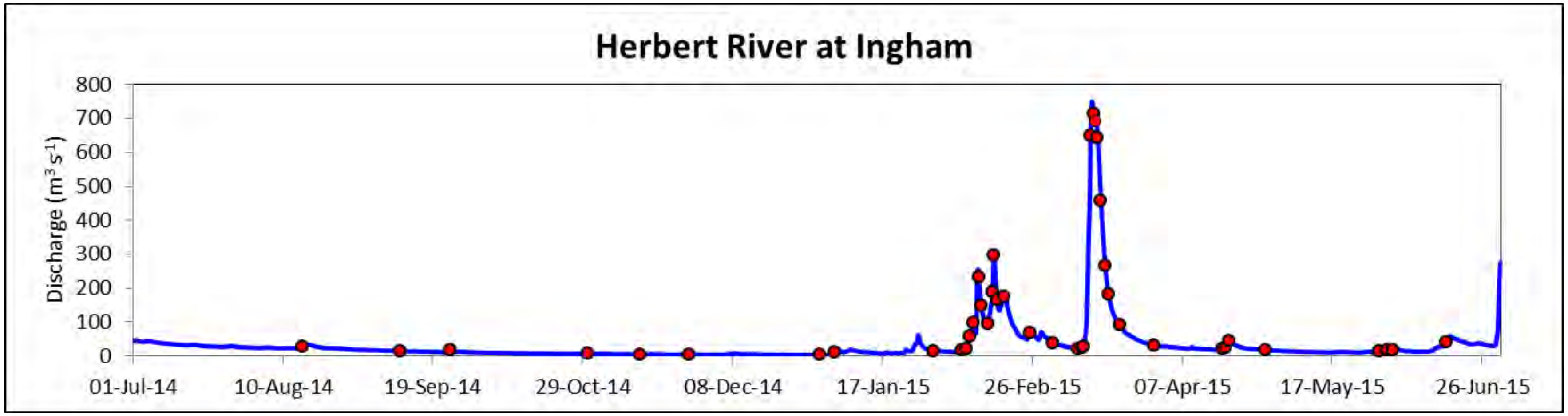

Figure 7.12 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Herbert River at Ingham between 1 July 2014 and 30 June 2015. Representivity rating was good for all analytes.

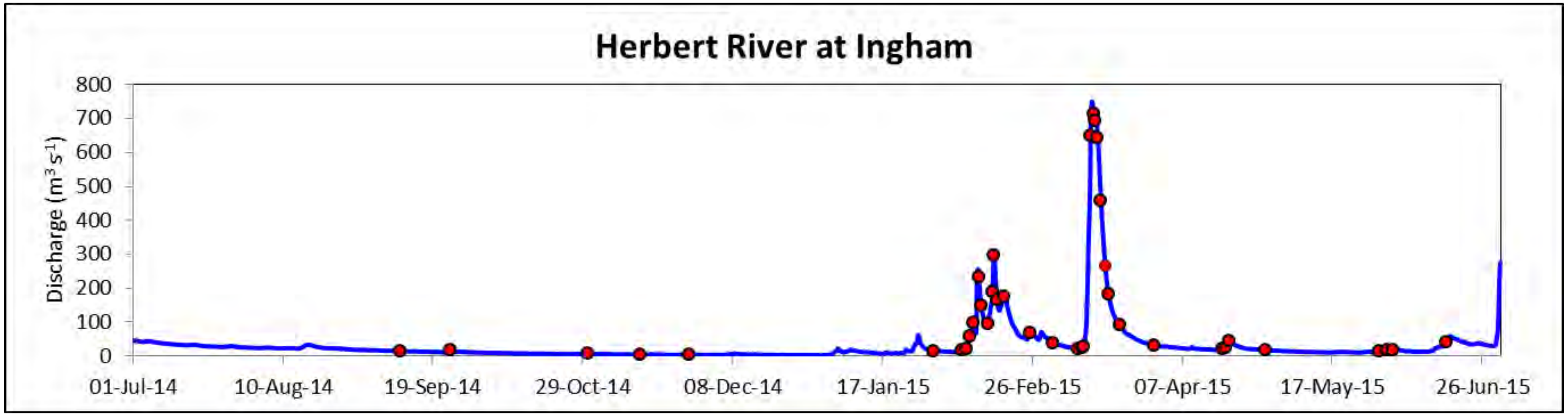

Figure 7.13 Hydrograph showing discharge (blue line) and sample coverage for photosystem II inhibiting herbicides (red circles) in the Herbert River at Ingham between 1 July 2014 and 30 June 2015. Representivity rating was excellent for all analytes. Sample representivity was not assessed for pesticides.

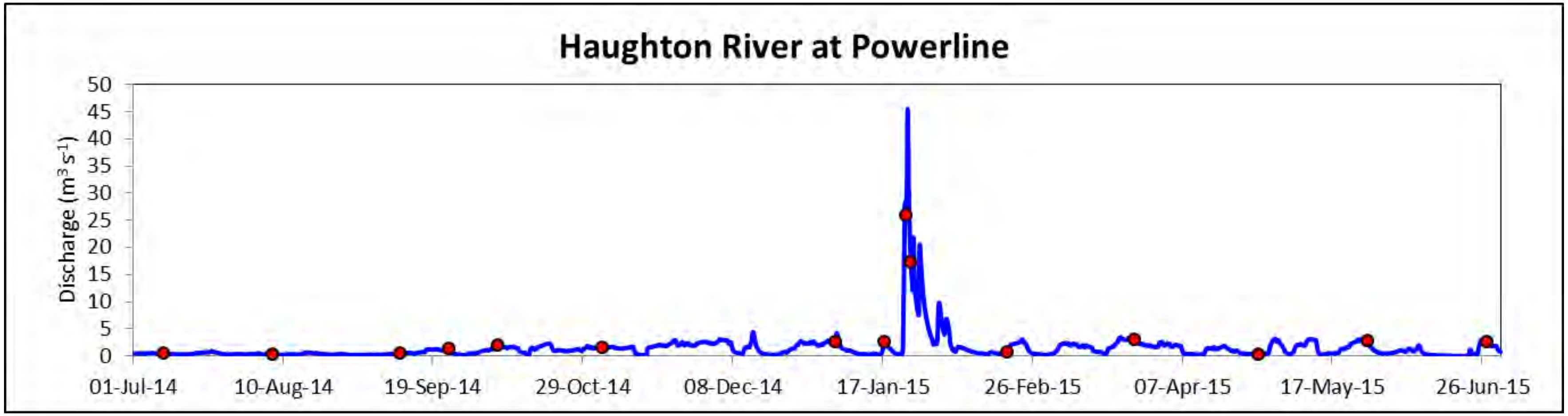

Figure 7.14 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Haughton River at Powerline between 1 July 2014 and 30 June 2015. Representivity rating was moderate for all analytes.

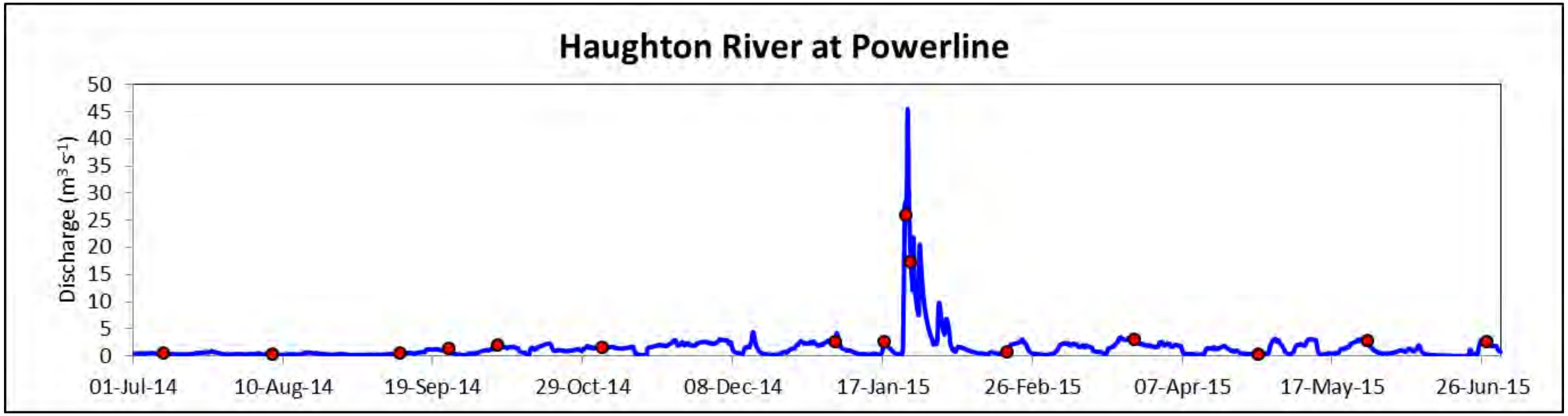

Figure 7.15 Hydrograph showing discharge (blue line) and sample coverage for photosystem II inhibiting herbicides (red circles) in the Haughton River at Powerline between 1 July 2014 and 30 June 2015. Sample representivity was not assessed for pesticides.

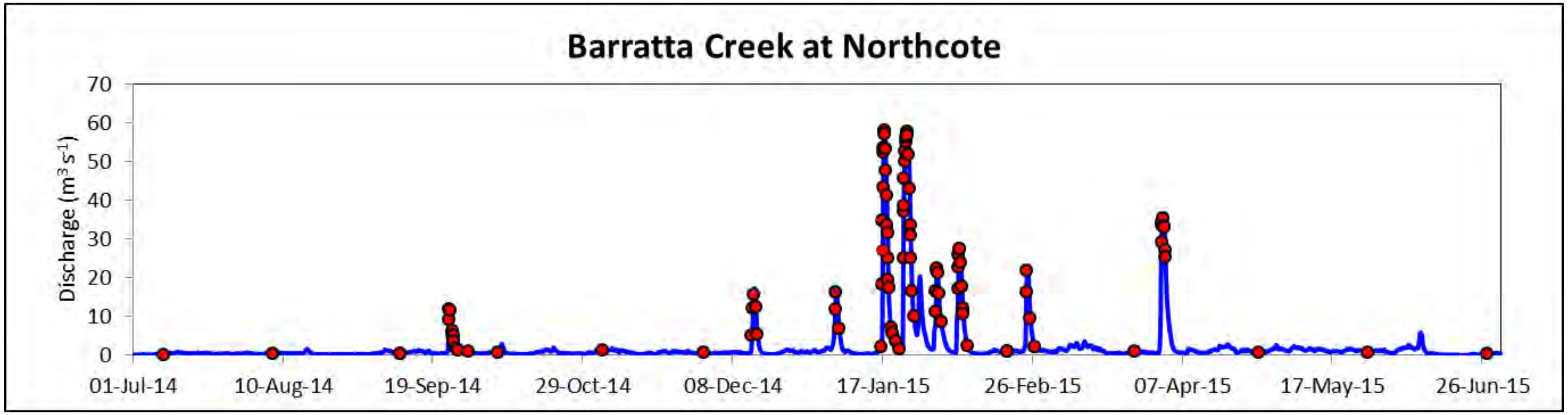

Figure 7.16 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in Barratta Creek at Northcote between 1 July 2014 and 30 June 2015. Representivity rating was excellent for all analytes.

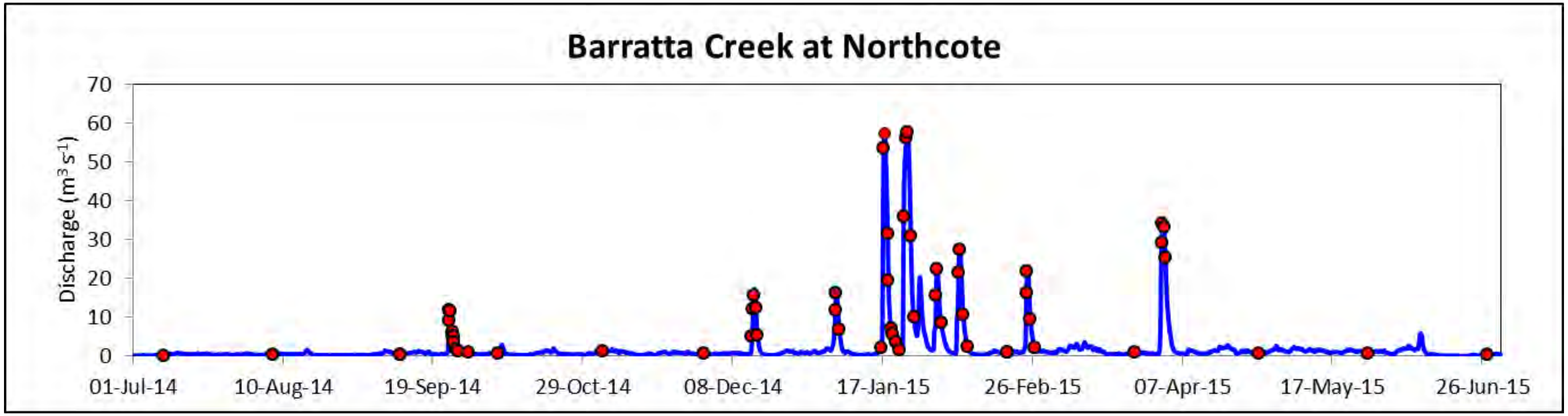

Figure 7.17 Hydrograph showing discharge (blue line) and sample coverage for photosystem II inhibiting herbicides (red circles) in Barratta Creek at Northcote between 1 July 2014 and 30 June 2015. Sample representivity was not assessed for pesticides.

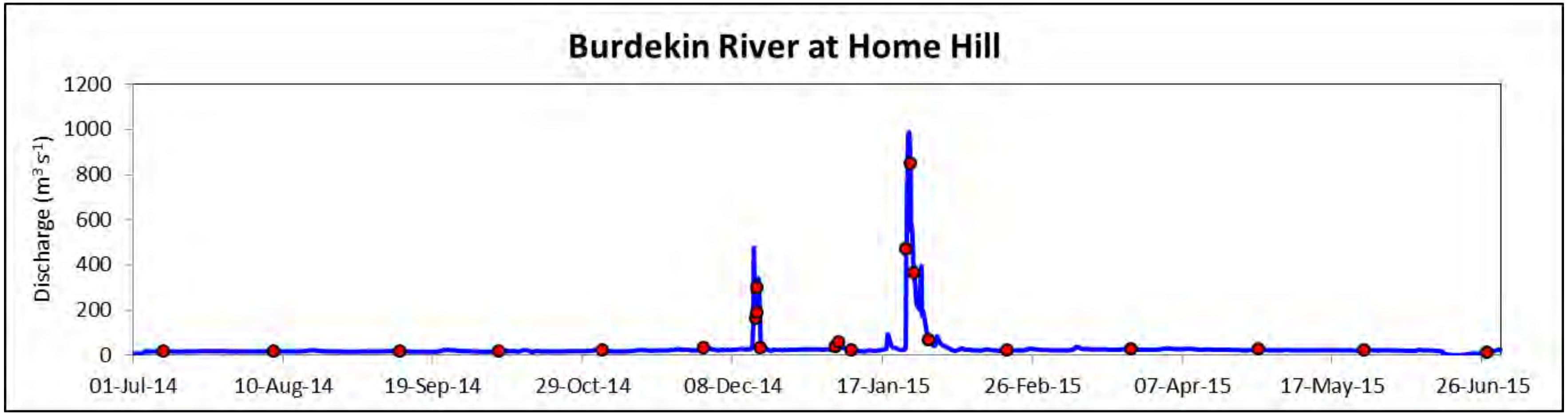

Figure 7.18 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients and photosystem II inhibiting herbicides (red circles) in the Burdekin River at Home Hill between 1 July 2014 and 30 June 2015. Representivity rating was good for all analytes. Sample representivity was not assessed for pesticides.

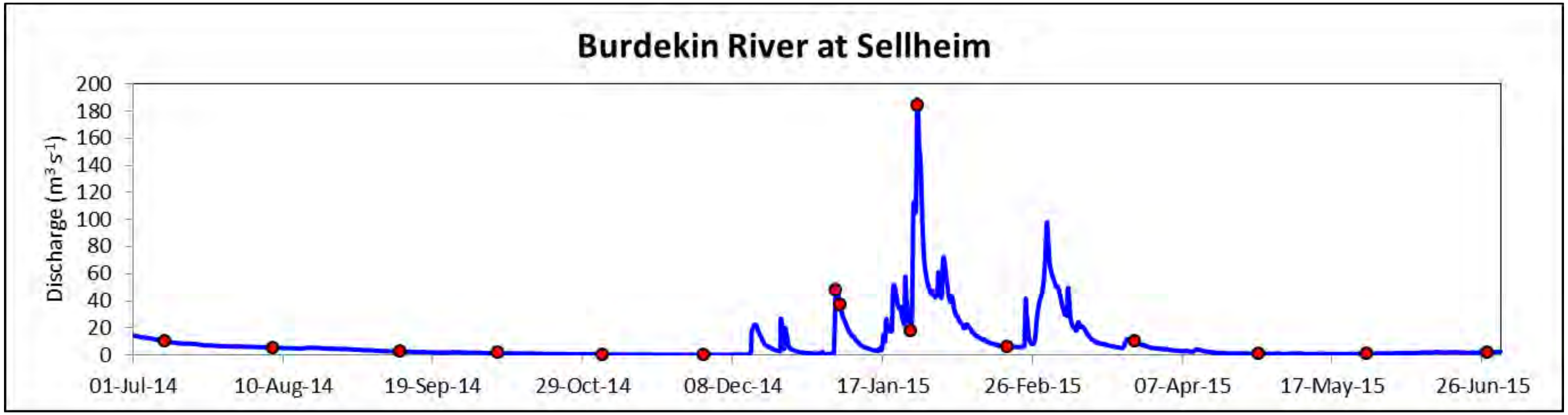

Figure 7.19 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Burdekin River at Sellheim between 1 July 2014 and 30 June 2015. Representivity rating was good for all analytes.

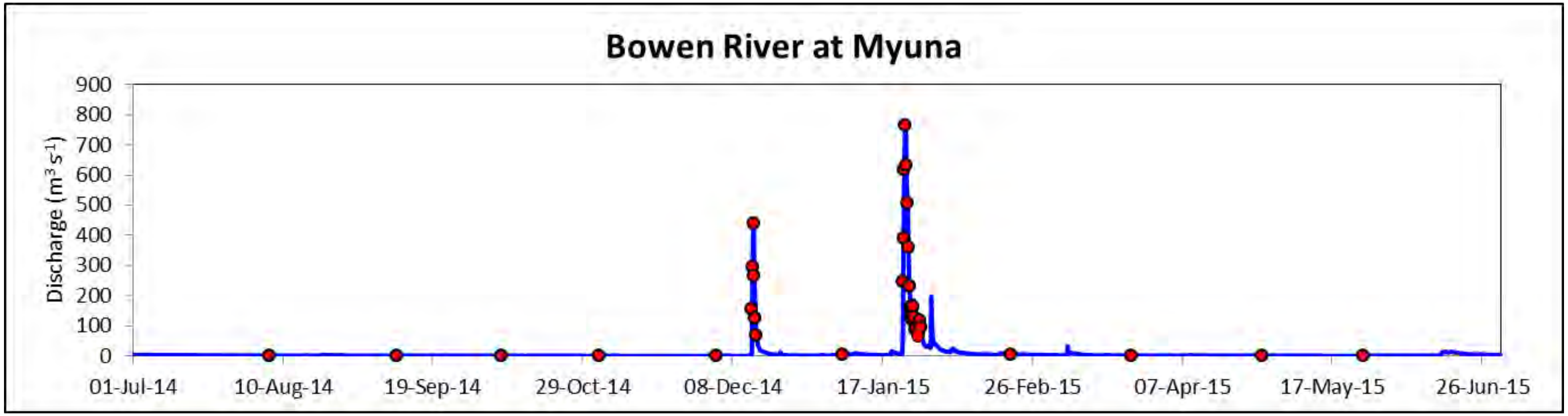

Figure 7.20 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Bowen River at Myuna between 1 July 2014 and 30 June 2015. Representivity rating was excellent for all analytes.

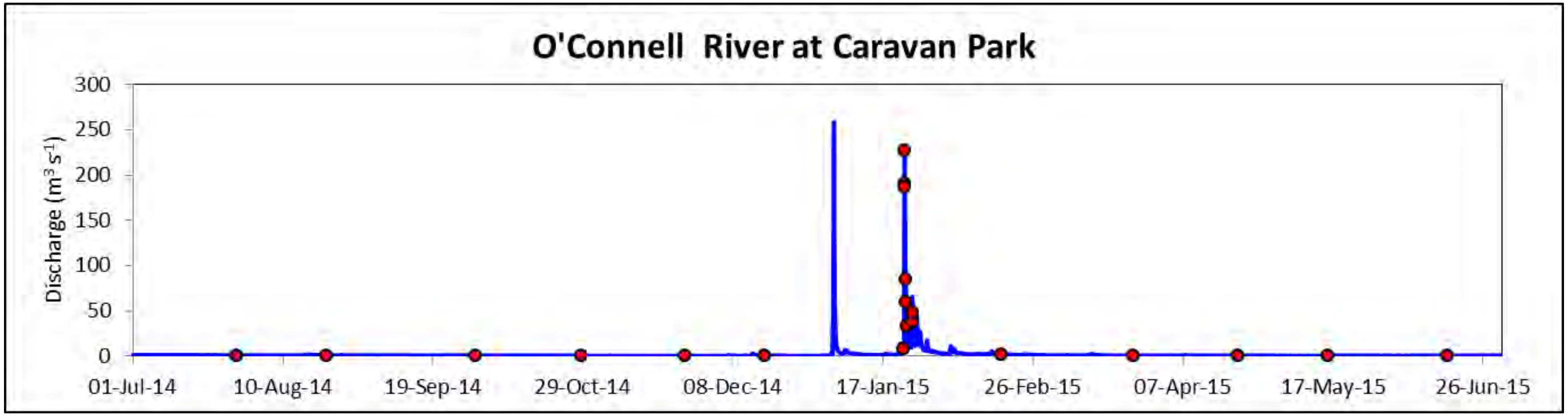

Figure 7.21 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients and photosystem II inhibiting herbicides (red circles) in the O'Connell River at Caravan Park between 1 July 2014 and 30 June 2015. Representivity rating was moderate for total suspended solids and good for the other analytes. Sample representivity was not assessed for pesticides.

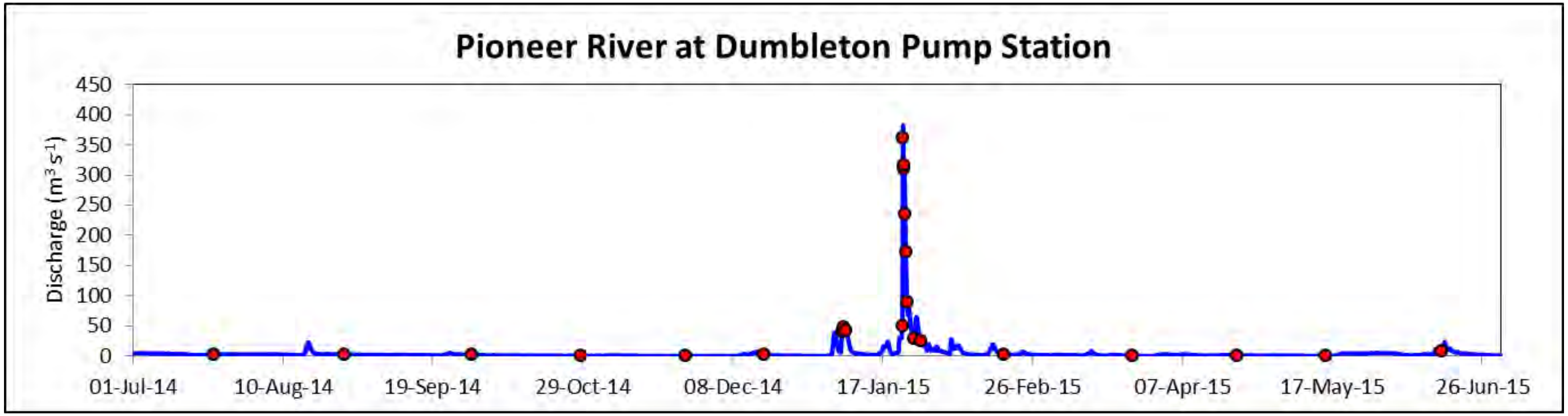

Figure 7.22 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients and photosystem II inhibiting herbicides (red circles) in the Pioneer River at Dumbleton Pump Station between 1 July 2014 and 30 June 2015. Representivity rating was good for all analytes. Sample representivity was not assessed for pesticides.

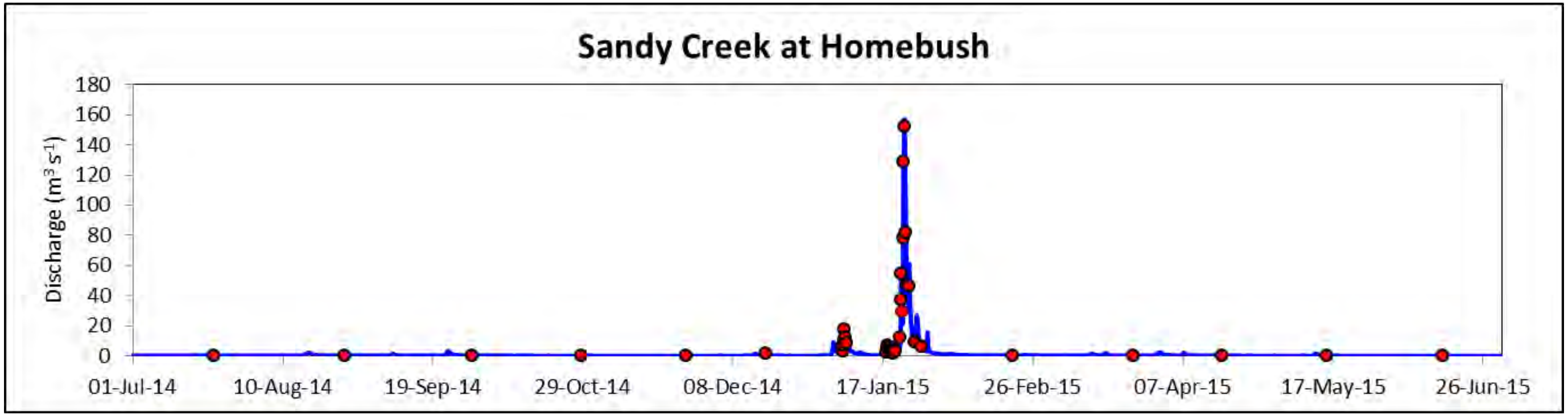

Figure 7.23 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients and photosystem II inhibiting herbicides (red circles) in Sandy Creek at Homebush between 1 July 2014 and 30 June 2015. Representivity rating was excellent for all analytes. Sample representivity was not assessed for pesticides.

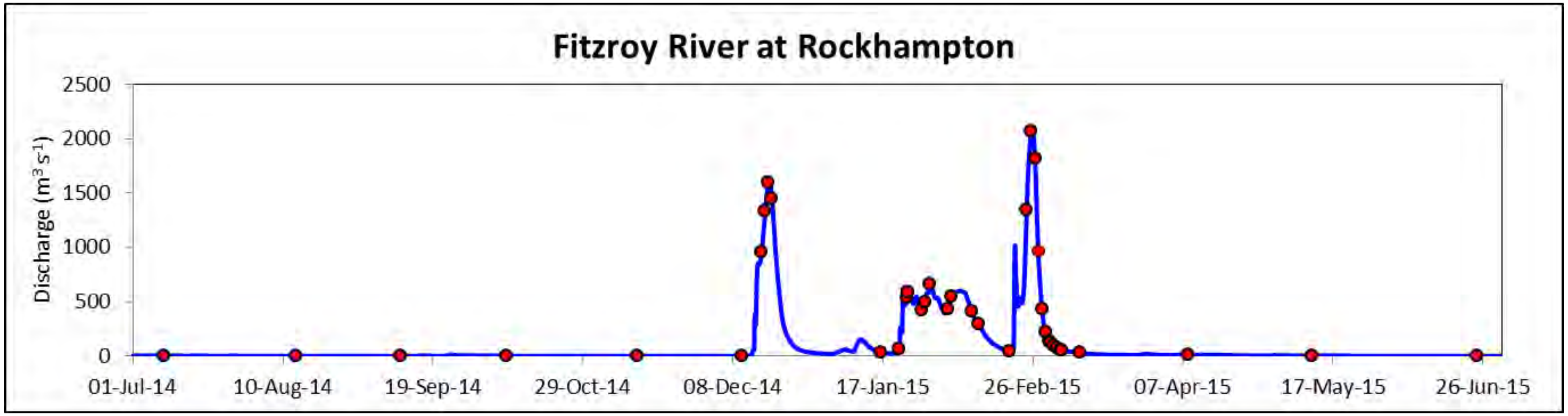

Figure 7.24 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Fitzroy River at Rockhampton between 1 July 2014 and 30 June 2015. Representivity rating was good for all analytes.

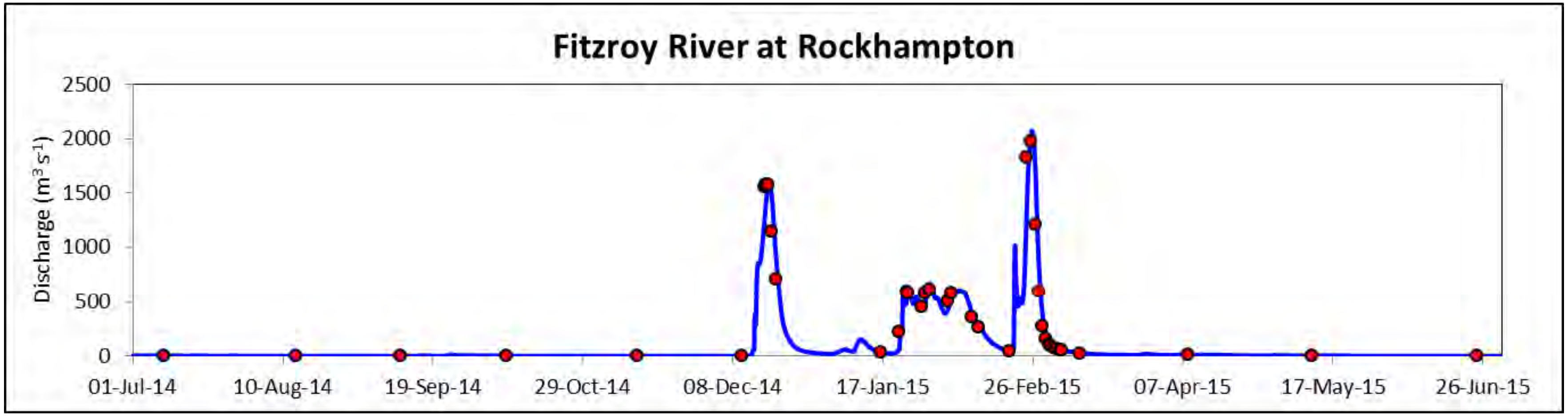

Figure 7.25 Hydrograph showing discharge (blue line) and photosystem II inhibiting herbicide sample coverage (red circles) in the Fitzroy River at Rockhampton between 1 July 2014 and 30 June 2015. Sample representivity was not assessed for pesticides.

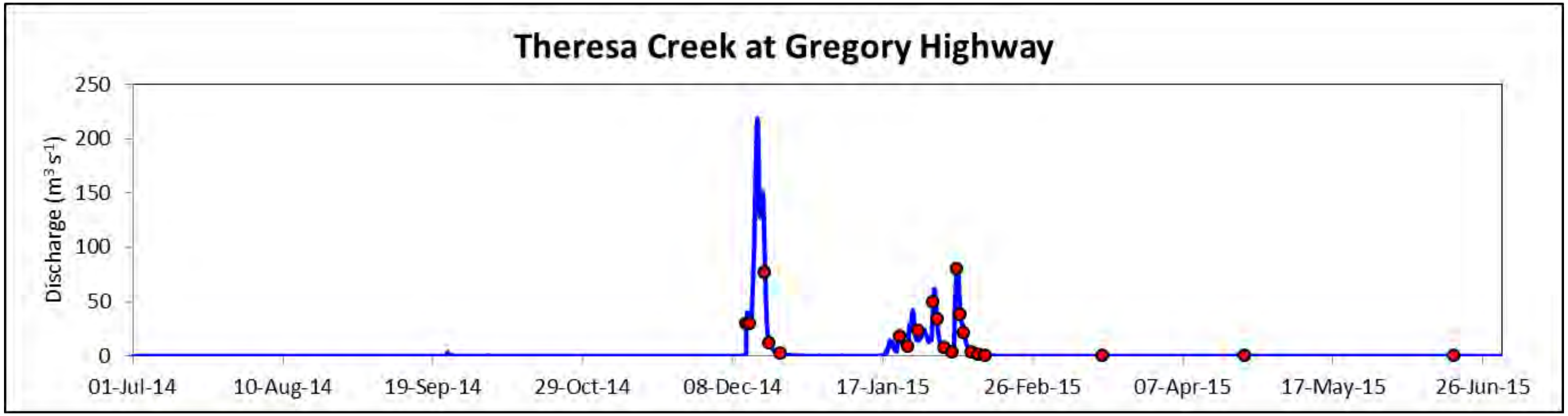

Figure 7.26 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in Theresa Creek at Gregory Highway between 1 July 2014 and 30 June 2015. Representivity rating was moderate for all analytes.

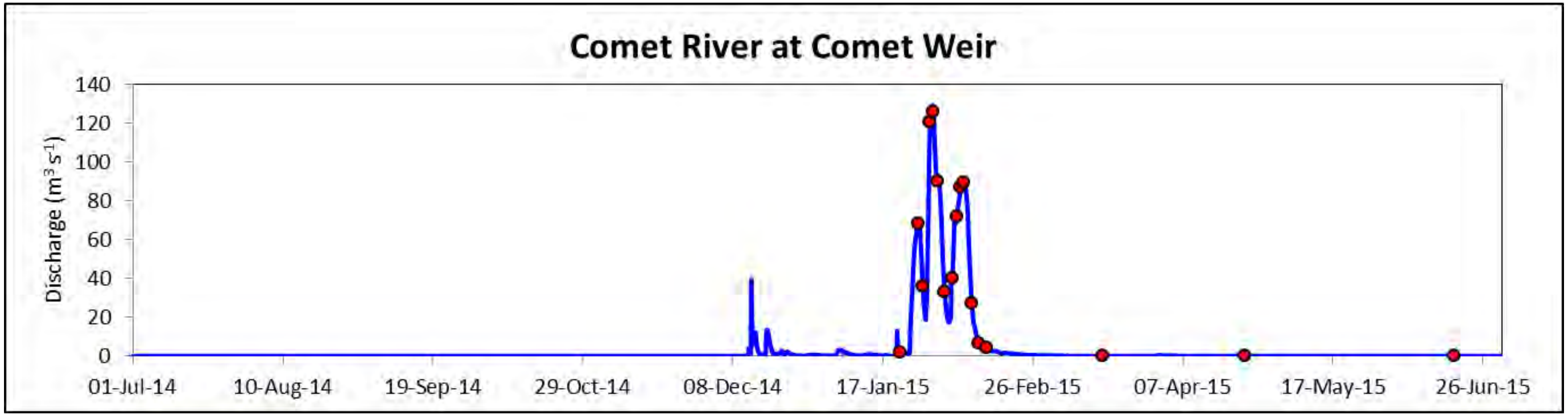

Figure 7.27 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients and photosystem II inhibiting herbicides (red circles) in the Comet River at Comet Weir between 1 July 2014 and 30 June 2015. Representivity rating was good for all analytes. Sample representivity was not assessed for pesticides.

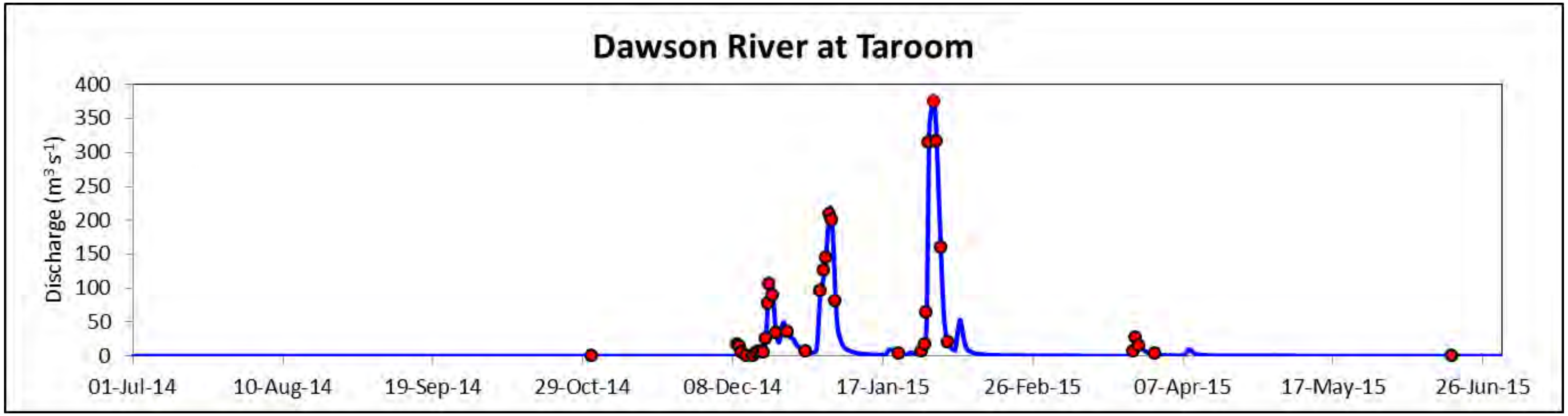

Figure 7.28 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Dawson River at Taroom between 1 July 2014 and 30 June 2015. Representivity rating was good for all analytes.

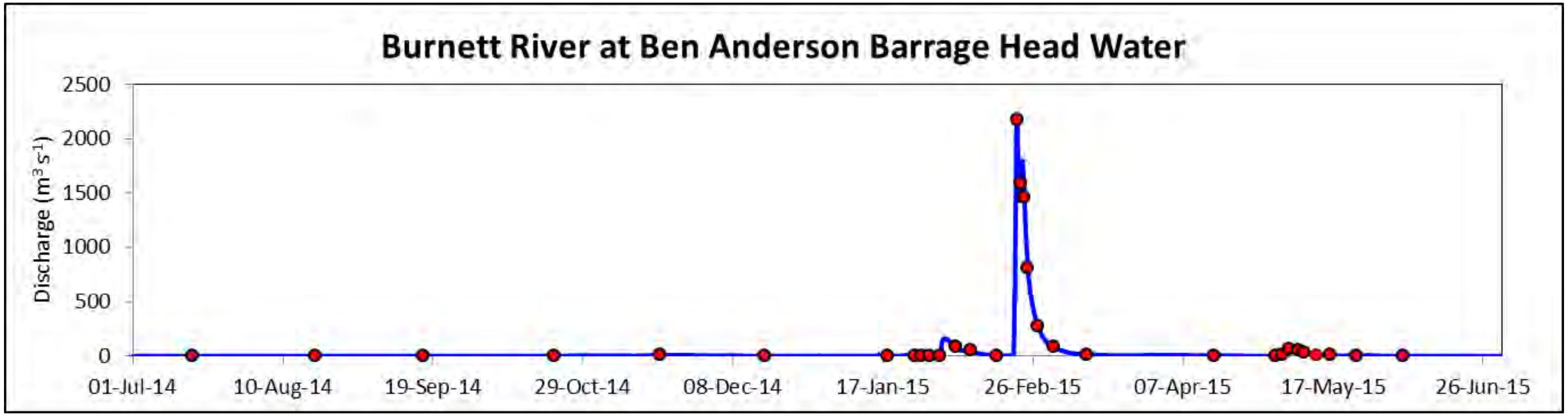

Figure 7.29 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients, and photosystem II inhibiting herbicides (red circles) in the Burnett River at Ben Anderson Barrage Head Water between 1 July 2014 and 30 June 2015. Representivity rating was not estimated for this site because all concentration data were excluded from analysis and reporting due to non-conformance of sample collection methods.

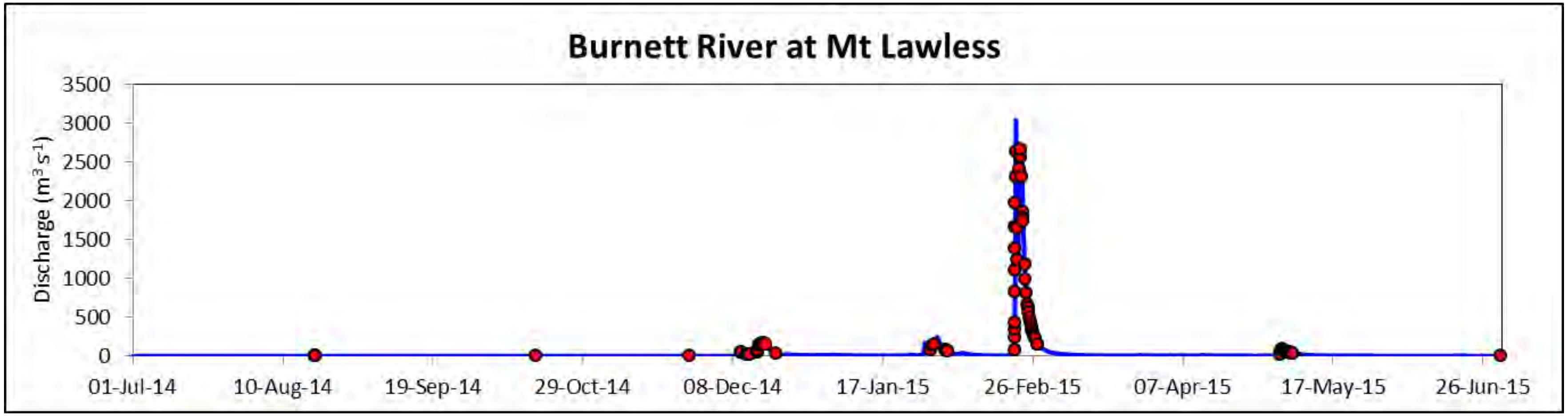

Figure 7.30 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients (red circles) in the Burnett River at Mt Lawless between 1 July 2014 and 30 June 2015. Representivity rating was not estimated for this site because all concentration data were excluded from analysis and reporting due to non-conformance of sample collection methods.

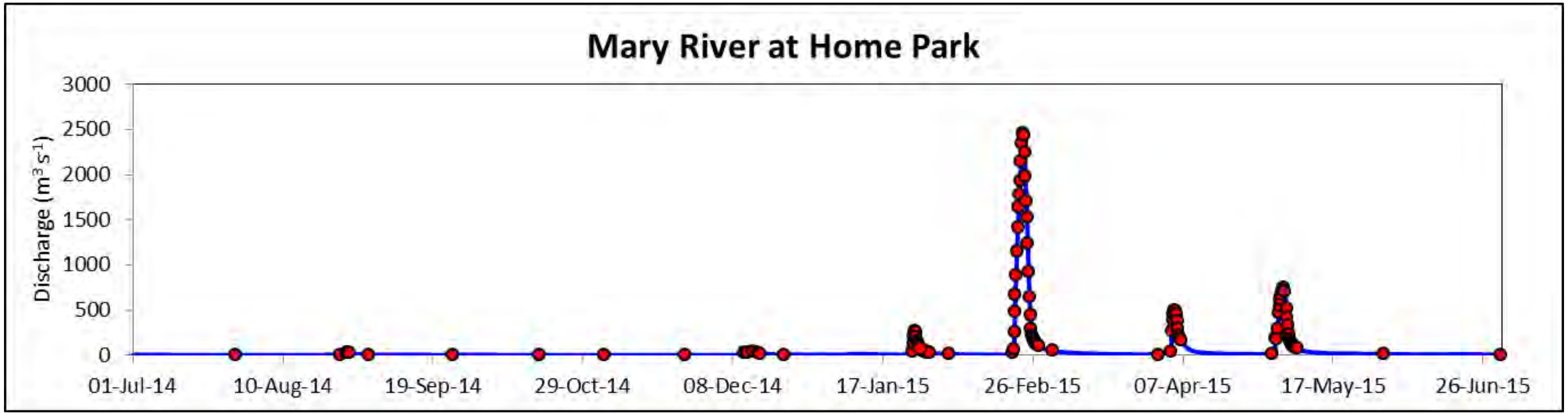

Figure 7.31 Hydrograph showing discharge (blue line) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients and photosystem II inhibiting herbicides (red circles) in the Mary River at Home Park between 1 July 2014 and 30 June 2015. Representivity rating was excellent for all analytes. Sample representivity was not assessed for pesticides.

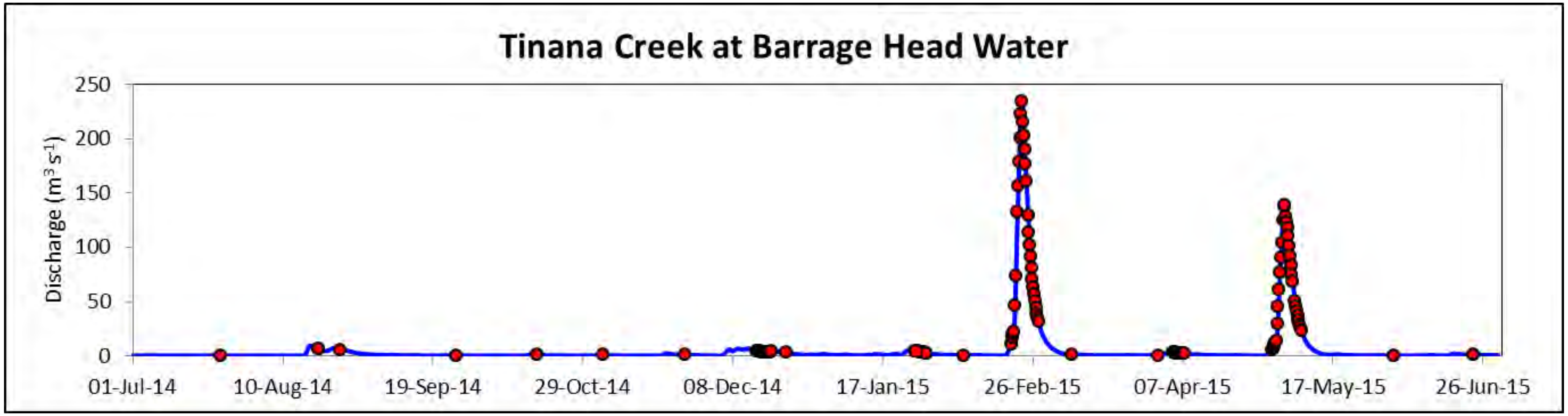

Figure 7.32 Hydrograph showing modelled discharge (blue line) (Section 2.6) and sample coverage for total suspended solids, total nutrients, dissolved and particulate nutrients and photosystem II inhibiting herbicides (red circles) in Tinana Creek at Barrage Head Water between 1 July 2014 and 30 June 2015. Sample representivity was not assessed for this site. Sample representivity was not assessed for pesticides.

Appendix F Monthly rainfall summary during 2014–2015

Rainfall in the Wet Tropics region was average to below average in July 2014 with monthly totals between 10 to 100 mm (BoM 2014a). Rainfall was below average to very much below average in the Burdekin, Mackay Whitsunday, Fitzroy and Burnett Mary regions over the same period.

Moderate rainfall was received in mid-August 2014 across southern and central Great Barrier Reef catchments associated with a surface trough over central Queensland extending from a low pressure system in western New South Wales. Monthly totals across the central and southern regions were generally in the range of 25 to 50 mm. Rainfall totals in the Wet Tropics region were in the range of 25 to 200 mm, and 1 to 10 mm in the Cape York region which is average to above average, respectively (BoM 2014b).

During September 2014, rainfall in the Cape York and Wet Tropics regions was below average to very much below average and average to below average across the catchments of the Burnett Mary region during the same period. A surface trough and low pressure system over central Queensland on the 7–8 September produced low to moderate falls across catchments in the upper-Fitzroy basin and coastal catchments in the Mackay Whitsunday region. A deepening trough on the 22–23 September produced further moderate falls across the same regions extending also across catchments of the Burnett Mary region. The rainfall associated with the second trough across the Fitzroy region resulted in above average to very much above average rainfall for catchments in this region during September (BoM 2014c).

Thunderstorms associated with a surface trough across southern Queensland produced isolated rainfall in the southern catchments of the Fitzroy basin in the first week of October. Overall however, rainfall across all regions in October was below average to very much below average across all monitored catchments (BoM 2014d).

During November 2014 rainfall across the whole of Queensland was 58 per cent below average, with the Cape York and Wet Tropics region receiving very much below average rainfall and some areas receiving their lowest November rainfall on record. Thunderstorms associated with a surface trough produced moderate falls on 20 November along the coastal margins of catchments in the Fitzroy and Burnett Mary regions, which contributed to sections of these regions receiving average monthly rainfall during November. Overall, all regions south of the Wet Tropics received below average rainfall during November (BoM 2015d).

In December 2014 rainfall across monitored regions in the southern half of Queensland was in the top 10 per cent of the long-term average; however, by contrast the Cape York region received rainfall totals in the lowest 10 per cent of the long-term average. Monthly rainfall across the southern regions of the Mackay Whitsunday, Fitzroy and Burnett Mary were generally in the range of 100 to 300 mm, which was above average to very much above average. Rain across these regions was received over a ten day period between 4 to 14 December, with the highest falls associated with a broad low pressure system on 12 and 13 December. Rainfall over this period resulted in the first flush event in the Burdekin catchment, including the upper Burdekin River sub-catchment and Bowen River, Fitzroy River including the Theresa Creek and Comet River, with further rainfall on 30 and 31 December (BoM 2015e).

A series of surface troughs produced moderate falls in early January across the Cape York and Mackay Whitsunday regions with the highest daily totals in the Mackay Whitsunday regions received on 3 January and the Cape York region on 10 January. Rainfall in the Mackay Whitsunday region resulted in the first event of the monitoring year for all sites in this region, including the largest event of the monitoring year in the O'Connell catchment. Between 15 and 18 January further rainfall associated with a surface trough provided moderate totals across the Herbert, Burdekin and Mackay Whitsunday regions and parts of the Fitzroy region. Heavy rainfall associated with thunderstorm activity across the Burnett Mary region resulted in flash flooding in some catchment areas and contributed to the small first flush events at all monitoring sites in this region (BoM 2015f).

Isolated falls on Cape York and the Wet Tropics region in the first and last weeks of February 2015 were associated with monsoon troughs over northern Australia (BoM 2015g). Rainfall during these periods kept the monthly rainfall totals across the monitored catchments in the Wet Tropics regions near average; however, further north in the Normanby catchment the rainfall totals were much below average. Rainfall across all other regions was very low during the first three weeks of February in advance of the low pressure system that developed in the Coral Sea, eventually becoming Tropical Cyclone Marcia. Tropical Cyclone Marcia made landfall north-east of Rockhampton on 20 March resulting in significant local falls in the catchments of the lower Fitzroy and Burnett Mary regions. Rain associated with Tropical Cyclone Marcia was very coastal, and overall, the majority of the monitored catchments in the Fitzroy and Burnett Mary regions received very much below average rainfall during February 2015.

During early March 2015 a surface trough over western Queensland followed by Tropical Cyclone Nathan on the Queensland east coast on the 10 March, generated moderate rainfall across the monitored catchments in the Cape York and Wet Tropics regions (BoM 2015h). A deep surface trough extending through central inland Queensland resulted in thunderstorms and rainfall across the inland catchment areas of the Fitzroy and Burnett Mary regions. Overall, catchments in the Cape York, Wet Tropics and southern Fitzroy regions received average to above average rainfall in March 2015. All other monitored catchments received rainfall totals very much below average.

Rainfall was below average to very below average across all monitored catchments in all regions during April 2015. Isolated falls in the Wet Tropics region were associated with moist onshore air flow and a surface trough in mid-April (BoM 2015i). Rainfall along the central Queensland coast at the end of the month was associated with a surface trough, which produce moderate falls. Rainfall continued into early May 2015 with good falls across the south Fitzroy region and the Burnett Mary region (BoM 2015j). This rainfall resulted in a moderate flow event in Tinana Creek. Rainfall across the remaining monitored catchments was below average to very much below average during May.

A surface trough across western Queensland in mid-June resulted in moderate rainfall in monitored catchments of central and southern Queensland; however, much of the state received only average to below average rainfall for the month. In the final days of the monitoring year, moderate falls were received in the catchments of the Wet Tropics region resulting in a late flow event in the Mulgrave River, Russell River and Tully River (BoM 2015k).

Appendix G Representivity rating of all monitored annual total suspended solids and nutrient loads

Table 7.11 The number of samples collected and the representivity rating for monitored sites in 2014–2015. Text in bold relate to end-of-catchment sites and the corresponding data, all others relate to sub-catchment sites. Green shading = excellent or good representivity rating; orange shading = moderate representivity; red shading = indicative representivity; grey shading = no representivity calculated; and black shading = no loads calculated.

NRM region	Basin	Catchment	River and site name	TSS		TN		PN		NO_x-N		NH_4-N		DIN	
				n	Rating	n	Rating	n	Rating	n	Rating	n	Rating	n	Rating
Cape York	Normanby	**Normanby River**	**Normanby River at Kalpowar Crossing**	31	Good	29	Good	29	Good	29	Good	29	Good	29	Good
Wet Tropics	Barron	**Barron River**	**Barron River at Myola**	40	Excellent	39	Excellent	39	Excellent	39	Excellent	39	Excellent	39	Excellent
	Mulgrave-Russell	**Mulgrave River**	**Mulgrave River at Deeral**	92	Excellent	95	Excellent	96	Excellent	96	Excellent	96	Excellent	96	Excellent
		Russell River	**Russell River at East Russell**	93	Excellent	93	Excellent	93	Excellent	93	Excellent	93	Excellent	93	Excellent
	Johnstone	**North Johnstone River**	**North Johnstone River at Old Bruce Highway Bridge (Goondi)**	37	Good	37	Good	37	Good	37	Good	37	Good	37	Good
		South Johnstone River	**South Johnstone River at Upstream Central Mill**	33	Good	33	Good	33	Good	33	Good	33	Good	33	Good
	Tully-Murray	**Tully River**	**Tully River at Euramo**	142	Excellent	142	Excellent	142	Excellent	142	Excellent	142	Excellent	142	Excellent
		Tully River	Tully River at Tully Gorge National Park	54	Excellent	54	Excellent	54	Excellent	54	Excellent	54	Excellent	54	Excellent
	Herbert	**Herbert River**	**Herbert River at Ingham**	42	Good	41	Good	42	Good	42	Good	42	Good	42	Good
Burdekin	Haughton	**Haughton River**	**Haughton River at Powerline**	15	NA	15	NA	15	NA	15	NA	15	NA	15	NA
		Barratta Creek	**Barratta Creek at Northcote**	100	Excellent	100	Excellent	100	Excellent	100	Excellent	99	Excellent	99	Excellent
	Burdekin	**Burdekin River**	**Burdekin River at Home Hill**	22	Good	22	Good	22	Good	22	Good	22	Good	22	Good
		Burdekin River	Burdekin River at Sellheim	15	Good	15	Good	15	Good	15	Good	15	Good	15	Good
		Bowen River	Bowen River at Myuna	35	Excellent	30	Excellent	35	Excellent	30	Excellent	30	Excellent	30	Excellent
Mackay Whitsunday	O'Connell	**O'Connell River**	**O'Connell River at Caravan Park**	20	Good	20	Good	20	Good	20	Good	20	Good	20	Good
	Pioneer	**Pioneer River**	**Pioneer River at Dumbleton Pump Station**	23	Good	23	Good	23	Good	23	Good	23	Good	23	Good
	Plane	**Sandy Creek**	**Sandy Creek at Homebush**	37	Excellent	37	Excellent	36	Excellent	37	Excellent	37	Excellent	37	Excellent
Fitzroy	Fitzroy	**Fitzroy River**	**Fitzroy River at Rockhampton**	38	Good	38	Good	38	Good	38	Good	38	Good	38	Good
		Theresa Creek	Theresa Creek at Gregory Highway	21	Moderate	21	Moderate	21	Moderate	21	Moderate	21	Moderate	21	Moderate
		Comet River	Dawson River at Taroom	36	Good	36	Good	34	Good	35	Good	35	Good	35	Good
		Dawson River	Comet River at Comet Weir	17	Good	17	Good	17	Good	17	Good	17	Good	17	Good
Burnett Mary	Burnett	**Burnett River**	**Burnett River at Ben Anderson Barrage Head Water**	31	Good	31	Good	31	Good	31	Good	31	Good	31	Good
		Burnett River	Burnett River at Mt Lawless	83	NA	83	NA	83	NA	82	NA	83	NA	82	NA
	Mary	**Mary River**	**Mary River at Home Park**	112	Excellent	112	Excellent	112	Excellent	112	Excellent	112	Excellent	112	Excellent
		Tinana Creek	**Tinana Creek at Barrage Head Water%**	121	Excellent	107	Excellent	107	Excellent	107	Excellent	107	Excellent	107	Excellent

n = number of concentration data points used in the calculation of loads; TSS = total suspended solids; TN = total nitrogen; PN = particulate nitrogen; NO_x-N = oxidised nitrogen as N; NH_4-N = ammonium nitrogen as N; DIN = dissolved inorganic nitrogen (DIN = (NO_x-N) + (NH_4-N)); and % Loads in the Tinana Creek catchment were classified as indicative due to the use of modelled flow in the calculation of all loads; NA = not assessed. The methods used to calculate the representivity ratings are explained in detail in Section 2.7.1.

Table 7.12 The number of samples collected and the representivity rating for monitored sites in 2014–2015. Text in bold relate to end-of-catchment sites and the corresponding data, all others relate to sub-catchment sites. Green shading = excellent or good representivity rating; orange shading = moderate representivity; red shading = indicative representivity; grey shading = no representivity calculated; black shading = no loads calculated.

NRM region	Basin	Catchment	River and site name	DON		TP		DIP		PP		DOP	
				n	Rating	n	Rating	n	Rating	n	Rating	n	Rating
Cape York	Normanby	**Normanby River**	**Normanby River at Kalpowar Crossing**	29	Good	29	Good	29	Good	29	Good	29	Good
Wet Tropics	Barron	**Barron River**	**Barron River at Myola**	39	Excellent	39	Excellent	39	Excellent	39	Excellent	39	Excellent
	Mulgrave-Russell	**Mulgrave River**	**Mulgrave River at Deeral**	96	Excellent	96	Excellent	96	Excellent	95	Excellent	95	Excellent
		Russell River	**Russell River at East Russell**	93	Excellent	93	Excellent	93	Excellent	93	Excellent	93	Excellent
	Johnstone	**North Johnstone River**	**North Johnstone River at Old Bruce Highway Bridge (Goondi)**	37	Good	37	Good	37	Good	37	Good	37	Good
		South Johnstone River	**South Johnstone River at Upstream Central Mill**	33	Good	33	Good	33	Good	33	Good	33	Good
	Tully-Murray	**Tully River**	**Tully River at Euramo**	142	Excellent	142	Excellent	142	Excellent	142	Excellent	142	Excellent
		Tully River	Tully River at Tully Gorge National Park	54	Excellent	54	Excellent	54	Excellent	54	Excellent	54	Excellent
	Herbert	**Herbert River**	**Herbert River at Ingham**	41	Good	42	Good	42	Good	41	Good	41	Good
Burdekin	Haughton	**Haughton River**	**Haughton River at Powerline**	15	NA	15	NA	15	NA	15	NA	15	NA
		Barratta Creek	**Barratta Creek at Northcote**	100	Excellent	99	Excellent	100	Excellent	100	Excellent	100	Excellent
	Burdekin	**Burdekin River**	**Burdekin River at Home Hill**	22	Good	21	Good	22	Good	22	Good	22	Good
		Burdekin River	Burdekin River at Sellheim	15	Good	15	Good	15	Good	15	Good	15	Good
		Bowen River	Bowen River at Myuna	30	Excellent	35	Excellent	30	Excellent	30	Excellent	30	Excellent
Mackay Whitsunday	O'Connell	**O'Connell River**	**O'Connell River at Caravan Park**	20	Good	20	Good	20	Good	20	Good	20	Good
	Pioneer	**Pioneer River**	**Pioneer River at Dumbleton Pump Station**	23	Good	23	Good	23	Good	23	Good	23	Good
	Plane	**Sandy Creek**	**Sandy Creek at Homebush**	36	Excellent	37	Excellent	37	Excellent	36	Excellent	36	Excellent
Fitzroy	Fitzroy	**Fitzroy River**	**Fitzroy River at Rockhampton**	38	Good	38	Good	38	Good	38	Good	38	Good
		Theresa Creek	Theresa Creek at Gregory Highway	21	Moderate	21	Moderate	21	Moderate	21	Moderate	21	Moderate
		Comet River	Dawson River at Taroom	34	Good	36	Good	34	Good	34	Good	34	Good
		Dawson River	Comet River at Comet Weir	17	Good	17	Good	17	Good	17	Good	17	Good
Burnett Mary	Burnett	**Burnett River**	**Burnett River at Ben Anderson Barrage Head Water**	31	Good	31	Good	31	Good	31	Good	31	Good
		Burnett River	Burnett River at Mt Lawless	83	NA	83	NA	83	NA	83	NA	83	NA
	Mary	**Mary River**	**Mary River at Home Park**	112	Excellent	112	Excellent	112	Excellent	111	Excellent	112	Excellent
		Tinana Creek	**Tinana Creek at Barrage Head Water**[%]	107	Excellent	107	Excellent	107	Excellent	107	Excellent	107	Excellent

n = the number of concentration data points used for the load calculation of DON = dissolved organic nitrogen; TP = total phosphorus; DIP = dissolved inorganic phosphorus; PP = particulate phosphorus; DOP = dissolved organic phosphorus; and

% Loads in the Tinana Creek catchment were classified as indicative due to the use of modelled flow in the calculation of all loads; NA= not assessed. The methods used to calculate the representivity ratings are explained in detail in Section 2.7.1.