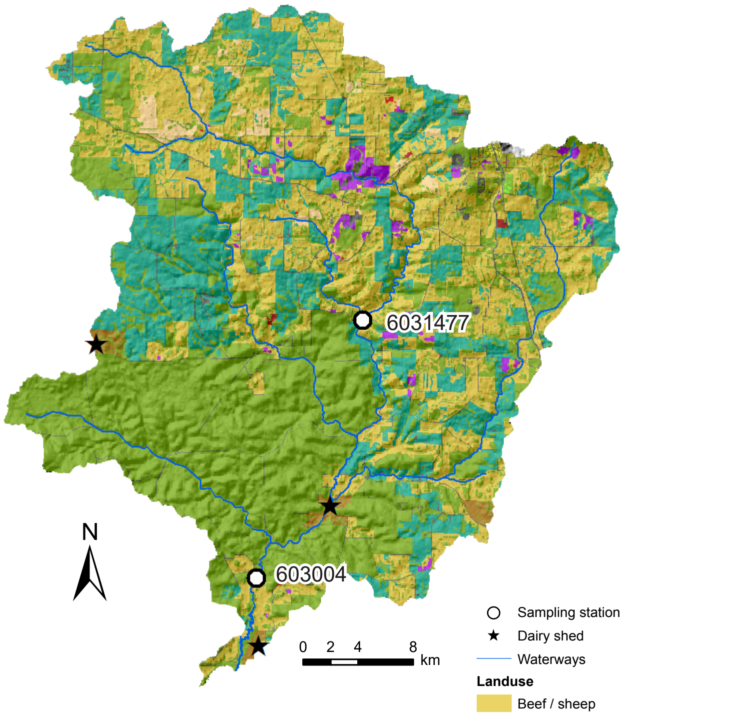
Department of **Water and Environmental Regulation**
Department of **Primary Industries and Regional Development**
GOVERNMENT OF WESTERN AUSTRALIA

Wilson Inlet catchment nutrient report 2019

HEALTHY ESTUARIES WA

Hay River

This data report provides a summary of the nutrients at the two Hay River sampling sites in 2019 as well as historical data from 2005–19. This report was produced as part of Healthy Estuaries WA. Downstream of the southern-most sampling site the river discharges to Wilson Inlet.



Location of Hay River catchment in the greater Wilson Inlet catchment.

About the catchment

Hay River has a catchment area of about 1,250 km^2 and is the largest of the Wilson Inlet catchments. It receives flow from four major tributaries. The western portion of the catchment is drained by the largely uncleared Mitchell River and Sheepwash Creek, which is mostly cleared for plantation and agriculture. Sunny Glen Creek (a monitored catchment) also enters from the west, though its confluence with the Hay River is below the Hay River sampling site. From the east, Blue Gum Creek flows from Mt Barker and includes a mix of plantations and cattle grazing.

Just under half the catchment is covered by native vegetation which is mostly fragmented, except for a large section in Mount Lindesay National Park. Other major land uses include plantations and grazing. Most of the soils in the catchment have a good capacity to bind phosphorus meaning that any phosphorus applied to them tends to be retained, helping to prevent it entering the waterways.

There are two sites monitored on the Hay River, one in the upper catchment, just downstream of Spencer Road in Narrikup (6031477, Upper Hay River) and the other, in the lower catchment, east of Sunny Glen Road, in Hay (603004, Hay River). The lower site is about 10 km upstream from the discharge point into Wilson Inlet.

Results summary

Nutrient concentrations in the Hay River catchment were classified as low to moderate (nitrogen) and low (phosphorus). Nitrogen loads were moderate to large compared with the other monitored catchments, caused by the large catchment size and corresponding large flow volumes, rather than elevated nitrogen concentrations. Phosphorus loads were small to moderate. The loads per square kilometre were small compared with other catchments.

The Hay River was by far the saltiest of the monitored catchments.

Facts and figures

Sampling site code	603004 (Hay River) 6031477 (Upper Hay River)
Catchment area	1,250 km^2
Per cent cleared area (2014)	55 per cent
River flow	Usually permanent but may stop flowing after a dry year
Main land use (2014)	Native vegetation, followed by plantations, beef cattle grazing and mixed grazing

Estimated loads and flow at Hay River

603004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Flow (GL)	120	7.4	10	39	66	9.5	41	23	18	14	20	83	39	17	9.2
TN load (t)	162	5.7	8.4	45	85	8.0	47	23	18	13	21	107	50	18	7.5
TP load (t)	4.43	0.09	0.14	1.08	2.21	0.14	1.12	0.49	0.36	0.26	0.44	2.78	1.28	0.39	0.13

Nitrogen over time (2005–19)

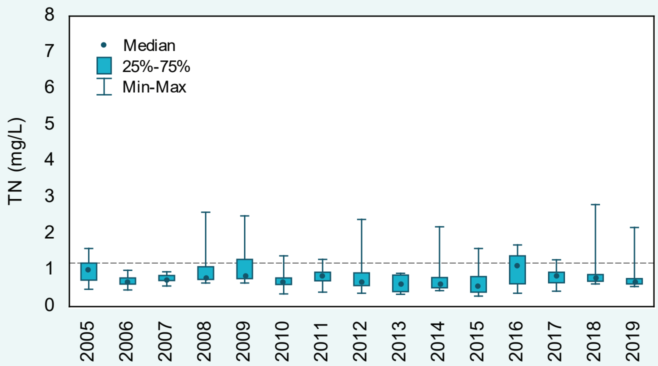
Concentrations

All total nitrogen (TN) annual median concentrations were below the Australian and New Zealand Environment and Conservation Council (ANZECC) trigger value. Using the State Wide River Water Quality Assessment (SWRWQA) methodology, 2014–17 were classified as low, and all other years as moderate at the Hay River site. All years were classified as moderate at the Upper Hay River. The 2019 annual median at Hay River (0.67 mg/L) was similar to Little River (0.67 mg/L) and Denmark Ag (0.68 mg/L). The Upper Hay River median (0.80 mg/L) was most similar to the Sleeman River (0.90 mg/L). The annual range of TN concentrations were larger at the Upper Hay River site in 2017–18 but not 2019.

Estimated loads

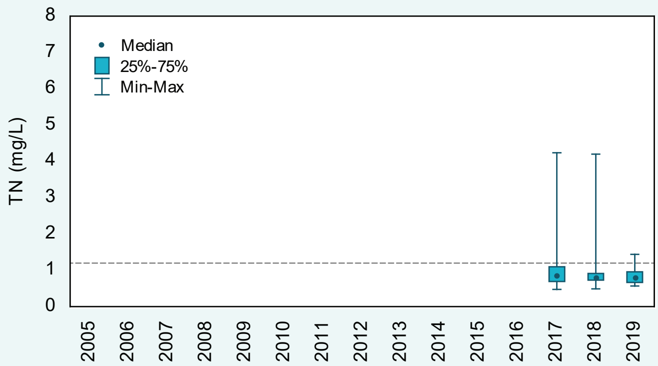
In 2019 the Hay River site had the third largest estimated TN load of the six Wilson Inlet catchments (7.5 t), similar to Denmark Ag (7.0 t). The moderate-large load was mostly because of the large catchment area and associated large flow volumes compared with the other Wilson Inlet catchments, TN concentrations were generally low. Hence, the small load per square kilometre (6.0 kg/km^2), the smallest of the Wilson Inlet catchments (the next smallest was Denmark Ag at 11 kg/km^2). Annual TN loads were closely related to flow volumes; years with large annual flow volumes had large TN loads and vice versa. As there were no flow data available for the Upper Hay River site it was not possible to calculate loads.

Hay River

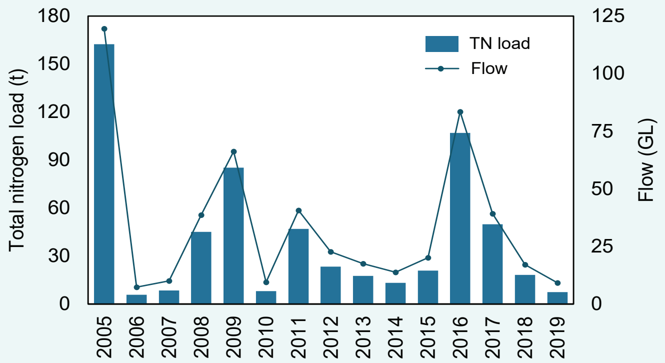


Total nitrogen concentrations, 2005–19 at site 603004. The dashed line is the ANZECC trigger value.

Upper Hay River



Total nitrogen concentrations, 2005–19 at site 6031477. The dashed line is the ANZECC trigger value.



Total nitrogen loads and annual flow, 2005–19 at site 603004.

Looking downstream from the Upper Hay sampling site, July 2018.

Hay River

Nitrogen (2019)

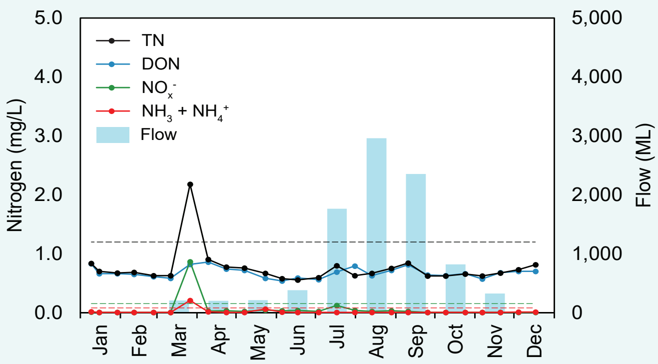
Types of nitrogen

Total N is made up of different types of N. At both sites in the Hay River, concentrations of nitrate (NO_x^-) and total ammonia (NH_3 + NH_4^+) were very low, so low that a large number of samples had a concentration below the laboratory limit of reporting (LOR). For this reason, nitrogen fraction pie charts have not been presented. However, it is clear that only a very small percentage of N was present as dissolved inorganic N (DIN – nitrate and total ammonia). This type of N is bioavailable, meaning plants and algae can easily use it. Most of the N was present as dissolved organic N (DON). DON consists of a range of different types of N, some of which need to be further broken down to become bioavailable, whereas others are readily available to bacteria and microalgae. DON comes from a range of sources, including fertiliser and degrading plant and animal matter as well as leachate from soils.

Concentrations

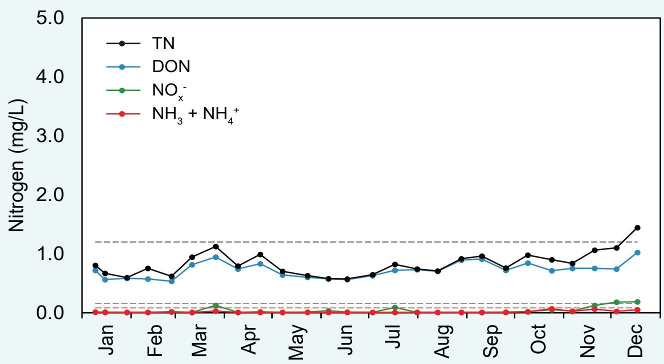
Nitrogen concentrations varied similarly at both sites in 2019. Both nitrate and total ammonia were below the laboratory LOR on a number of sampling occasions at both sites. On all other sampling occasions, nitrate and total ammonia concentrations were very low, with the exception of the nitrate peak in March at Hay River. This sample was collected a few days after a peak in flow, suggesting that nitrate was flushed into the river from surrounding land use via surface flows at this time. During the drier months, when flow volumes were low, groundwater and in-stream sources would have been the major contributors of N to the river. The large peaks in TN and nitrate observed at both sites in August 2018 are not evident in 2019. This is likely because of smaller flows with the peak daily flow volume in 2018 being more than four times greater that the peak daily flow volume in 2019 (both of which occurred in August).

Hay River



2019 nitrogen concentrations and monthly flow at 603004. The dashed lines are the ANZECC trigger values for the different N species.

Upper Hay River



2019 nitrogen concentrations at 6031477. The dashed lines are the ANZECC trigger values for the different N species.

Taking flow measurements during higher than normal flows at the Hay River site, August 2016.

Hay River

Phosphorus over time (2005–19)

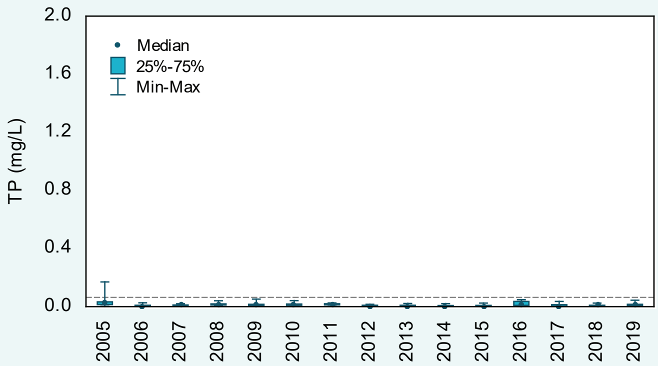
Concentrations

Total phosphorus (TP) concentrations were consistently low in the Hay River across the reporting period, with all years classified as low using the SWRWQA methodology at both sites. The 2019 median TP concentrations were the lowest (Hay River; 0.011 mg/L) and equal second lowest (Upper Hay River; 0.023 mg/L, the same as Denmark ML) of the Wilson Inlet catchment sites. It is likely that the soils present in the catchment are contributing to the low TP concentrations as most of the catchment has soils with a high phosphorus-binding capacity. This means that any P applied to the catchment tends to bind to the soils rather than being exported to the river.

Estimated loads

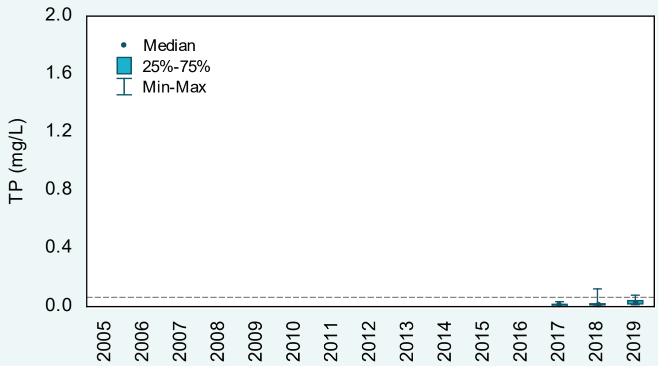
Estimated TP loads at the Hay River site were small to moderate compared with the other Wilson Inlet catchment sites. The Hay River had the third smallest load (0.13 t), similar to Sunny Glen Creek (0.12 t). The size of the TP load was driven by the large flow volumes (caused by the large catchment area). P concentrations were very low, which is reflected in the TP load per square kilometre, the smallest of the Wilson Inlet catchment sites in 2019 (0.1 kg/km^2); Denmark Ag had the next smallest load per square kilometre (0.3 kg/km^2). Annual TP loads were closely related to flow volumes; years with large annual flow volumes had large TP loads and vice versa.

Hay River

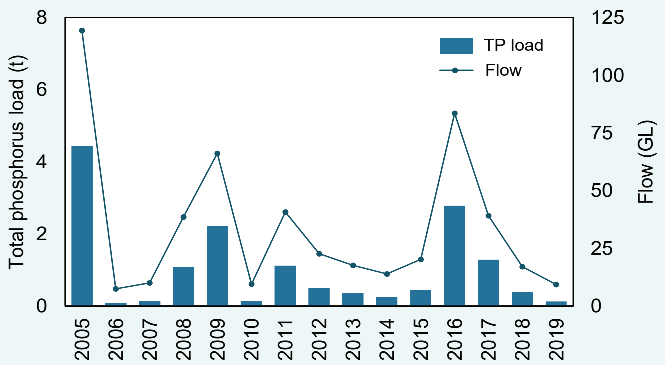


Total phosphorus concentrations, 2005–19 at site 603004. The dashed line is the ANZECC trigger value.

Upper Hay River



Total phosphorus concentrations, 2005–19 at site 6031477. The dashed line is the ANZECC trigger value.



Total phosphorus loads and annual flow, 2005–19 at site 603004.

Hay River sampling site, February 2019.

Phosphorus (2019)

Types of phosphorus

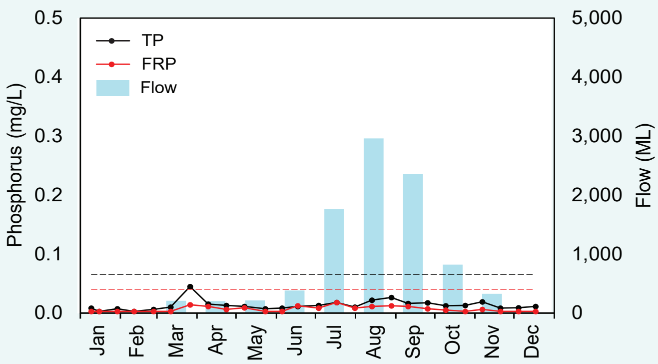
Total P is made up of many different types of P. Because a large number of samples were below the laboratory limit of reporting (LOR) in 2019 (12 of 26 phosphate samples), phosphorus fraction pie charts were not generated for the Hay River site. At the Upper Hay River site, nearly half of the P was present as phosphate; measured as filterable reactive phosphorus (FRP), in surface waters this is mainly present as phosphate (PO_4^{3-}) species. This type of P is readily bioavailable. Phosphate was probably derived from animal waste and fertilisers as well as natural sources. The remaining P was present as either particulate P or dissolved organic P (DOP) or both (shown as ‘other types of P’ in the pie chart below). Particulate P generally needs to be broken down before becoming bioavailable. The bioavailability of DOP varies and is poorly understood.

Concentrations

Phosphate and TP concentrations were low at both sites, with a number of samples having phosphate values below the LOR at the Hay River site. Both sites had a peak in TP concentrations in late March, collected a few days after a peak in flow, suggesting that surface water run-off was the main source of P at this time. Why TP concentrations increased at the Upper Hay River site late in the year is unclear. Total suspended solids also increased at this time so P may have been coming from particulate matter, likely sourced from within the river. P was likely entering the river year-round through a variety of pathways including surface flows, in-stream sources and groundwater.

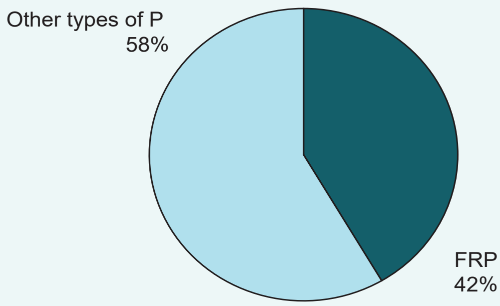
Hay River

The Hay River sampling site with much higher than usual water levels, August 2016.

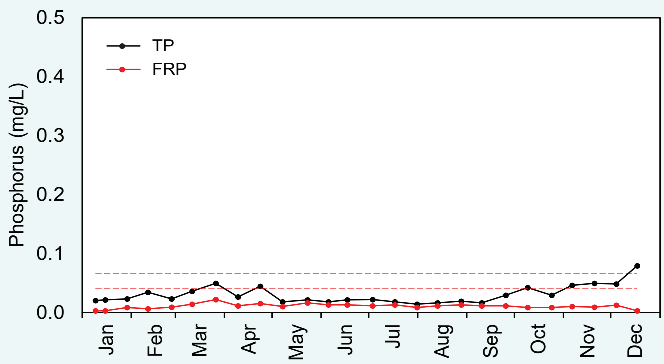


2019 phosphorus concentrations and monthly flow at 603004. The dashed lines are the ANZECC trigger values for the different P species.

Upper Hay River



2019 average phosphorus fractions at site 6031477.



2019 phosphorus concentrations at 6031477. The dashed lines are the ANZECC trigger values for the different P species.

Total suspended solids over time (2005–19)

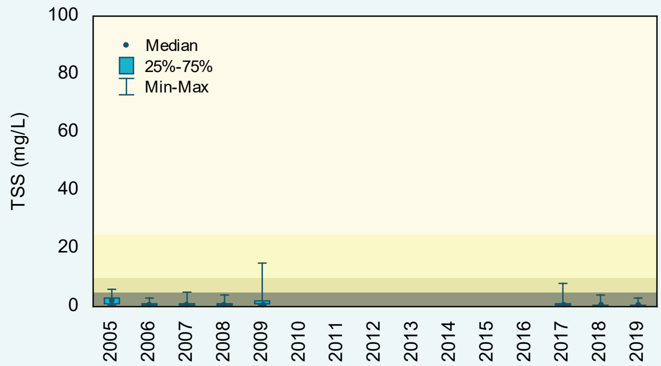
Concentrations

Total suspended solids (TSS) concentrations were lower at the Hay River than the Upper Hay River site, though all years at both sites were classified as low using the SWRWQA methodology. The Hay River had one of the lowest 2019 median TSS concentrations (0.5 mg/L, which was below the LOR of 1 mg/L), the same as Denmark ML. The median was higher at the Upper Hay River site (2 mg/L), the same as Denmark Ag and Scotsdale Brook.

Estimated loads

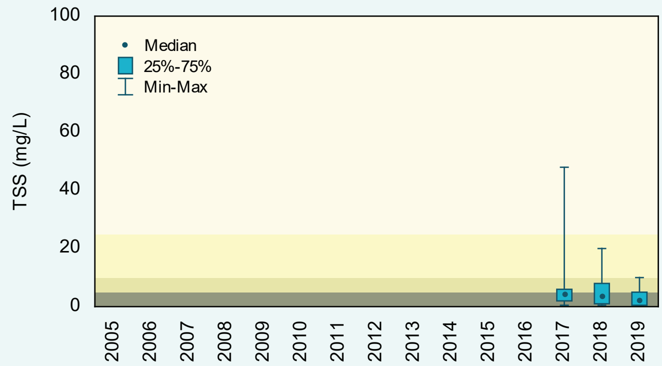
The estimated TSS loads at the Hay River sampling site were small compared with the other Wilson Inlet catchments. The Hay River had the third smallest TSS load (9 t) and the smallest TSS load per square kilometre in 2019 (7 kg/km^2) of the Wilson Inlet catchment sites. This was because of the large catchment area and associated large flow volumes and the low TSS concentrations. As there were no flow data available for the Upper Hay River site, it was not possible to calculate estimated TSS loads for this site. Annual TSS loads were closely related to flow volumes; years with large annual flow volumes had large TSS loads and vice versa.

Hay River



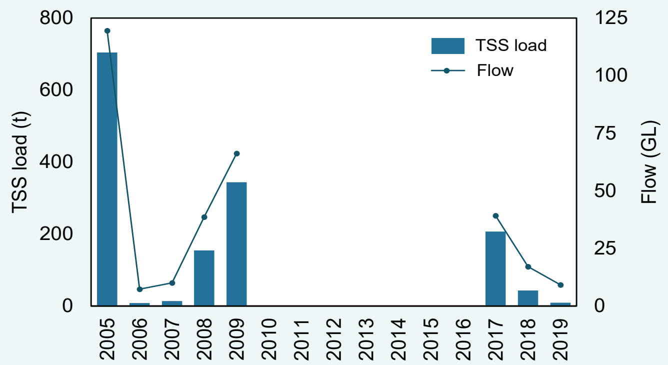
Total suspended solids concentrations, 2005–19 at site 603004. The shading refers to the SWRWQA classification bands.

Upper Hay River



Total suspended solids concentrations, 2005–19 at site 6031477. The shading refers to the SWRWQA classification bands.

low moderate high very high



Total suspended solids loads and annual flow, 2005–19 at site 603004.

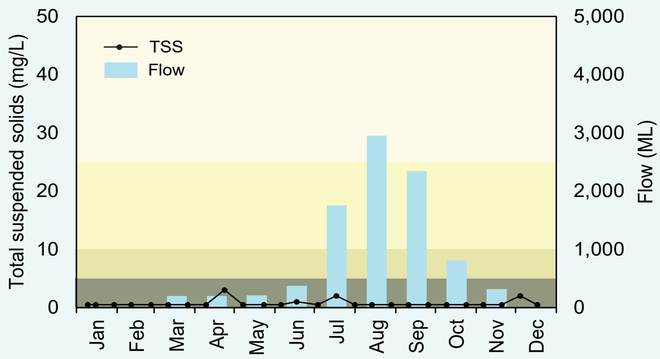
Collecting water quality samples at the Upper Hay site, January 2019.

Total suspended solids (2019)

Concentrations

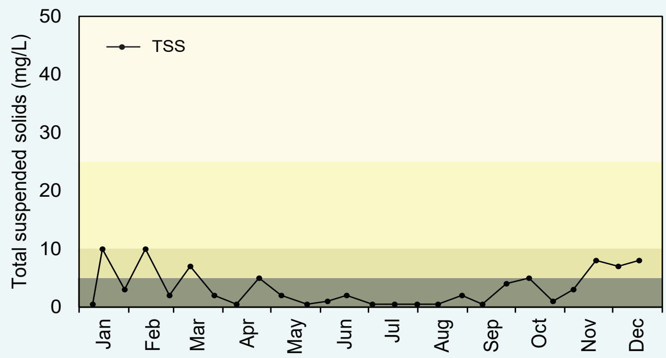
In 2019, all of the samples collected at the Hay River site fell into the low band. TSS concentrations were higher at the Upper Hay River site, where there were a number of samples in the moderate and high bands. It is likely that particles were entering the river at both sites from runoff as well as from in-stream sources because of erosion. Stock access to the river may also increase the amount of particulate matter which is detected by the laboratory as TSS.

Hay River



2019 total suspended solids concentrations and monthly flow at 603004. The shading refers to the SWRWQA classification bands.

Upper Hay River



2019 total suspended solids concentrations at 6031477. The shading refers to the SWRWQA classification bands.

low moderate high very high

The weir at the Hay River sampling site, October 2017.

Hay River

pH over time (2005–19)

pH values

pH in the Hay River fluctuated over the reporting period. Most of the pH values at the Hay River site were within the upper and lower ANZECC trigger values suggesting that pH at this site is within the bounds required for a healthy ecosystem. In 2012, pH levels appear to be lower, though the reason for this is unknown. They were lower again in 2016 and 2017 but these values may have been recorded as lower than the actual in-stream pH.

There is some concern the probe used to collect the pH data from the catchments of Wilson Inlet (including the Hay River sites) was not functioning correctly from about October 2016 to October 2017. This may have caused the low pH shown in the graphs below. After October 2017, a new probe was used and pH increased and stabilised. Although there is no way of verifying the 2016–17 pH data, they have still been presented here.

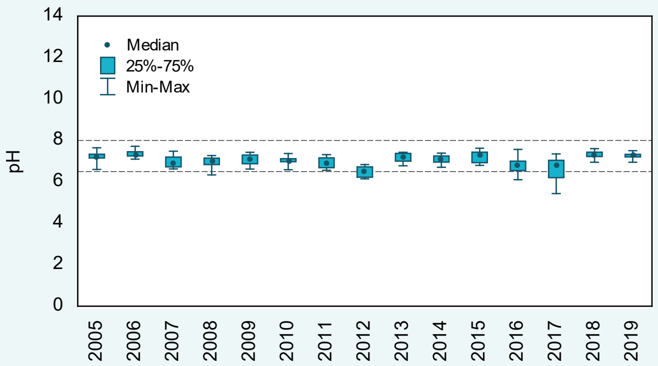
pH (2019)

pH values

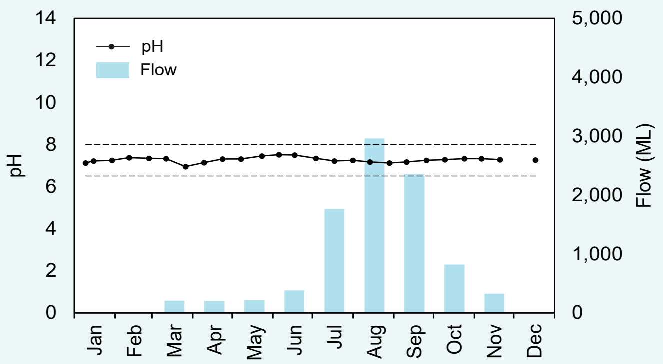
In 2019, pH followed a similar pattern at both sites, fluctuating during the year. pH was slightly higher at the Upper Hay River site, with a few samples over the upper ANZECC trigger value.

The missing data point in early December was a result of the probe malfunctioning on that sampling occasion.

Hay River

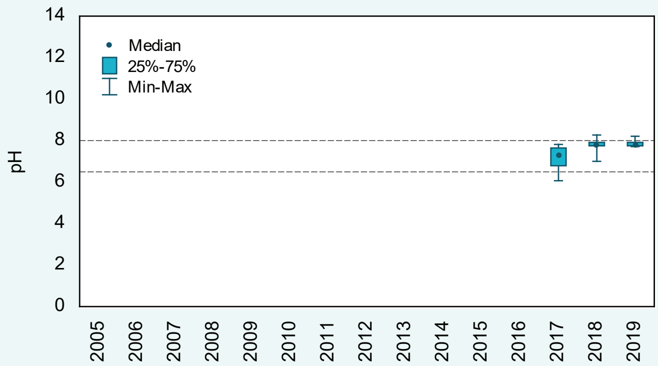


pH levels, 2005–19 at site 603004. The dashed lines are the upper and lower ANZECC trigger values.

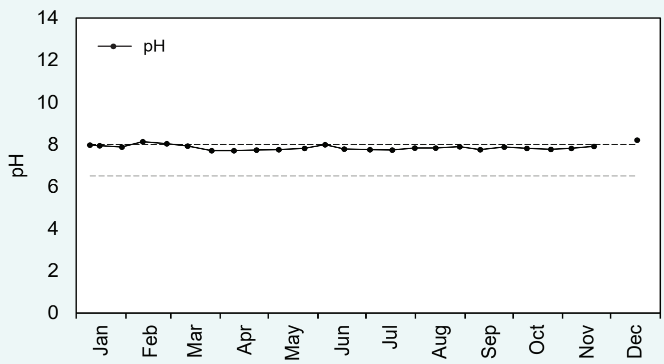


2019 pH levels and monthly flow at 603004. The dashed lines are the upper and lower ANZECC trigger values.

Upper Hay River



pH levels, 2005–19 at site 6031477. The dashed lines are the upper and lower ANZECC trigger values.



2019 pH levels and monthly flow at 6031477. The dashed lines are the upper and lower ANZECC trigger values.

Hay River

Salinity over time (2005–19)

Concentrations

The Hay River was by far the most saline of the monitored catchments that discharge to Wilson Inlet. Using the Water Resources Inventory 2014 salinity ranges (note the 2018 nutrient report used the SWRWQA bands), the Hay River site was classified as brackish up to and including 2016 and as saline since then. All years were classified as saline at the Upper Hay River site. In 2019, the median salinity concentrations were the highest (Upper Hay River site 5,770 mg/L) and second highest (Hay River site 4,420 mg/L) of the Wilson Inlet catchment sites. By contrast, the catchments with the next highest median salinities were Cuppup Creek (975 mg/L) and Sunny Glen Creek (715 mg/L).

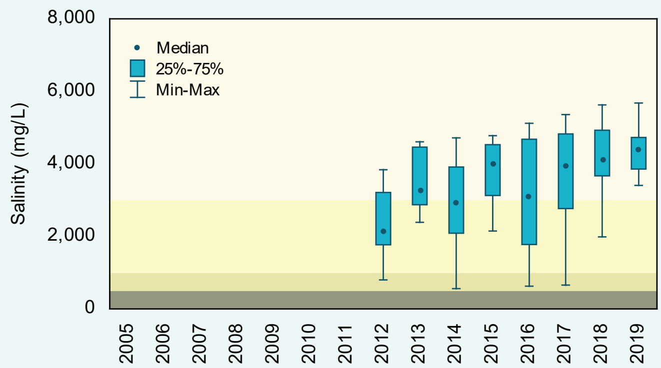
Salinity (2019)

Concentrations

Salinity showed a seasonal relationship at both Hay River sites though it was not as evident in 2018 when flow volumes were larger. The water was more saline during the drier months and fresher when river flows were higher. This suggests the groundwater was more saline than the water entering the river via surface run-off. At no point was the water at either site fresh. Clearing for agriculture is the likely reason for the high salinity levels in the Hay River. When deep-rooted vegetation is removed, groundwater levels rise, bringing salts that have been stored in the soil over many years up with them. These salts are then transported to the river via the groundwater. Re-establishing deep-rooted vegetation lowers groundwater levels and helps reduce salinity in rivers and streams. The reason for the peak in salinity in early March at the Upper Hay River site is unclear.

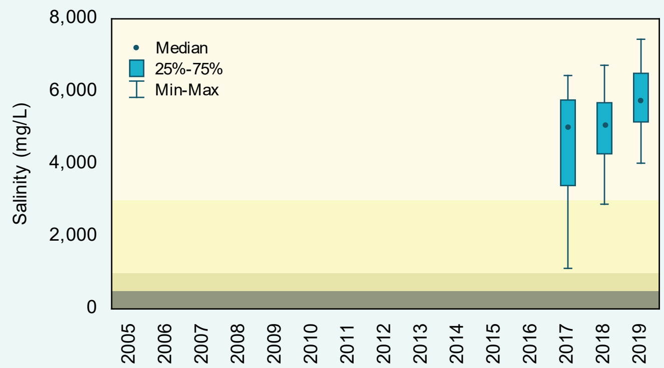
The missing data point in early December was a result of the probe malfunctioning on that sampling occasion.

Hay River

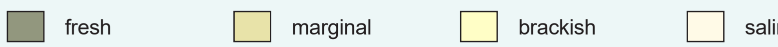


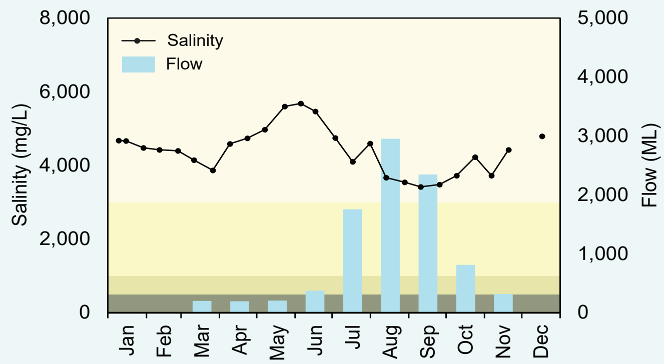
Salinity concentrations, 2005–19 at site 603004. The shading refers to the Water Resources Inventory 2014 salinity ranges.

Upper Hay River

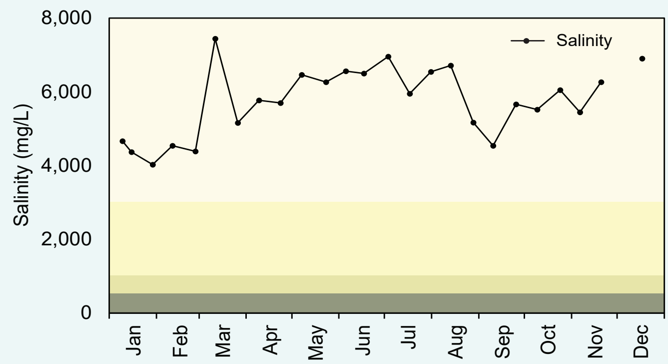


Salinity concentrations, 2005–19 at site 6031477. The shading refers to the Water Resources Inventory 2014 salinity ranges.





2019 salinity concentrations and monthly flow at 603004. The shading refers to the Water Resources Inventory 2014 salinity ranges.



2019 salinity concentrations at 6031477. The shading refers to the Water Resources Inventory 2014 salinity ranges.

Hay River

Background

Healthy Estuaries WA is a State Government program launched in 2020 and builds on the work of the Regional Estuaries Initiative. Collecting and reporting water quality data, such as in this report, helps build understanding of the whole system; both the catchment and the estuary. By understanding the whole system, we can direct investment towards the most effective actions in the catchments to protect and restore the health of our waterways.

Nutrients (nitrogen and phosphorus) are compounds that are important for plants to grow. Excess nutrients entering waterways from effluent, fertilisers and other sources can fuel algal growth, decrease oxygen levels in the water and harm fish and other species. Total suspended solids, pH and salinity data are also presented as these help us better understand the processes occurring in the catchment.

You can find information on the condition of Wilson Inlet at estuaries.dwer.wa.gov.au/estuary/wilson-inlet/

Healthy Estuaries WA partners with the Wilson Inlet Catchment Committee to fund best-practice management of fertiliser, dairy effluent and watercourses on farms.

- To find out how you can be involved visit estuaries.dwer.wa.gov.au/participate
- To find out more about the Wilson Inlet Catchment Committee go to wicc.org.au
- To find out more about the health of the rivers in the Wilson Inlet catchment go to rivers.dwer.wa.gov.au/assessments/results

Methods

Variables were compared with ANZECC trigger values where available, or the SWRWQA bands or 2014 Water Resources Inventory ranges. They were classified using the SWRWQA methodology. Standard statistical tests were used to calculate trends and loads. For further information on the methods visit estuaries.dwer.wa.gov.au/nutrient-reports/data-analysis

Glossary

Bioavailable: bioavailable nutrients refers to those nutrients which plants and algae can take up from the water and use straight away for growth.

Concentration: the amount of a substance present per volume of water.
Evapoconcentration: the increase in concentration of a substance dissolved in water because of water being lost by evaporation.

First flush: material washed into a waterway by the first rainfall after an extended dry period. The first flush is often associated with high concentrations of nutrients and particulate matter.

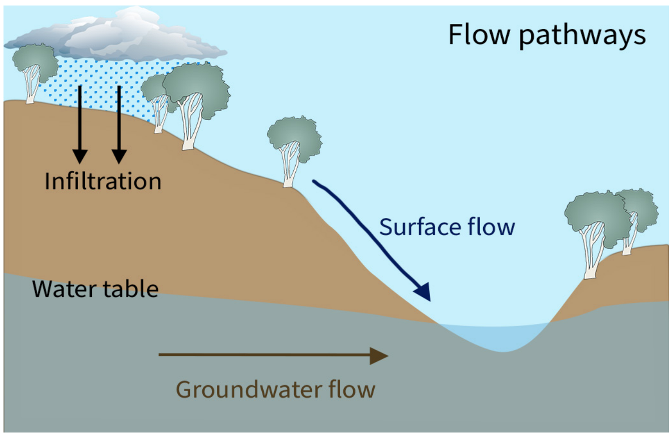
Laboratory limit of reporting: (LOR) this is the lowest concentration of an analyte that can be reported by a laboratory.

Load: the total mass of a substance passing a certain point.

Load per square kilometre: the load at the sampling site divided by the entire catchment area upstream of the sampling site.

Nitrate: The measurement for the nutrient nitrate actually measures both nitrate (NO_3^-) and nitrite (NO_2^-), which is reported as NO_x^-. We still refer to this as nitrate as in most surface waters nitrite is present in very low concentrations.

The schematic below shows the main flow pathways which may contribute nutrients, particulates and salts to the waterways. Connection between surface water and groundwater depends on the location in the catchment, geology and the time of year.



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