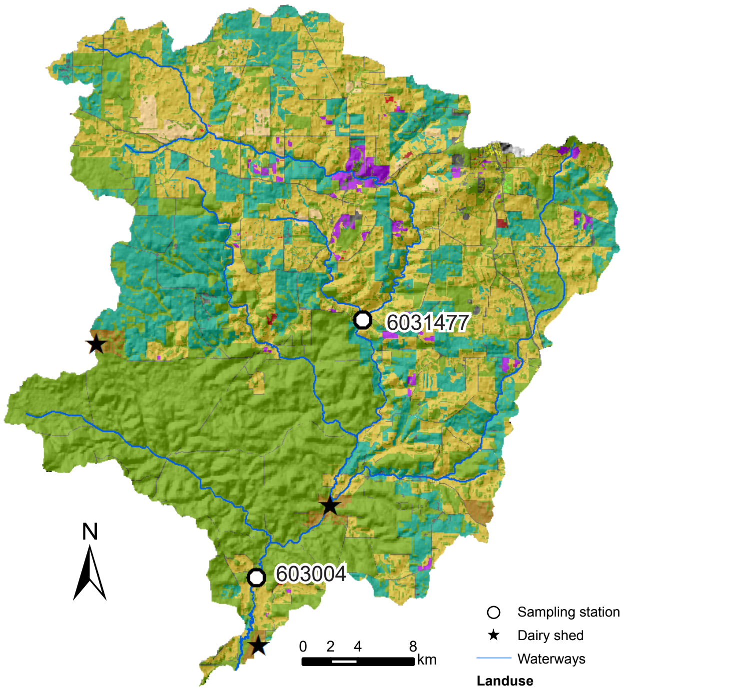
GOVERNMENT OF WESTERN AUSTRALIA
Department of **Water and Environmental Regulation**
Department of **Primary Industries and Regional Development**

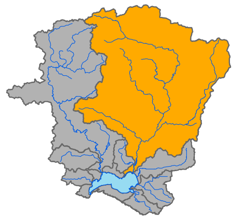
Wilson Inlet catchment nutrient report 2018

REGIONAL ESTUARIES INITIATIVE

Hay River

This data report provides a summary of the nutrients at the two Hay River sampling sites in 2018 as well as historical data from 2004–18. This report was produced as part of the Regional Estuaries Initiative. Downstream of the southern-most site the river discharges to Wilson Inlet. 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.





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.

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 (total nitrogen and total phosphorus) in the Hay River catchment were low to moderate. The nutrient loads were moderate to large compared with the other monitored catchments, because of the large catchment size and corresponding large flow volumes, rather than elevated nutrient concentrations. As a result, 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)
Rainfall at Denmark (2018)	776 mm
Catchment area	1,250 km^2
Per cent cleared area (2014)	55%
River flow	Generally flows year round though may stop flowing for a month or two following a dry year
Annual flow (2018)	17.0 GL (Hay River)
Main land use (2014)	Native vegetation, followed by plantations, beef cattle grazing and mixed grazing

Hay River

Nitrogen over time (2004–18)

Concentrations

All total nitrogen (TN) annual median concentrations were below the Australian and New Zealand Environment and Conservation Council (ANZECC) trigger value. TN concentrations were moderate in the Hay River compared with the other sites sampled in the Wilson Inlet catchment and fluctuated over time. The two sites had the third and fourth highest 2018 median TN concentrations (0.79 mg/L at Hay River, 0.80 mg/L at Upper Hay River), after Cuppup and Sunny Glen creeks (2.3 mg/L). The annual range of TN concentrations were larger at the Upper Hay River site.

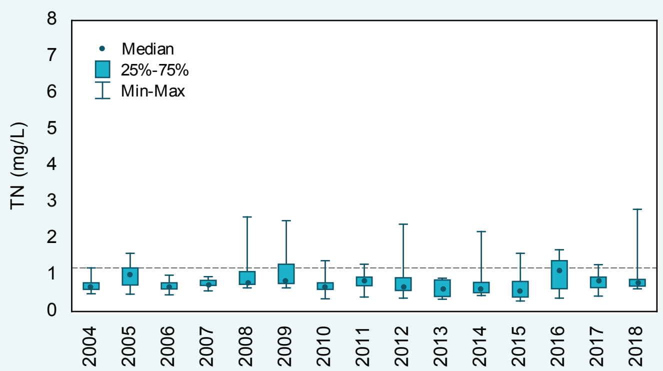
Trends

There was no long-term (2004–18) trend at Hay River; however, there was an increasing short-term trend (0.04 mg/L/yr, 2014–18). This may be part of natural fluctuations at this site or because of an actual increase in TN concentrations. Ongoing monitoring will help determine if water quality is getting worse at this site. It as not possible to test for trends at the Upper Hay site.

Estimated loads

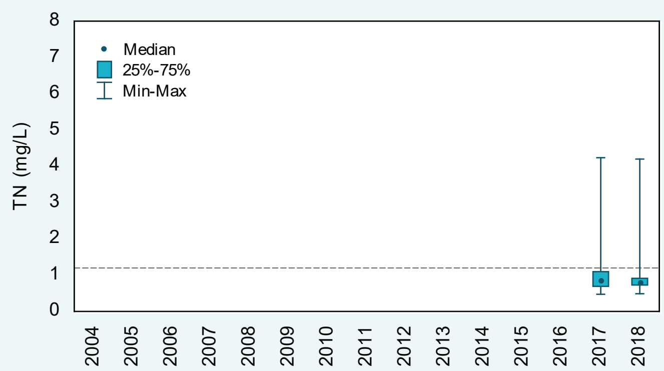
Estimated TN loads at the Hay River site were one of the largest of the Wilson Inlet catchments. In 2018, the river had a TN load of 18.2 t; the largest of the six monitored catchments, though only slightly larger than Cuppup Creek which had a load of 16.9 t. The large load was mostly because of the large catchment area and associated large flow volumes compared with the other Wilson Inlet catchments. In 2018, it had the smallest load per unit area of 15 kg/km^2 (Denmark Ag had the next smallest load per unit area of 19 kg/km^2). Annual TN loads were closely related to flow volumes; years with high annual flow 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

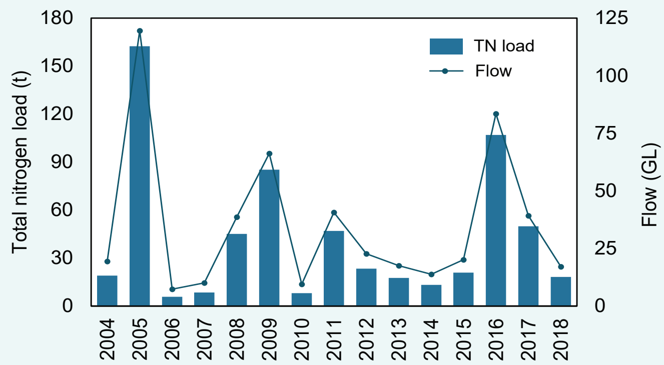


Total nitrogen concentrations, 2004–18 at site 603004. The dashed line is the ANZECC trigger value for lowland rivers.

Upper Hay River



Total nitrogen concentrations, 2004–18 at site 6031477. The dashed line is the ANZECC trigger value for lowland rivers.



Total nitrogen loads and annual flow, 2004–18 at site 603004.

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

Nitrogen (2018)

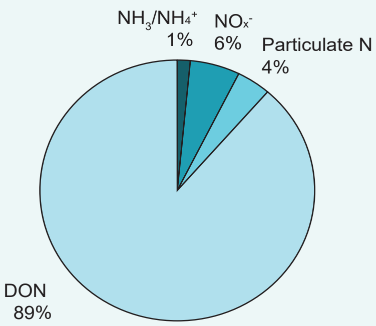
Types of nitrogen

Total N is made up of many different types of N. At both sites in the Hay River, only a very small percentage of N was present as dissolved inorganic N (DIN – NO_x^- and NH_3/NH_4^+). This form 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

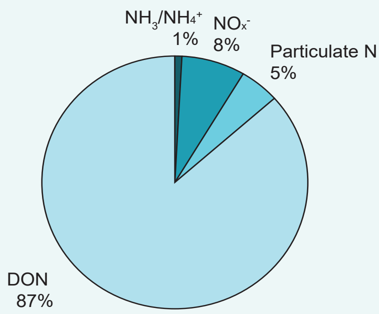
Nitrogen concentrations varied similarly at both sites in 2018. Both NO_x^- and NH_3/NH_4^+ were below the concentration at which the laboratory can detect them for at least half the sampling occasions at each site. On all other sampling occasions, NO_x^- and NH_3/NH_4^+ concentrations were very low, with the exception of the NO_x^- peak in August. This peak coincided with the highest flow volumes. At this time, NO_x^- was flushed into the river from surrounding land use via surface flows. 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 reason for the peak in late January is unknown.

Hay River

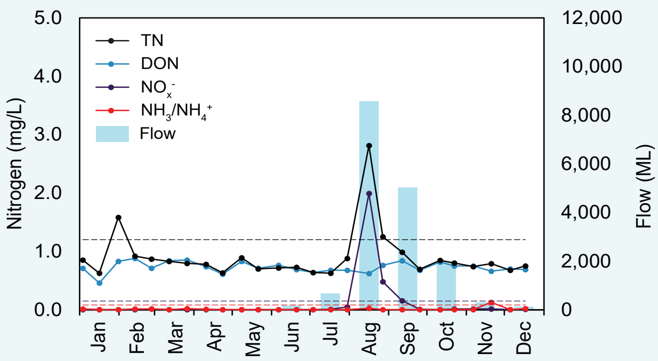


2018 average nitrogen fractions at site 603004. Note: a large number of samples were below the laboratory limit of reporting for both NH_3/NH_4^+ and NO_x^-.

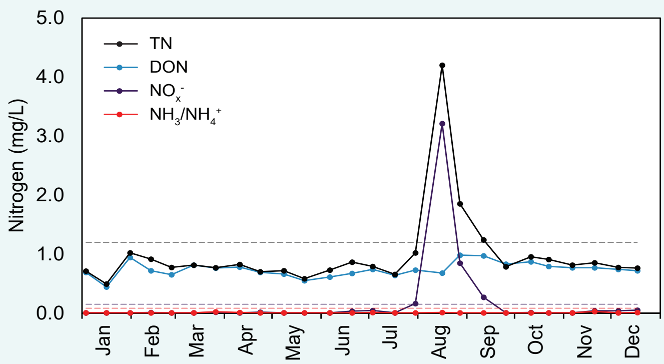
Upper Hay River



2018 average nitrogen fractions at site 6031477. Note: a large number of samples were below the laboratory limit of reporting for both NH_3/NH_4^+ and NO_x^-.



2018 nitrogen concentrations and monthly flow at 603004. The dashed lines are the ANZECC trigger values for lowland rivers for the different N species.



2018 nitrogen concentrations at 6031477. The dashed lines are the ANZECC trigger values for lowland rivers for the different N species.

Hay River

Phosphorus over time (2004–18)

Concentrations

Total phosphorus (TP) concentrations were consistently low in the Hay River across the reporting period. The 2018 median TP concentrations were the lowest (Hay River was 0.009 mg/L) and third lowest (Upper Hay River was 0.017 mg/L) of the Wilson Inlet catchment sites (similar to Denmark ML which was 0.016 mg/L). 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.

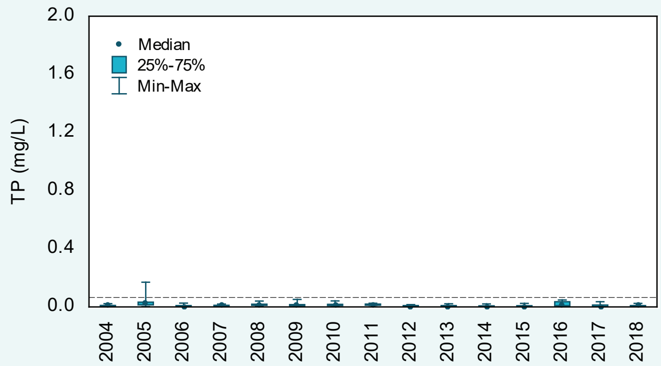
Trends

There were no trends in TP concentrations at the Hay River site. As 2017 was the first year the Upper Hay River site was sampled year-round it was not possible to calculate trends for this site.

Estimated loads

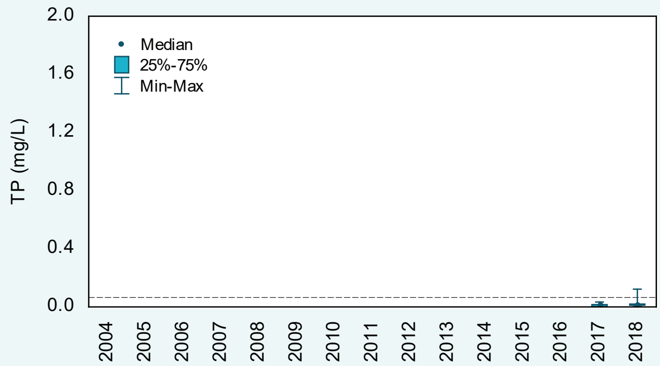
Estimated TP loads at the Hay River site were moderate compared with the other Wilson Inlet catchments. The Hay River had the second smallest load (0.39 t). The TP load was moderate because of the comparatively high flow volumes from the Hay River. P concentrations were very low, which is reflected in the TP load per unit area, the lowest in 2018 (0.3 kg/km^2). Annual TP loads were closely related to flow volumes; years with high annual flow had large TP loads and vice versa.

Hay River

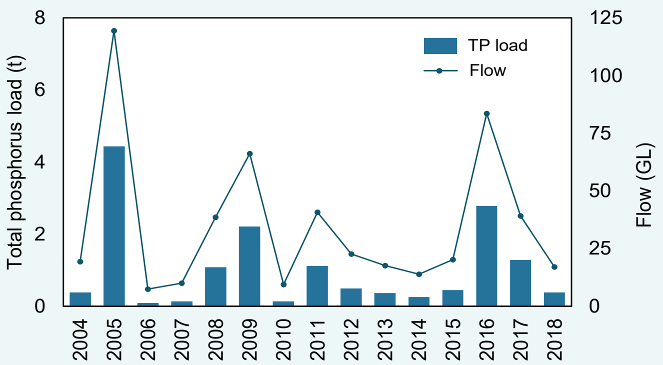


Total phosphorus concentrations, 2004–18 at site 603004. The dashed line is the ANZECC trigger value for lowland rivers.

Upper Hay River



Total phosphorus concentrations, 2004–18 at site 6031477. The dashed line is the ANZECC trigger value for lowland rivers.



Total phosphorus loads and annual flow, 2004–18 at site 603004.

Hay River sampling site, February 2019.

Phosphorus (2018)

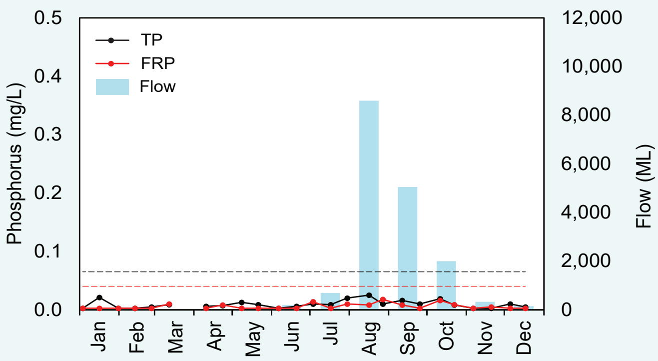
Types of phosphorus

Total P is made up of many different types of P. Because a large number of samples were below the laboratory limit of reporting in 2018, phosphorus fraction pie charts were not generated for either the Hay River or the Upper Hay River sites. At the Hay River site, six of the 26 TP samples and 15 of the 26 filterable reactive phosphorus (FRP) samples were below their limits of reporting (0.005 mg/L in each case). At the Upper Hay River site, two of the 26 TP samples and six of the 26 FRP samples were below their limits of reporting.

Concentrations

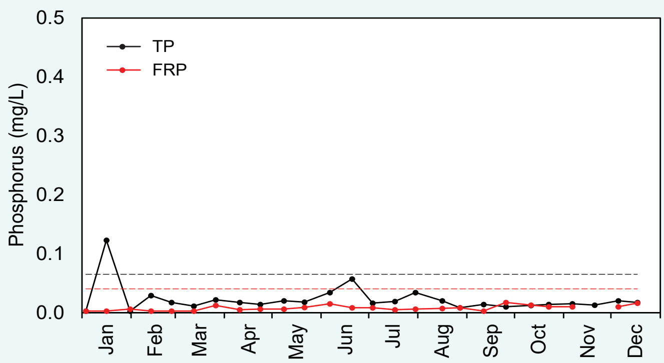
Filterable reactive P and TP concentrations were low at both sites, with a number of samples having FRP values below the laboratory limit of reporting. There was a slight seasonal pattern in FRP and TP concentrations, with concentrations increasing in July–August. This was because of a first-flush effect when the increase in flow, following the onset of winter rainfall, flushed nutrients (and other matter) into the rivers. Even at this time, however, P concentrations were still very low. The reason for the peak in TP concentrations in January at both sites is unclear. P was likely entering the river year-round through a variety of pathways including surface flows, in-stream sources and groundwater.

Hay River



2018 phosphorus concentrations and monthly flow at 603004. The dashed lines are the ANZECC trigger values for lowland rivers for the different P species.

Upper Hay River



2018 phosphorus concentrations at 6031477. The dashed lines are the ANZECC trigger values for lowland rivers for the different P species.

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

Hay River

Total suspended solids over time (2004–18)

Concentrations

Total suspended solids (TSS) concentrations were lower at the Hay River than the Upper Hay River site. The majority of samples collected at the Hay River site were classified as low using the Statewide River Water Quality Assessment (SWRWQA) classification bands. While the 2017 and 2018 medians were still classified as low at the Upper Hay River site, the range in TSS concentrations was much greater than at the Hay River site. The Hay River had one of the lowest 2018 median TSS concentrations (0.5 mg/L), the same as Denmark ML.

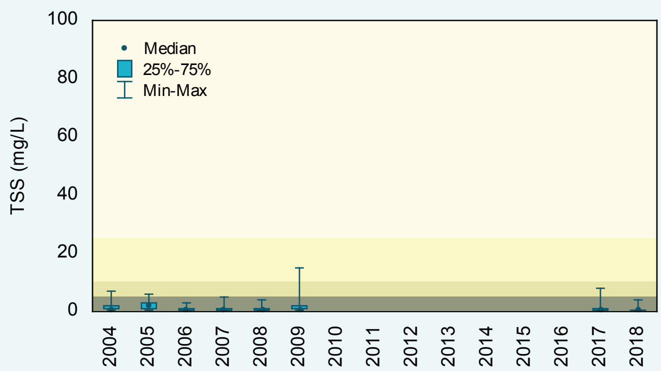
Trends

It was not possible to test for trends because regular monitoring was not conducted between 2010–16 at the Hay River site and only 2017–18 data were available at the Upper Hay River site.

Estimated loads

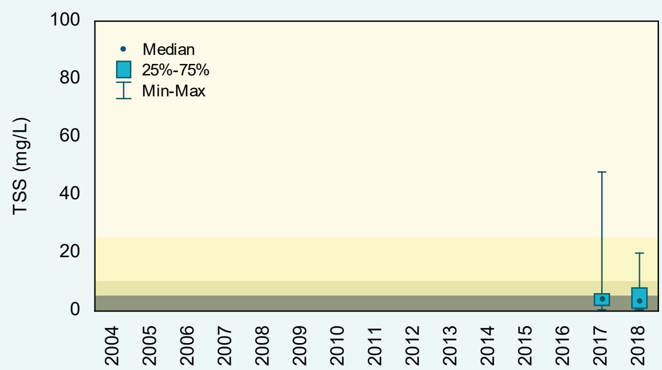
The estimated TSS loads at the Hay River sampling site were moderate compared with the other Wilson Inlet catchments. The Hay River had the second smallest TSS load (44 t) and the smallest TSS load per unit area in 2018 (35 kg/km^2). This was because of the large catchment area and the low TSS concentrations. 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 high annual flow had large TSS loads and vice versa.

Hay River



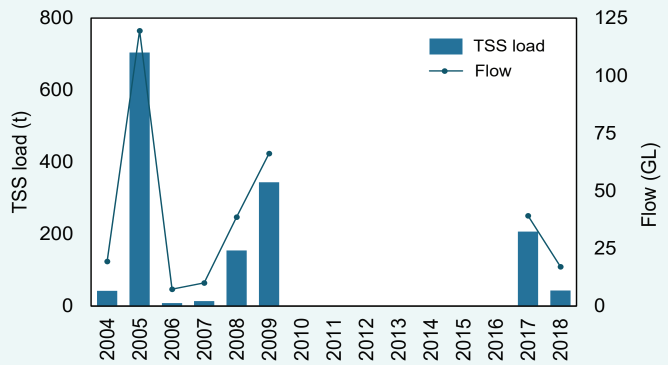
Total suspended solids concentrations, 2004–18 at site 603004. The shading refers to the SWRWQA classification bands.

Upper Hay River



Total suspended solids concentrations, 2004–18 at site 6031477. The shading refers to the SWRWQA classification bands.

very high high moderate low



Total suspended solids loads and annual flow, 2004–18 at site 603004.

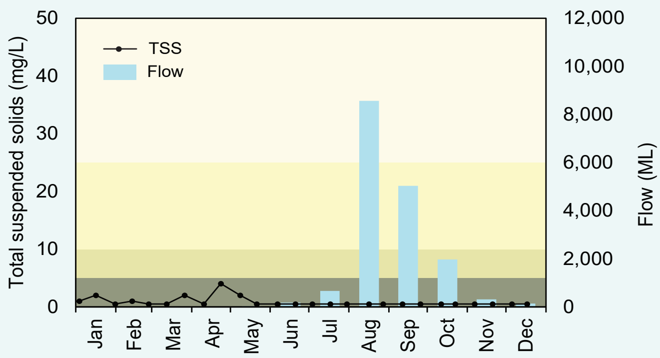
Collecting water quality samples at the Upper Hay site, January 2019.

Total suspended solids (2018)

Concentrations

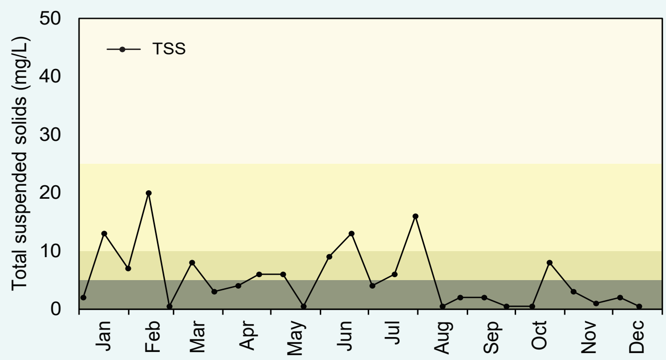
In 2018, all of the samples at the Hay River site were classified as low. TSS concentrations were higher at the Upper Hay River site, where there were a number of samples fell into the moderate and high bands. It is likely that particles were entering the river at both sites from runoff as well as from 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

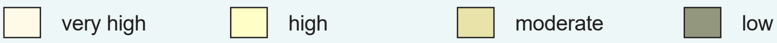


2018 total suspended solids concentrations and monthly flow at 603004. The shading refers to the SWRWQA classification bands.

Upper Hay River



2018 total suspended solids concentrations at 6031477. The shading refers to the SWRWQA classification bands.



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

Hay River

pH over time (2004–18)

pH values

Over the past 15 years, pH in the Hay River fluctuated. Most of the pH values at the Hay River site were within the upper and lower ANZECC trigger values. 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 (see comment under 'pH (2018)'). At the Upper Hay River site, pH was slightly higher than the Hay River site.

Trends

There was no short- (2014–18) or long-term (2004–18) trends present in pH at the Hay River site. The Upper Hay River did not have enough data to test for trends.

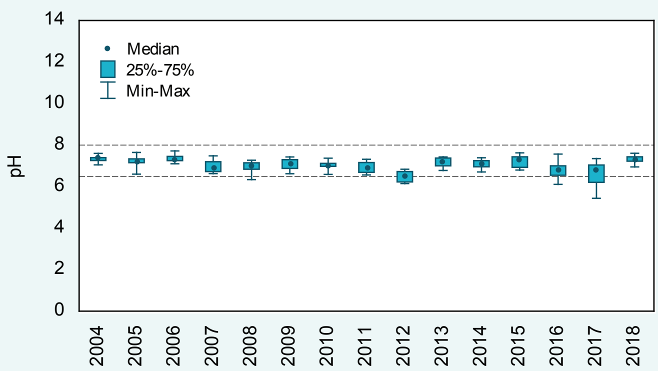
pH (2018)

pH values

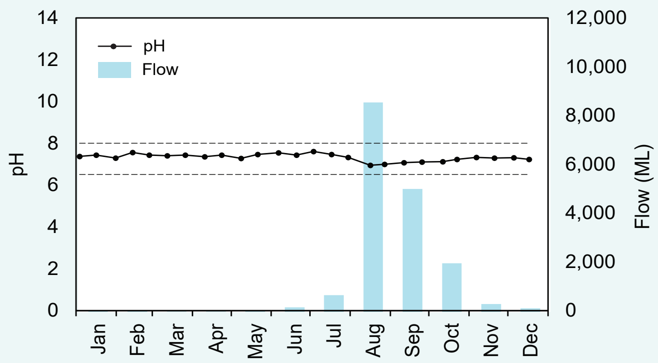
In 2018, pH followed a similar pattern at both sites, being slightly higher in the first half of the year. This suggests that the water entering the river via surface runoff was slightly more acidic than the groundwater. pH was slightly higher at the Upper Hay River site, with a few samples over the upper ANZECC trigger value.

There is some concern the probe used to collect the pH data from the catchments of Wilson Inlet (including the Hay River sites) from about October 2016 to October 2017 was not functioning correctly. 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.

Hay River

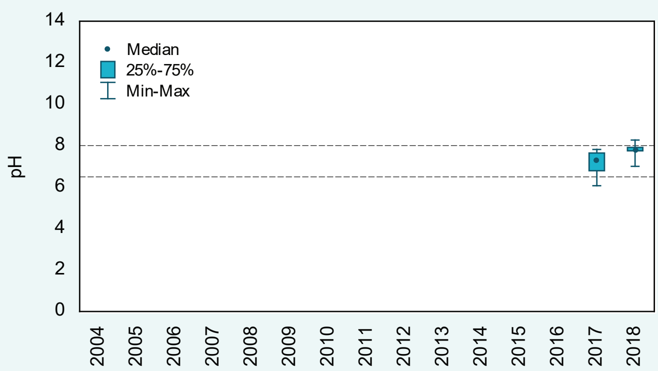


pH levels, 2004–18 at site 603004. The dashed lines are the upper and lower ANZECC trigger values for lowland rivers.

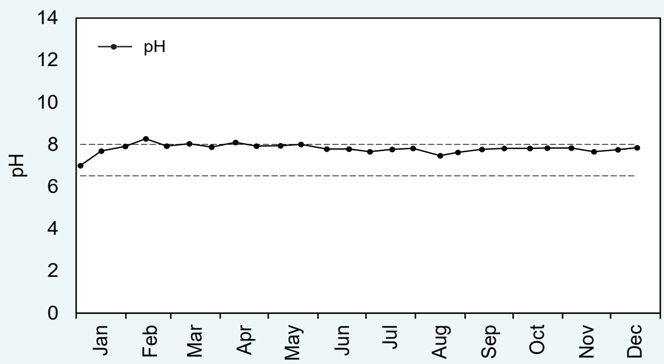


2018 pH levels and monthly flow at 603004. The dashed lines are the upper and lower ANZECC trigger values for lowland rivers.

Upper Hay River



pH levels, 2004–18 at site 6031477. The dashed lines are the upper and lower ANZECC trigger values for lowland rivers.



2018 pH levels and monthly flow at 6031477. The dashed lines are the upper and lower ANZECC trigger values for lowland rivers.

Hay River

Salinity over time (2004–18)

Concentrations

The Hay River was by far the most saline of the monitored catchments that discharge to Wilson Inlet. Using the SWRWQA classification bands, the median salinity was brackish for all years sampled at the Hay River site and saline at the Upper Hay River site.

In 2018, the median salinity concentrations were the highest (Upper Hay River, 5,060 mg/L) and second highest (Hay River site 4,140 mg/L). By contrast, the catchments with the next highest median salinities were the Sleeman River and Cuppup Creek, both with 2018 medians of 670 mg/L.

Trends

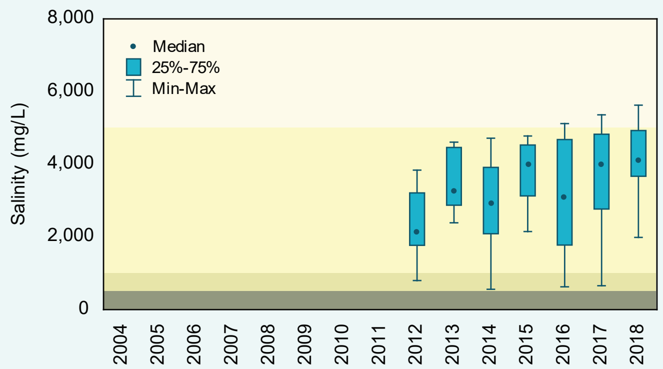
There was an increasing trend in salinity concentrations at the Hay River site of 109 mg/L/yr (2012–18). Ongoing monitoring will help determine if salinity at the Hay River site is continuing to deteriorate. There were not enough data to test for trends at the Upper Hay River site.

Salinity (2018)

Concentrations

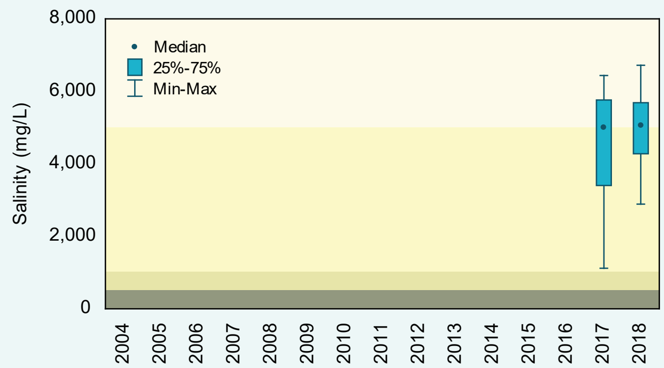
Salinity showed a strong seasonal relationship at both Hay River sites. The water was more saline during the drier months and fresher when river flows were higher. This suggests the groundwater was more saline than the water entering the river via surface run-off. At no point was the water at either site fresh. Clearing in the catchment 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.

Hay River



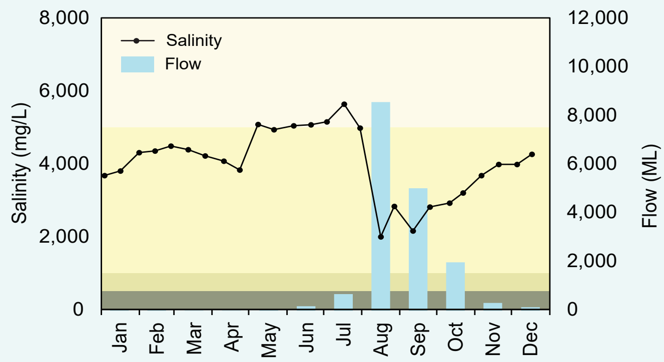
Salinity concentrations, 2004–18 at site 603004. The shading refers to the SWRWQA classification bands.

Upper Hay River

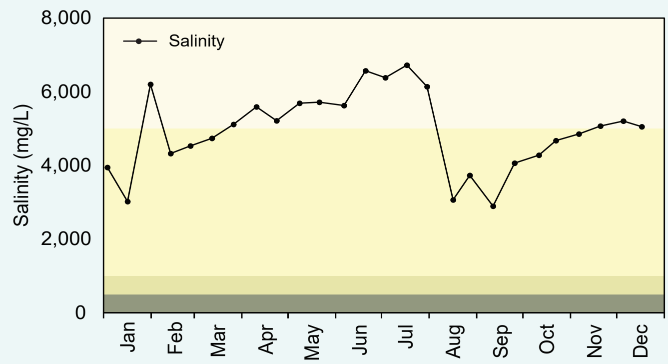


Salinity concentrations, 2004–18 at site 6031477. The shading refers to the SWRWQA classification bands.

saline brackish marginal fresh



2018 salinity concentrations and monthly flow at 603004. The shading refers to the SWRWQA classification bands.



2018 salinity concentrations at 6031477. The shading refers to the SWRWQA classification bands.

Hay River

Background

The Regional Estuaries Initiative is a State Government program to improve the health of waterways and estuaries in the south-west of Western Australia. Healthy Estuaries WA is a Royalties for Regions program launched in 2020 and will build 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. 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.

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

The Regional Estuaries Initiative partners with the Wilson Inlet Catchment Committee to fund best-practice fertiliser, dairy effluent and watercourse management 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

Where possible, parameters were compared with the ANZECC trigger values for lowland rivers in south-west Australia. These values provide a value above which there may be a risk of adverse effect. For pH there is both an upper and lower trigger value which represent the acceptable pH range. Where there were no ANZECC trigger values available (for TSS and salinity) the SWRWQA classification bands were used to allow samples and sites to be classified and compared.

Trend testing was carried out using either the Mann or Seasonal Kendall tests as appropriate. Where there were flow data available and there was a flow-concentration relationship, the data were flow-adjusted before trend analysis.

Annual loads were calculated by multiplying daily flow with daily nutrient concentrations and aggregating over the year. Measured daily concentrations were not available as samples were collected fortnightly at best, so daily concentration data were calculated using the locally estimated scatterplot smoothing algorithm (LOESS).

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 in the water.

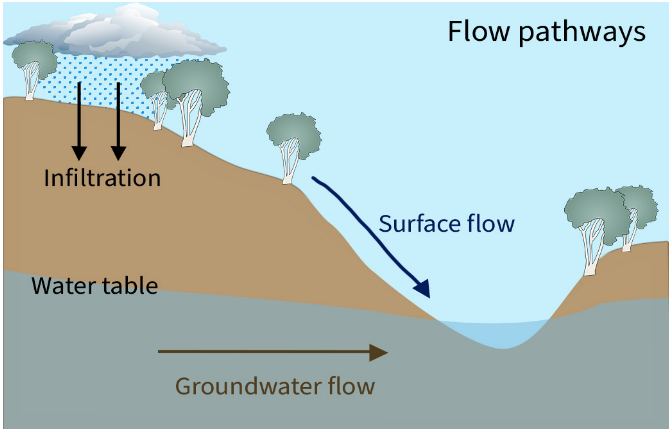
Evapoconcentration: the increase in concentration of a substance dissolved in water because of water being lost by evaporation.

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

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

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

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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