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

King River

This data report provides a summary of the nutrients at the King River sampling site in 2018 as well as historical data from 2004–18. This report was produced as part of the Regional Estuaries Initiative. Both Mill Brook and Willyung Creek join the King River downstream of the sampling site before it discharges to Oyster Harbour. 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 water and harm fish and other species. Total suspended solids, pH and salinity data are also presented as they help us better understand the processes occurring in the catchment.

About the catchment

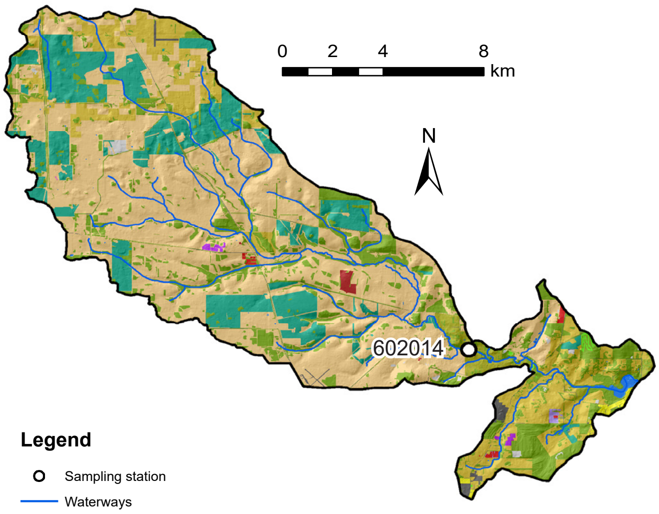
The King River has a catchment area of 197 km^2, which has been almost entirely cleared for agriculture. The dominant land use in the catchment is cropping and mixed grazing which covers nearly 50 per cent of the catchment. There are also substantial areas of blue gum plantations as well as beef cattle farming in the north of the catchment. While the waterways retain their natural form, much of the fringing vegetation is in poor condition or missing.

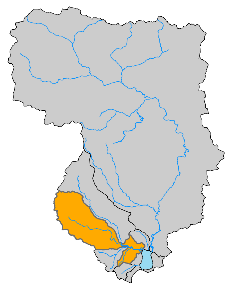
Most of the catchment has soils with a poor to moderate phosphorus-binding capacity. Where the phosphorus-binding capacity is poor, any phosphorus applied to the soils can move relatively quickly to waterways.

Water quality is measured at site 602014, Billa Boya, within the Billa Boya Reserve, in Millbrook.

Results summary

Nutrient concentrations (total nitrogen and total phosphorus) at the King River sampling site were moderate (total nitrogen) to high (total phosphorus). Total phosphorus loads were large, as were the loads contributed per square kilometer of catchment. These large loads were driven by the high phosphorus concentrations which are a result of the agricultural land use in the catchment and the often poor phosphorus-binding capacity of the soils.





Location of King River catchment in the greater Oyster Harbour catchment.

Facts and figures

Sampling site code	602014
Catchment area	197 km^2
Per cent cleared area (2018)	96%
River flow	Permanent
Annual flow (2018)	5 GL
Main land use (2018)	Cropping and mixed grazing

Nitrogen over time (2004–18)

Concentrations

Total nitrogen (TN) concentrations at the King River sampling site fluctuated over the reporting period. Compared with the other five sites sampled in the Oyster Harbour catchment, TN was moderate. While the annual median was generally below the Australian and New Zealand Environment and Conservation Council (ANZECC) trigger value, most years had a number of samples above the trigger value.

Trends

There was a short-term (2014–18) decreasing trend in TN concentrations of 0.04 mg/L/yr. This may be because of natural fluctuations at this site or an actual decrease in TN concentrations. Ongoing monitoring will help determine if the water quality is getting better at this site. There was no long-term (2004–18) trend present.

Estimated loads

Estimated TN loads at the King River sampling site were moderate compared with the other sites in the Oyster Harbour catchment. In 2018, the King River had the second largest TN load of the three sites where it was possible to calculate loads (7 t; the Kalgan River site had the largest load of 17 t). The load per unit area was also large, with the King River having the largest load per unit area in 2018 (44 kg/km^2; Mill Brook had the next largest load per unit area of 16 kg/km^2). TN loads were closely related to flow volume, years with high annual flow had large TN loads and vice versa.

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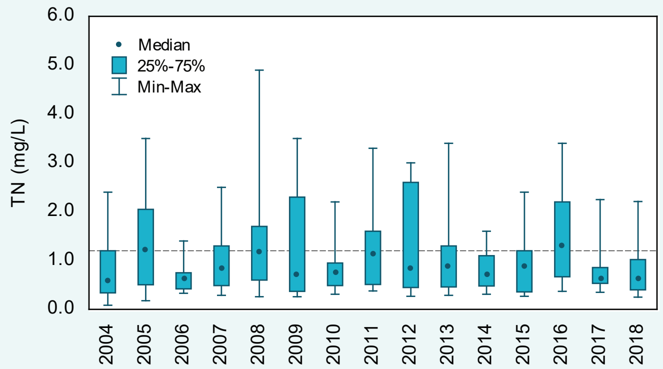
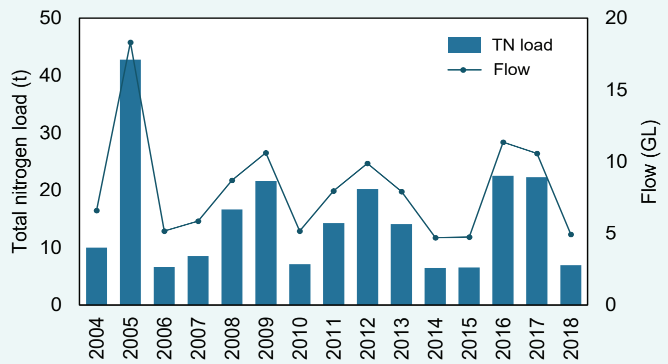


Total nitrogen concentrations, 2004–18 at site 602014. The dashed line is the ANZECC trigger value for lowland rivers.



Total nitrogen loads and annual discharge, 2004–18 at site 602014.

The King River gauging station during normal flows, October 2020. The river is flowing through the channel directly behind the gauging station.

Nitrogen (2018)

Types of nitrogen

Total N is made up of different forms of N. The dominant form of N at the King River site was dissolved organic N (DON). This form of N consists mainly of degrading plant and animal matter but may also include other, more bioavailable forms. Degrading plant and animal matter generally needs to be further broken down to become bioavailable, whereas some other forms of DON are highly bioavailable. Compared with the other Oyster Harbour catchment sites, the proportion of N present as bioavailable dissolved inorganic N (DIN – consisting of ammonia N – NH_3/NH_4^+ and total oxides of N – NO_x^-) was moderate. This form of N is readily bioavailable and is likely sourced from fertilisers and animal wastes.

Concentrations

Total N, DON and NH_3/NH_4^+ showed a seasonal response, increasing as rainfall and flow increased. It is likely that the NH_3/NH_4^+ was being washed into the river from surrounding land use via surface flows. DON was likely being washed into the river from soils and remnant wetlands where it built up over the summer period. NO_x^- also showed a seasonal response; however, it did not show a clear peak like the other forms of N. Instead, it increased as rainfall and flow increased and then stayed fairly steady until falling again in December, with the exception of a peak in October. The NO_x^- was likely being washed into the river via surface flows.

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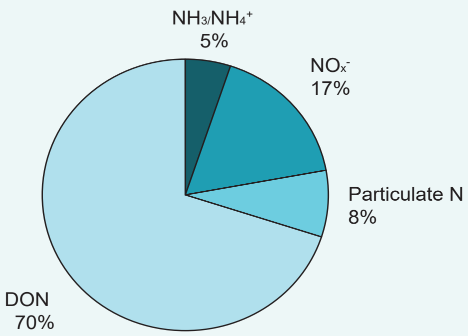
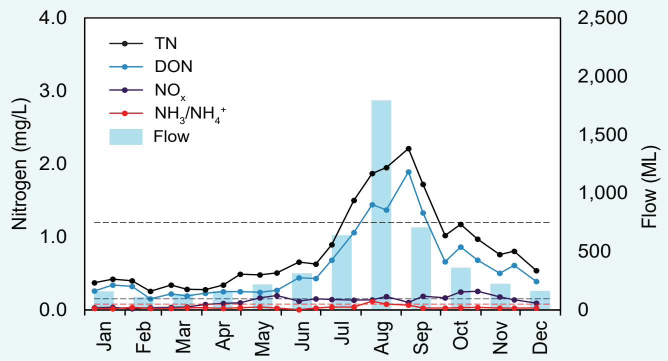


2018 average nitrogen fractions at site 602014.



2018 nitrogen concentrations and monthly discharge at 602014. The dashed lines are the ANZECC trigger values for lowland rivers for the different N species.

The King River gauging station submerged during high flows, June 2012. Note the difference in water levels with the photograph on the previous page.

Phosphorus over time (2004–18)

Concentrations

Total phosphorus (TP) concentrations at the King River sampling site were high. Not only were most annual medians over the ANZECC trigger value, the annual range in TP concentrations was often the largest of the Oyster Harbour catchment sampling sites. The 2018 median TP concentration was the highest of the Oyster Harbour catchment sites at 0.059 mg/L, similar to Willyung Creek which had a median of 0.056 mg/L.

Trends

There was no short- (2014–18) or long-term (2004–18) trend present in TP concentrations at the King River sampling site.

Estimated loads

Estimated TP loads at the King River sampling site were large compared with the other sites in the Oyster Harbour catchment. In 2018, the King River had the largest TP load of the three sites where it was possible to calculate loads (0.80 t; the Kalgan River site had the next largest load of 0.46 t). The load per unit area was also large, with the King River having the largest load per unit area in 2018 (5.1 kg/km^2; Mill Brook had the next largest load per unit area of 1.3 kg/km^2). TP loads were closely related to flow volume, years with high annual flow had large TP loads and vice versa.

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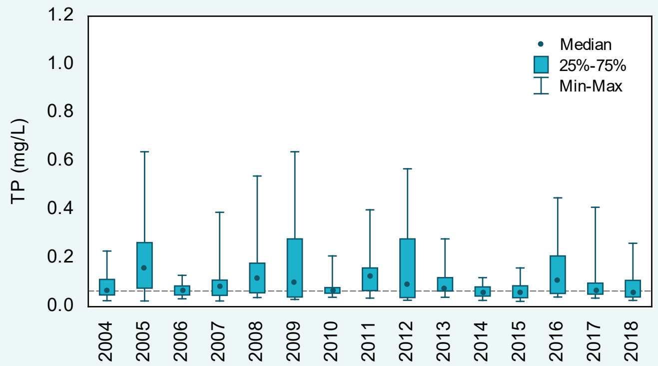
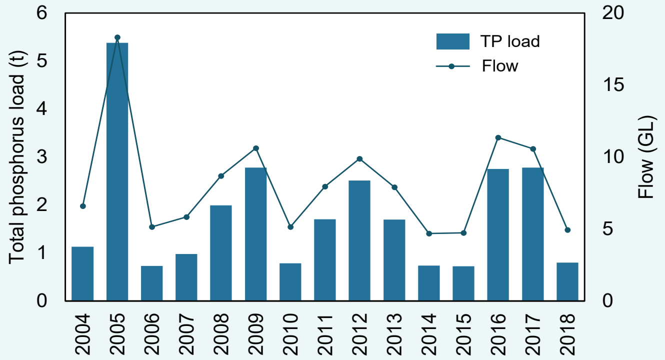


Total phosphorus concentrations, 2004–18 at site 602014. The dashed line is the ANZECC trigger value for lowland rivers.



Total phosphorus loads and annual discharge, 2004–18 at site 602014.

Fyke net set in the King River to capture fish as part of a river health assessment, March 2020.

Phosphorus (2018)

Types of phosphorus

Total P is made up of different forms of P. At the King River sampling site, two-thirds of the P was present as either particulate P, dissolved organic P (DOP) or both (shown as 'Other forms of P' in the chart below). Particulate P generally needs to be broken down before becoming bioavailable to algae. The bioavailability of DOP varies and is poorly understood. The remainder of the P was present as filterable reactive phosphorus (FRP) which is readily bioavailable, meaning that plants and algae can use it to fuel rapid growth. The FRP was probably derived from animal waste and fertilisers as well as natural sources.

Concentrations

Total P and FRP concentrations showed a seasonal pattern in 2018 at the King River sampling site. Concentrations were low during the first half of the year before increasing in July as rainfall and flow increased. It is likely that most of the P at this site was entering the river via surface flows, with groundwater contributing proportionally less.

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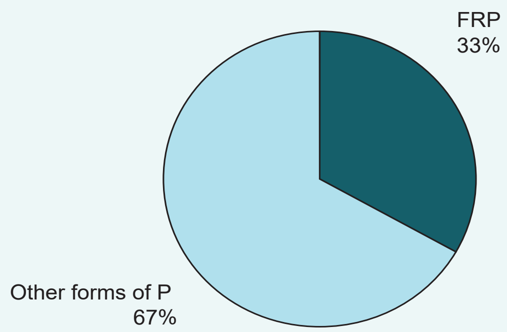
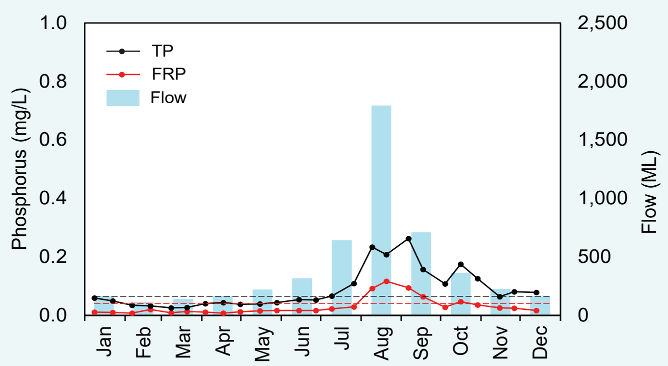


2018 average phosphorus fractions at site 602014.



2018 phosphorus concentrations and monthly discharge at 602014. The dashed lines are the ANZECC trigger values for the different P species in lowland rivers.

Juvenile black bream (Acanthopagrus butcheri) captured as part of the river health assessment in the King River. This is an estuarine species which is also found in the lower reaches of rivers.

Total suspended solids over time (2004–18)

Concentrations

There were only two years with sufficient total suspended solids (TSS) data available to graph at the King River sampling site. Both of the annual medians fell within the low band of the Statewide River Water Quality Assessment (SWRWQA) classification bands.

Trends

As there was only two years of data, it was not possible to calculate trends in TSS concentrations at the King River sampling site. A minimum of five consecutive years of data are required to test for trends.

Estimated loads

Estimated TSS loads at the King River sampling site were moderate compared with the other sites in the Oyster Harbour catchment. In 2018, the King River had the second largest TSS load of the three sites where it was possible to calculate loads (31 t; the Kalgan River site had the largest load of 44 t). The load per unit area was large, with the King River having the largest load per unit area in 2018 (197 kg/km^2; Mill Brook had the next largest load per unit area of 79 kg/km^2). TSS loads were closely related to flow volume, years with high annual flow had large TSS loads and vice versa.

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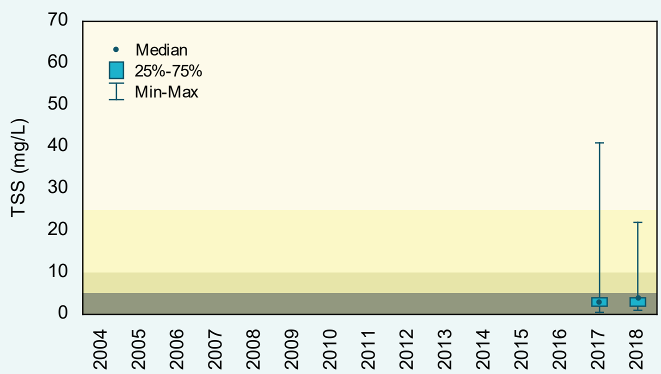
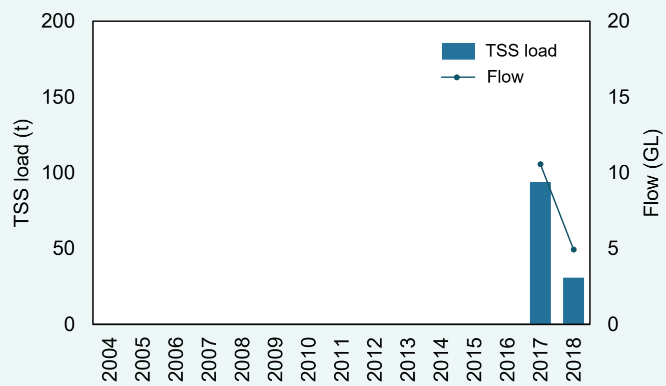


Total suspended solids concentrations, 2004–18 at site 602014. The shading refers to the SWRWQA classification bands.



Total suspended solids loads and annual discharge, 2004–18 at site 602014.

very high | high | moderate | low

The King River at the sampling site. The fringing vegetation here is a mix of native and exotic species, October 2009.

Total suspended solids (2018)

Concentrations

There was evidence of a seasonal pattern in 2018 TSS concentrations at the King River sampling site. With the exception of the peak in May, concentrations were highest from about August to September, when rainfall and flow were at their highest. This suggests that at this time, particulate matter was being washed into the river via surface flows as well as coming from in-stream sources such as erosion. The peak in May was possibly because of a dog that was swimming in the river when the sample was taken. Though the sampler took care to collect the sample upstream of where the dog was, it may have disturbed some particulate matter where the sample was taken before the sampler arrived.

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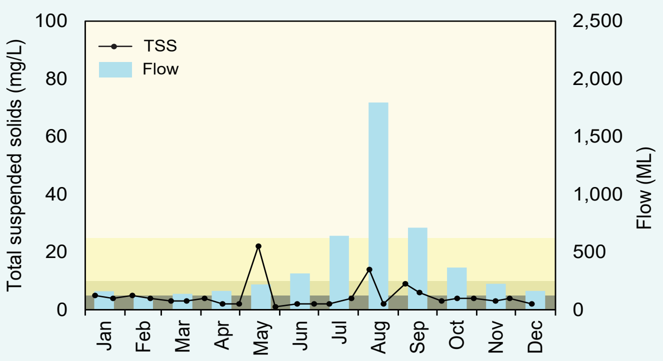


2018 total suspended solids concentrations and monthly discharge at 602014. The shading refers to the SWRWQA classification bands.

very high | high | moderate | low

Undercutting of the bank near the sampling site has caused it to slump, October 2017.

King River

pH over time (2004–18)

pH values

pH fluctuated at the King River sampling site during the reporting period. While all annual medians fell within the upper and lower ANZECC trigger values, many years had some samples which were either above or below the trigger values.

There is some concern that the probe used to collect the pH data from the catchments of Oyster Harbour (including the King River site) from about October 2016 to October 2017 was not functioning correctly. This may have caused lower-than-actual pH values to be recorded. From October 2017, a new probe was used. Although there is no way of verifying the 2016 and 2017 pH data, they have still been presented here.

Trends

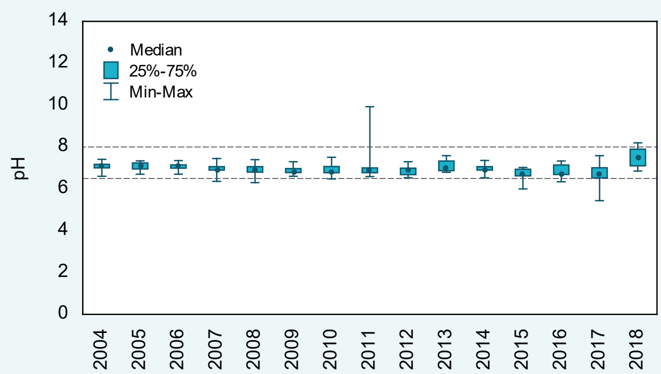
There was no short- (2014–18) or long-term (2004–18) trend present in pH levels at the King River sampling site.

pH (2018)

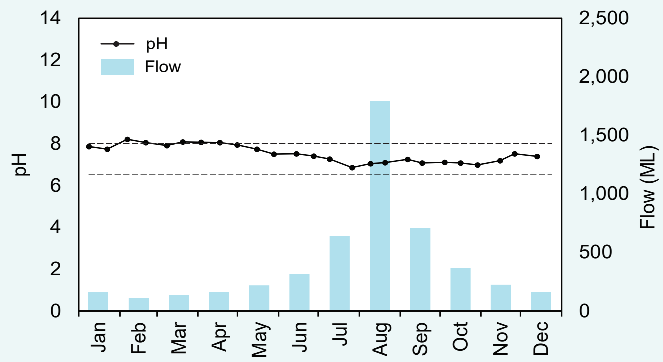
pH values

pH at the King River sampling site showed some evidence of a reverse seasonal trend. That is, pH was highest during the first half of the year, before falling about June when rainfall and flow increased. This suggests that the groundwater at the site was slightly more acidic than the surface water.

King River



pH levels, 2004–18 at site 602014. The dashed lines are the upper and lower ANZECC trigger values for lowland rivers.



2018 pH levels and monthly discharge at 602014. The dashed lines are the upper and lower ANZECC trigger values for lowland rivers.

Aerial view from gauging station, looking across the catchment to Oyster Harbour, March 2020.

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Salinity over time (2004–18)

Concentrations

Salinity concentrations at the King River sampling site appear to be increasing (see comment under Trends, below). The annual median has shifted from the fresh band of the SWRWQA band to the marginal band.

Trends

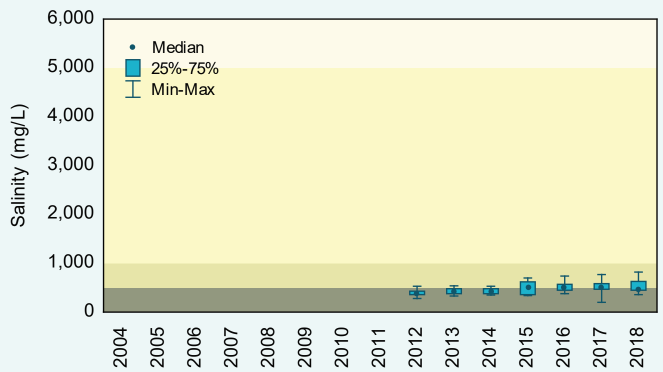
There was a short-term (2014–18) increasing trend in salinity concentrations at the King River sampling site of 12 mg/L/yr. Ongoing monitoring will help determine if this is part of the natural fluctuations at this site or an actual increase in salinity.

Salinity (2018)

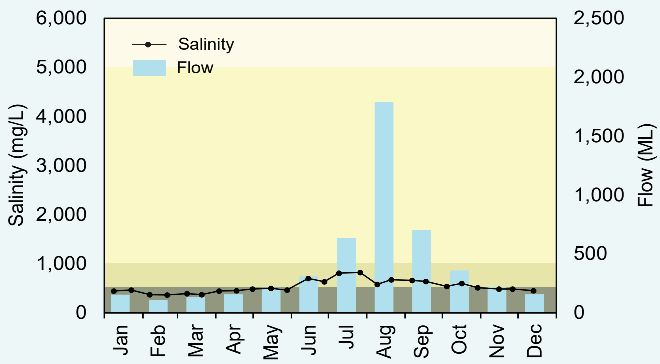
Concentrations

Salinity at the King River sampling site showed a seasonal pattern in 2018. Concentrations were lowest at the start and end of the year when flow and rainfall were at their lowest, and slightly higher in the middle of the year when flow and rainfall were at their highest. This suggests that most of the salt at this site is being washed into the river via surface flows from surrounding land.

King River



Salinity concentrations, 2004–18 at site 602014. The shading refers to the SWRWQA classification bands.



2018 salinity and monthly discharge at 602014. The shading refers to the SWRWQA classification bands.

saline | brackish | marginal | fresh

The King River sampling site. The understorey of the fringing vegetation is dominated by exotic grasses, August 2019.

King 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 Oyster Harbour at estuaries.dwer.wa.gov.au/estuary/oyster-harbour/

The Regional Estuaries Initiative partners with the Oyster Harbour Catchment Group 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 Oyster Harbour Catchment Group go to ohcg.org.au
- To find out more about the health of the rivers in the Oyster Harbour 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.

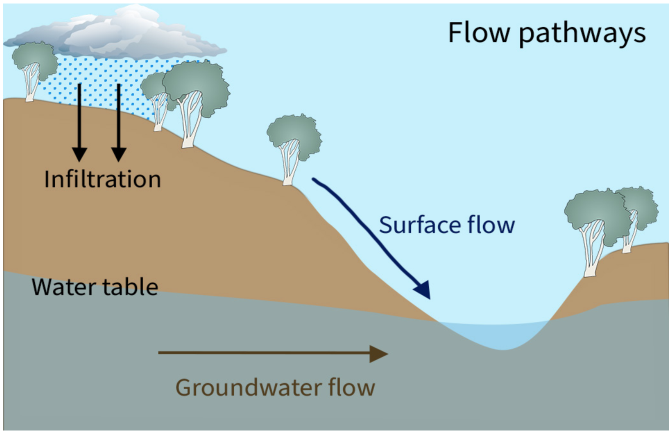
Evapoconcentration: the increase in concentration of a substance dissolved in water because of water being lost by evaporation.

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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