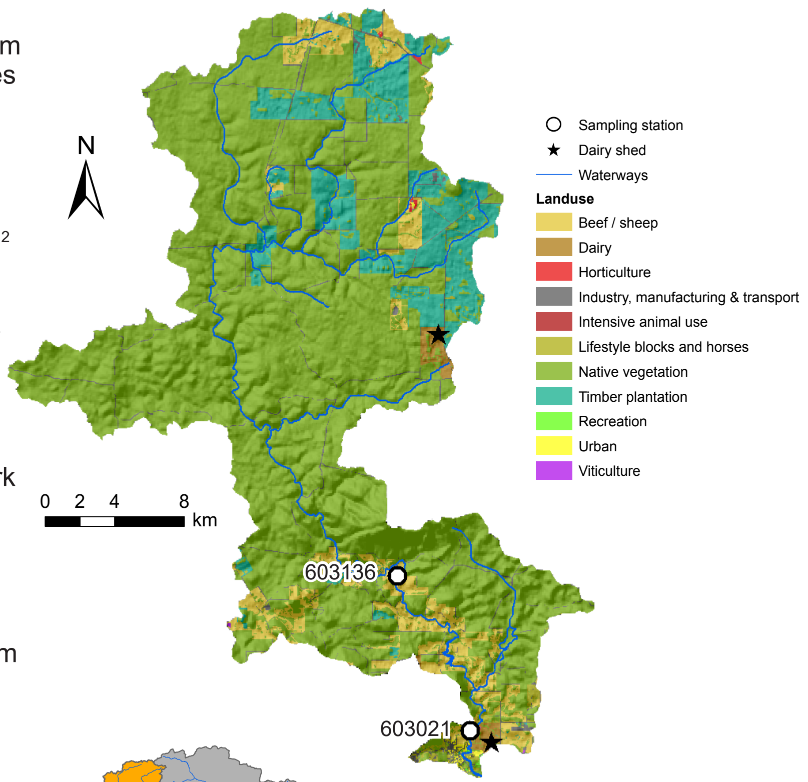
GOVERNMENT OF WESTERN AUSTRALIA
Department of **Water and Environmental Regulation**
Department of **Primary Industries and Regional Development**

Wilson Inlet catchment nutrient report 2019

HEALTHY ESTUARIES WA

Denmark River

This data report provides a summary of the nutrients at the two Denmark 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.

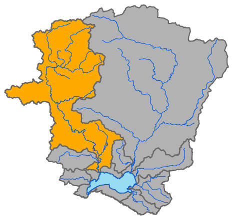


About the catchment

Denmark River has a catchment area of about 600 km^2 and receives flow from three major tributaries, Yate Flat Creek and the Quickup River from the east and Scotsdale Brook (which is a monitored catchment; site 603023) from the west. There are timber plantations present in the Yate Flat Creek catchment while the Quickup River catchment is largely uncleared and contains one of the potable water supply dams for the town of Denmark. There is a second dam, the Denmark Dam, which is on the Denmark River between the two sampling sites shown on the map. Clearing in the upper catchment caused elevated salinity levels in the Denmark Dam, making the water unfit for use. Extensive revegetation has reversed this salinity trend and, together with the Quickup Dam, the Denmark Dam is now part of the integrated scheme that provides for Denmark's ongoing water needs.

Just over three-quarters of the catchment is covered in native vegetation. The other major land uses are plantations and beef cattle, though combined these cover less than a fifth of the catchment. Soils in the central portion of the catchment have a poor capacity to bind phosphorus. The upper and lower sections of the catchments soils have a better phosphorus binding capacity.

There are two sites monitored on the Denmark River, one near the WA College of Agriculture, Denmark, which is below the confluence with Scotsdale Brook (Denmark Ag; site 603021) and the other, further upstream, near Mt Lindesay (Denmark ML; site 603136).



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

Results summary

Nutrient concentrations (total nitrogen and total phosphorus) in the Denmark River were classified as low (nitrogen) and moderate (phosphorus). Nitrogen loads were moderate to large while phosphorus loads were small compared with the other Wilson Inlet catchments. The nutrient loads per square kilometre were small.

Facts and figures

Sampling site code	603021 (Denmark Ag) 603136 (Denmark ML)
Catchment area	604 km^2 (670 km^2 combined Denmark and Scotsdale Brook catchment)
Per cent cleared area (2014)	22 per cent (Scotsdale Brook is 60 per cent cleared)
River flow	Flows year-round at Denmark Ag.
Main land use (2014)	Native vegetation (Denmark River catchment)

Estimated loads and flow at Denmark Ag

603021	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Flow (GL)	74	11	13	35	55	12	39	22	41	12	15	55	26	14.3	8.8
TN load (t)	68	8.2	11	32	51	9.9	36	19	37	9.4	13	52	22	12	7.0
TP load (t)	2.29	0.27	0.37	1.08	1.78	0.34	1.25	0.63	1.29	0.30	0.43	1.75	0.69	0.43	0.23

Denmark River

Nitrogen over time (2005–19)

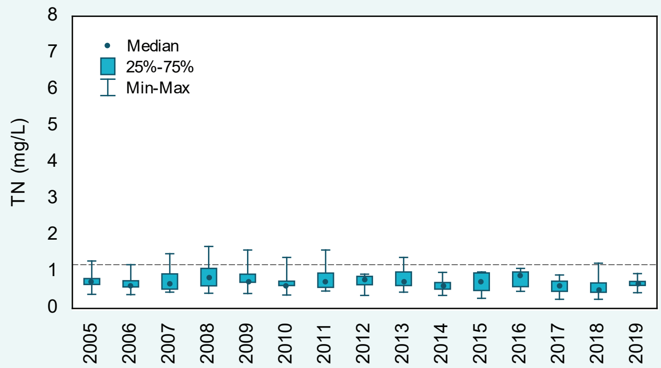
Concentrations

The two Denmark River sites had similar total nitrogen (TN) concentrations and all annual medians were below the Australian and New Zealand Environment and Conservation Council (ANZECC) trigger value. Using the State Wide River Water Quality Assessment (SWRWQA) methodology, all annual TN concentrations at both sites were classified as low.

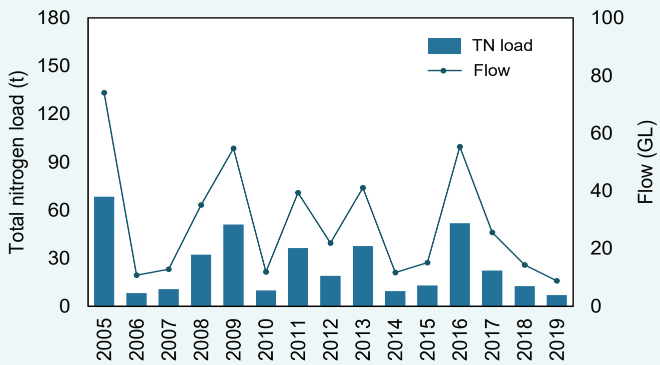
Estimated loads

Estimated TN loads at the Denmark River sampling sites were small (Denmark ML) to moderate-large (Denmark Ag) compared with the other sites in the Wilson Inlet catchment. In 2019, Denmark Ag had a TN load of 7.0 t, similar to the Hay River with a load of 7.5 t. The load per square kilometre of 11 kg/km^2 was small compared with the other Wilson Inlet catchment sites. TN loads were larger at Denmark Ag than Denmark ML because of a number of factors, the two main ones being the larger flow volumes at Denmark Ag caused by the larger catchment area (including Scotsdale Brook which discharges into the Denmark River above the Denmark Ag sampling site) and the more intensive land use in the Scotsdale Brook catchment. Annual TN loads were closely related to flow volumes; years with large annual flow volumes had large TN loads and vice versa.

Denmark Ag

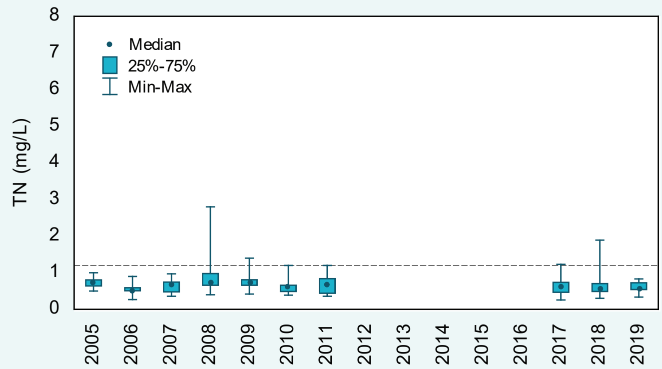


Total nitrogen concentrations, 2005–19 at site 603021. The dashed line is the ANZECC trigger value.

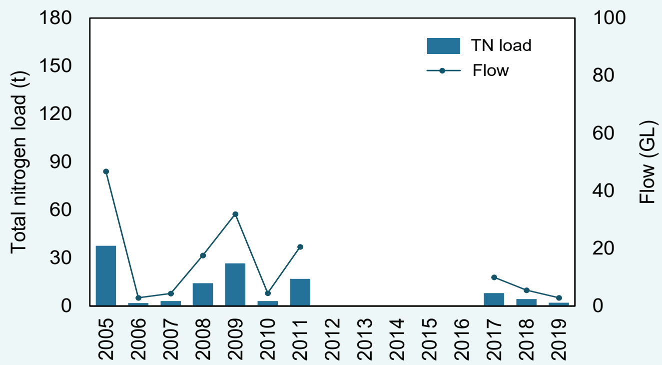


Total nitrogen loads and annual flow, 2005–19 at site 603021.

Denmark ML



Total nitrogen concentrations, 2005–19 at site 603136. The dashed line is the ANZECC trigger value.



Total nitrogen loads and annual flow, 2005–19 at site 603136.

Nitrogen (2019)

Types of nitrogen

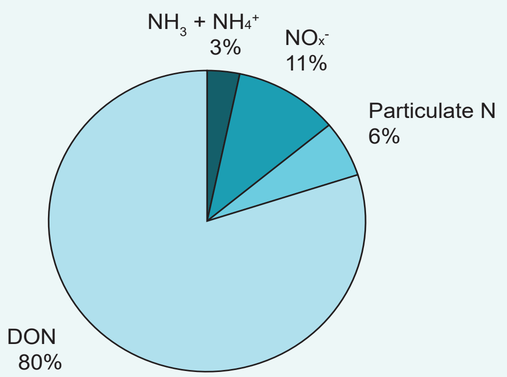
Total N is made up of different types of N. The relative proportions of the different types of N were very similar at the two Denmark River sites. Most of the N was present as dissolved organic N (DON) which consists mainly of degrading plant and animal matter but may include other, bioavailable, types. Particulate N is composed of plant and animal detritus. Most types of particulate N and DON need to be further broken down to become available to plants and algae, though some DON types are readily bioavailable. Only a small amount of N was present as dissolved inorganic N (total ammonia – NH_3 + NH_4^+ and nitrate – NO_x^-), which is bioavailable to plants and algae and can be used to fuel rapid growth.

Concentrations

With the exception of the peak in nitrate in June and July at Denmark ML, N concentrations varied in a similar way at both sites during the year. The seasonal pattern evident in 2018, where N concentrations followed a similar pattern to flow volumes, was not as obvious in 2019. It is likely that DON and nitrate were entering the river during the wetter months via surface flows, with groundwater and in-stream sources contributing proportionally less. During the drier months, groundwater and in-stream sources were likely contributing proportionally more N. The reason for the peak in nitrate at Denmark ML in June and July is unknown; it does not coincide with a peak in flows.

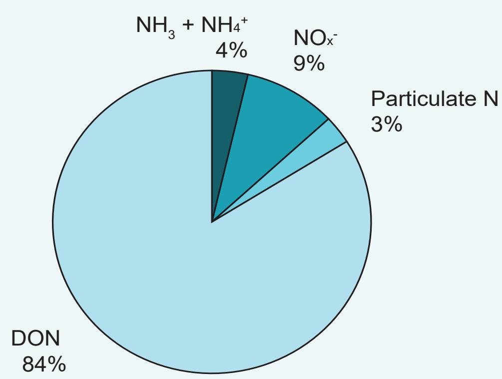
Where there are no data shown in the graphs, there was water present; however, the water levels were low and the river was not flowing.

Denmark Ag

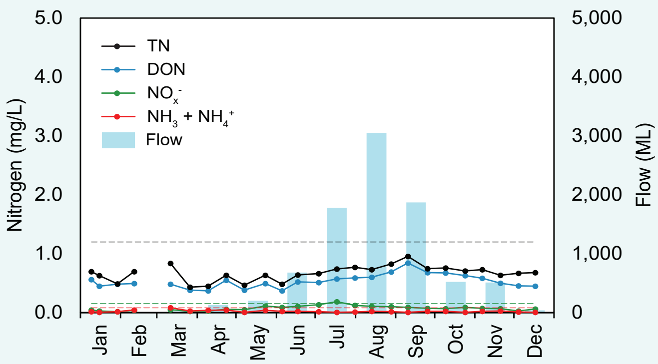


2019 average nitrogen fractions at site 603021.

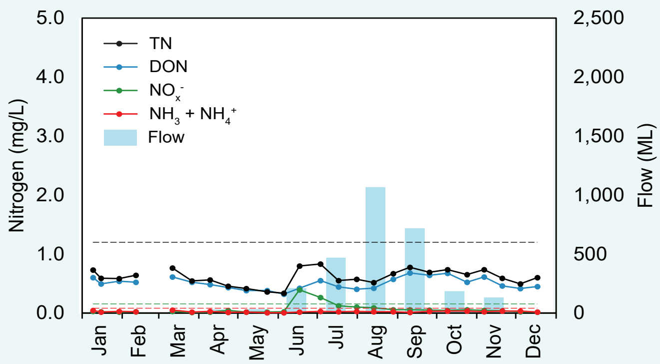
Denmark ML



2019 average nitrogen fractions at site 603136.



2019 nitrogen concentrations and monthly flow at 603021. The dashed lines are the ANZECC trigger values for the different N species.



2019 nitrogen concentrations and monthly flow at 603136. The dashed lines are the ANZECC trigger values for the different N species.

Denmark River

Phosphorus over time (2005–19)

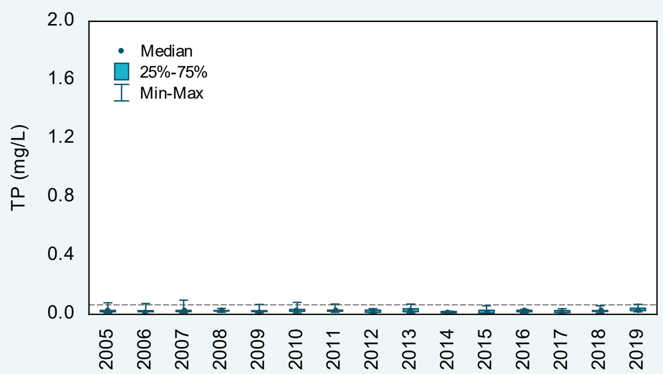
Concentrations

Using the SWRWQA methodology, annual total phosphorus (TP) concentrations were classified as moderate at Denmark Ag and low at Denmark ML. TP concentrations were slightly higher at Denmark Ag than Denmark ML because of the more intensive land use between the two sampling sites. In 2019, Denmark ML (0.023 mg/L) and Denmark Ag (0.032 mg/L) had some of the lowest median TP concentrations of the Wilson Inlet catchment sites (only the Hay River site had a lower median of 0.011 mg/L, the upper Hay River site had a similar median to Denmark ML of 0.023 mg/L, and Scotsdale Brook had a similar median to Denmark Ag of 0.033 mg/L).

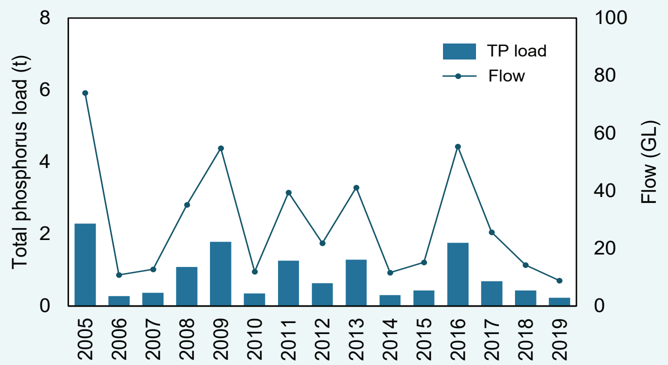
Estimated loads

The Denmark River Ag site had a moderate estimated TP load compared with the other six catchment sites (0.23 t in 2019). It had the second smallest load per square kilometre with 0.3 kg/km^2 being exported in 2019 (the Hay River had 0.1 kg/km^2). TP loads were larger at Denmark Ag than Denmark ML because of a number of factors, the two main ones being the larger catchment area contributing to the load at Denmark Ag (including Scotsdale Brook which discharges into the Denmark River above this sampling site) and the more intensive land use in the Scotsdale Brook and lower half of the Denmark River catchments (most of the catchment above Denmark ML is uncleared). In 2019, Scotsdale Brook had a TP load of 0.22 t, similar to the load at Denmark Ag. Annual TP loads were closely related to flow volumes; years with large annual flow volumes had large TP loads and vice versa.

Denmark Ag

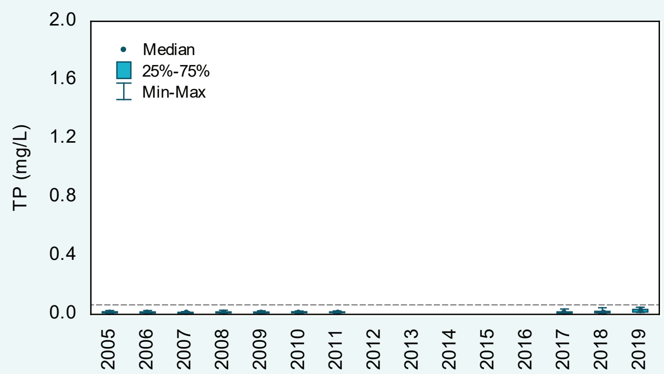


Total phosphorus concentrations, 2005–19 at site 603021. The dashed line is the ANZECC trigger value.

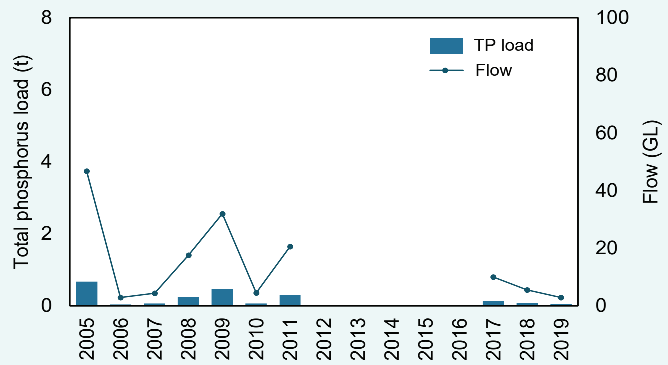


Total phosphorus loads and annual flow, 2005–19 at site 603021.

Denmark ML



Total phosphorus concentrations, 2005–19 at site 603136. The dashed line is the ANZECC trigger value.



Total phosphorus loads and annual flow, 2005–19 at site 603136.

Phosphorus (2019)

Types of phosphorus

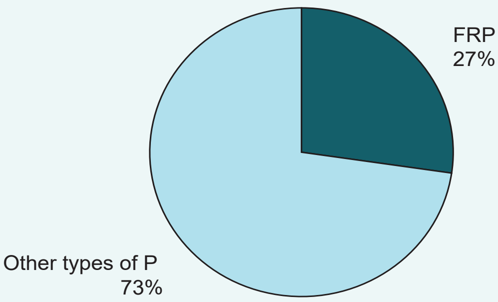
Total P is made up of different types of P. The proportion of P present as phosphate was smaller at Denmark Ag than Denmark ML. The reason that the proportion of P present as phosphate at the Denmark Ag site was smaller was because TP concentrations at this site were larger; phosphate concentrations were similar at the two sites. Phosphate is measured as filterable reactive phosphorus (FRP); in surface waters this is mainly present as phosphate (PO_4^{3-}) species and is a readily bioavailable type of P. The remainder of the P was present as either particulate P or dissolved organic P (DOP) or both (shown as 'Other types of P' in the graphs below). Particulate P generally needs to be broken down before becoming bioavailable. The bioavailability of DOP varies and is poorly understood.

Concentrations

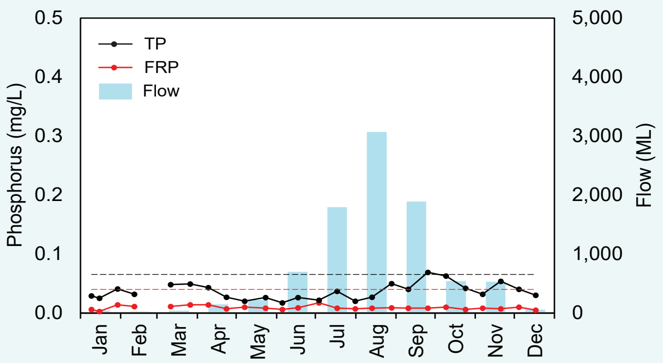
P concentrations were very low in the Denmark River (below the relevant ANZECC trigger values) on all sampling occasions bar one in September at the Denmark Ag site which was just above. TP and phosphate concentrations fluctuated slightly throughout the year. During the drier months, the majority of the P was entering the river via groundwater and in-stream sources, with surface flows contributing less. During the wetter months, surface flows contributed proportionally more P.

Where there are no data shown in the graphs, there was water present; however, the water levels were low and the river was not flowing.

Denmark Ag

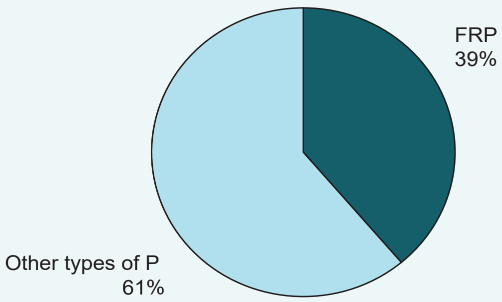


2019 average phosphorus fractions at site 603021.

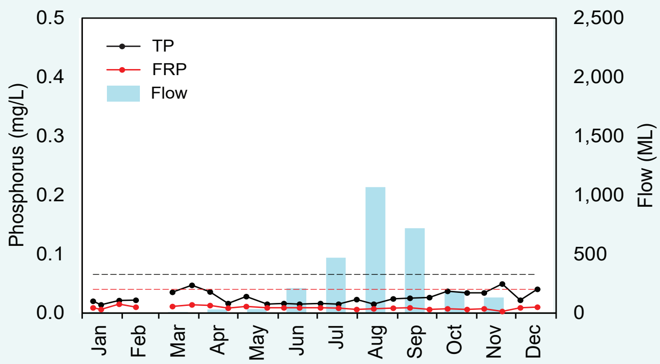


2019 phosphorus concentrations and monthly flow at 603021. The dashed lines are the ANZECC trigger values for the different P species.

Denmark ML



2019 average phosphorus fractions at site 603136.



2019 phosphorus concentrations and monthly flow at 603136. The dashed lines are the ANZECC trigger values for the different P species.

Total suspended solids over time (2005–19)

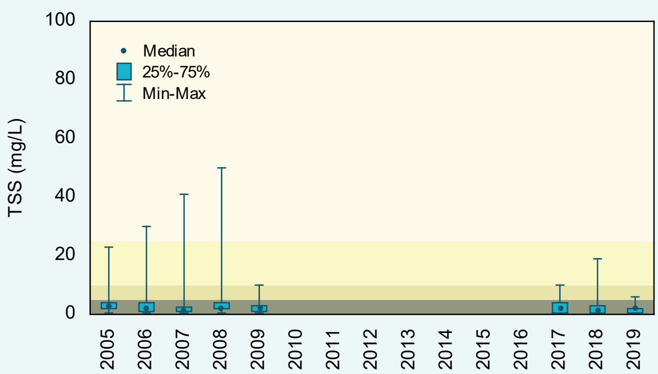
Concentrations

Compared with the other sites sampled in the Wilson Inlet catchment, total suspended solids (TSS) concentrations were low in the Denmark River. Using the SWRWQA methodology, all years were classified as low at both sites. TSS concentrations were generally lower at the Denmark ML site than the Denmark Ag site, likely a result of the more intensive land use present between the two sites. In 2019, the median TSS concentrations were some of the lowest of all sites in the Wilson Inlet catchment (Denmark ML 0.5 mg/L, Denmark Ag 2 mg/L).

Estimated loads

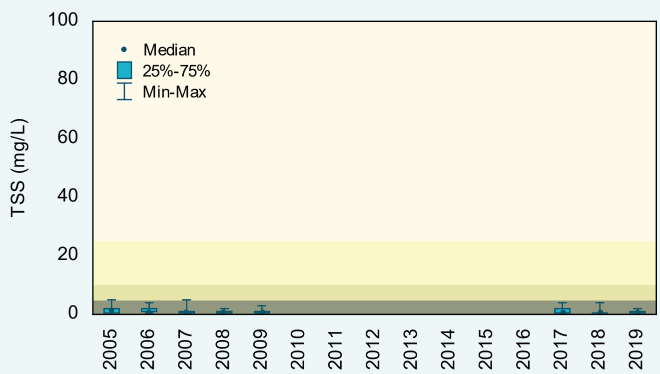
Estimated TSS loads at the Denmark River Ag site were low to moderate (they were very low upstream at Denmark ML) compared with the other sites in the Wilson Inlet catchment. The load at Denmark Ag (23 t in 2019) was much larger than at Denmark ML (2 t in 2019), probably because of the influence of Scotsdale Brook which had a large TSS load (43 t in 2019) as well as the more intensive land uses found downstream of Denmark ML. As the Denmark River has a relatively large catchment area, the TSS load per square kilometre was small (35 kg/km^2 in 2019, the second smallest load per square kilometre of the Wilson Inlet catchments). Annual TSS loads were closely related to flow volumes; years with large annual flow volumes had large TSS loads and vice versa.

Denmark Ag



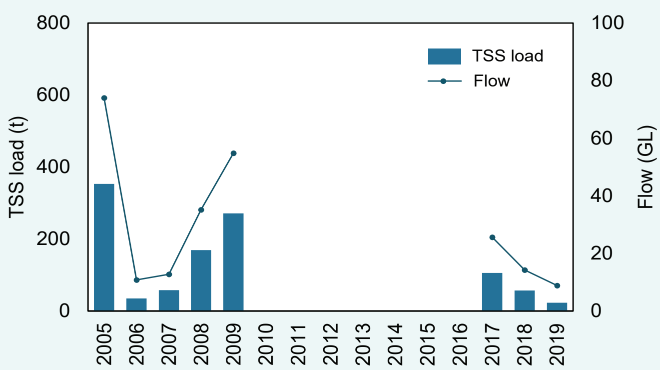
Total suspended solids concentrations, 2005–19 at site 603021. The shading refers to the SWRWQA classification bands.

Denmark ML

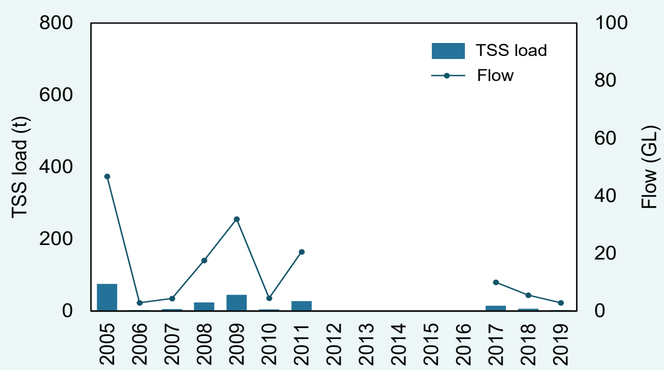


Total suspended solids concentrations, 2005–19 at site 603136. The shading refers to the SWRWQA classification bands.

low moderate high very high



Total suspended solids loads and annual flow, 2005–19 at site 603021.



Total suspended solids loads and annual flow, 2005–19 at site 603136.

Total suspended solids (2019)

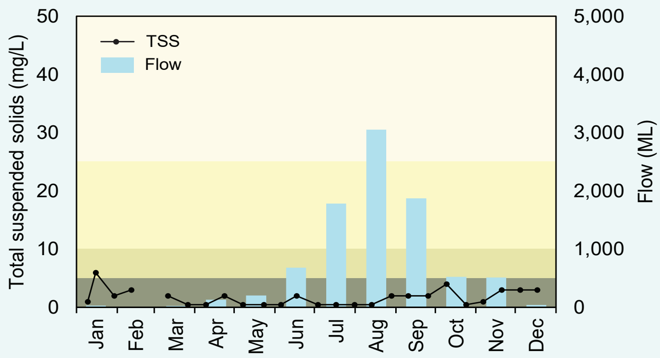
Concentrations

In 2019, most of the samples fell into the low band with the exception of one sample collected in January at Denmark Ag which fell into the moderate band. At both sites a number of the samples were below the laboratory limit of reporting (LOR) of 1 mg/L (10 of 25 samples at Denmark Ag and 14 of 25 samples at Denmark ML). TSS concentrations fluctuated over the year at both sites with no clear seasonal pattern.

Where there are no data shown in the graphs, there was water present; however, the water levels were low and the river was not flowing.

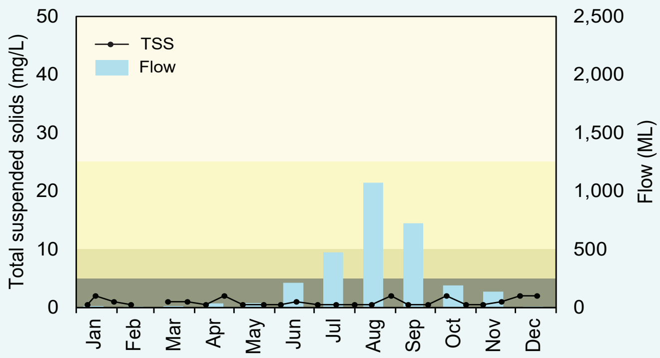
The Old Railway Bridge just upstream of Wilson Inlet, July 2019.

Denmark Ag



2019 total suspended solids concentrations and monthly flow at 603021. The shading refers to the SWRWQA classification bands.

Denmark ML



2019 total suspended solids concentrations and monthly flow at 603136. The shading refers to the SWRWQA classification bands.

low moderate high very high

Weir on the Denmark River, September 2016.

Denmark River

pH over time (2005–19)

pH values

pH fluctuated over the reporting period at both sites in the Denmark River. In 2019, all samples bar one at Denmark ML fell within the upper and lower ANZECC trigger values suggesting that pH at these sites is within the bounds required for a healthy ecosystem.

There is some concern the probe used to collect the pH data from the catchments of Wilson Inlet (including the Denmark 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 the pH values increased and stabilised. Although there is no way of verifying the 2016–17 data, they have still been presented here.

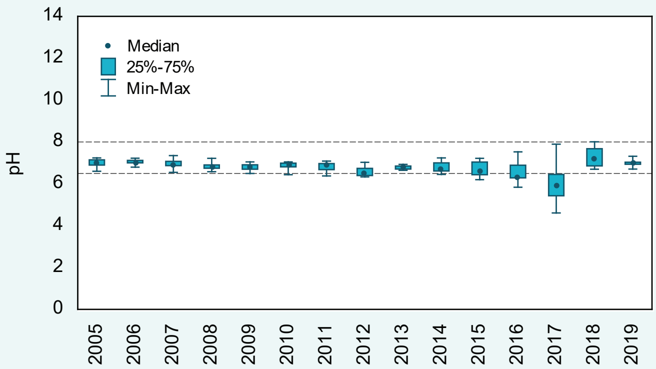
pH (2019)

pH values

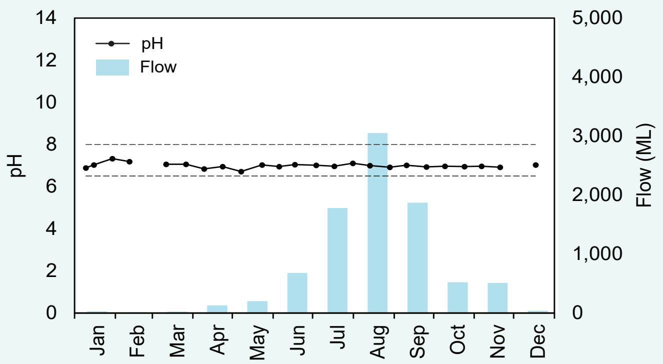
At both sites, pH remained fairly constant throughout the year. This is different to 2018, when the first half of the year had higher pH values than the second half of the year at both sites. This difference may be because of the lower flow volumes in 2019, though this is not clear.

Where there are no data shown in the graphs, there was water present; however, the water levels were low and the river was not flowing.

Denmark Ag

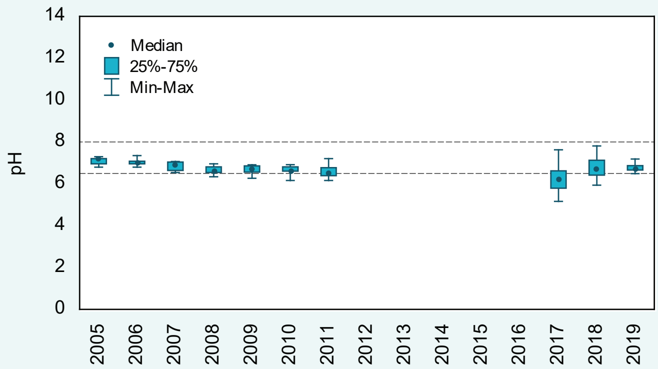


pH levels, 2005–19 at site 603021. The dashed lines are the upper and lower ANZECC trigger values.

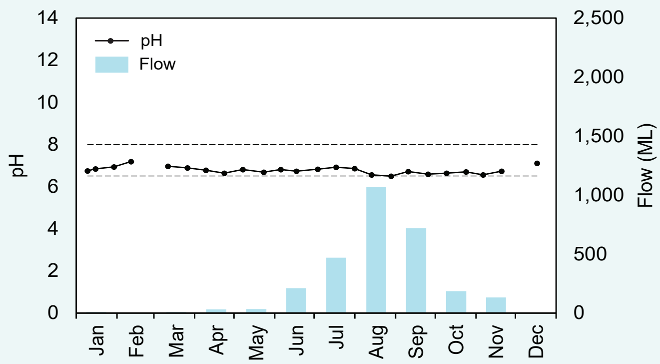


2019 pH levels and monthly flow at 603021. The dashed lines are the upper and lower ANZECC trigger values.

Denmark ML



pH levels, 2005–19 at site 603136. The dashed lines are the upper and lower ANZECC trigger values.



2019 pH levels and monthly flow at 603136. The dashed lines are the upper and lower ANZECC trigger values.

Denmark River

Salinity over time (2005–19)

Concentrations

Salinity fluctuated over the reporting period at both sites. Using the Water Resources Inventory 2014 salinity bands, both sites were classified as fresh for all years for which there were data (note, the 2018 nutrient report used the SWRWQA bands). In 2019, the sites had the same median salinity (400 mg/L) which was the third lowest of the Wilson Inlet catchment sites, The only sites with lower median salinities were Scotsdale Brook (300 mg/L) and Little River (270 mg/L).

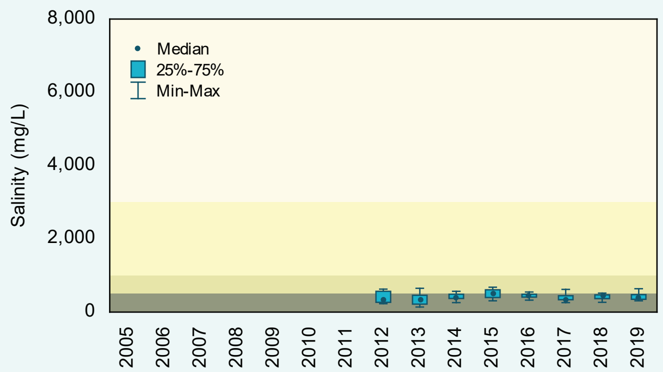
Salinity (2019)

Concentrations

Salinity concentrations fluctuated slightly at both sites in 2019. Unlike in 2018, when salinity was slightly lower at the Denmark Ag site, in 2019, salinity was very similar between the two sites. This may be because of the smaller flow volumes in 2019 or just part of the natural fluctuations at these sites. Ongoing sampling may help tease this out.

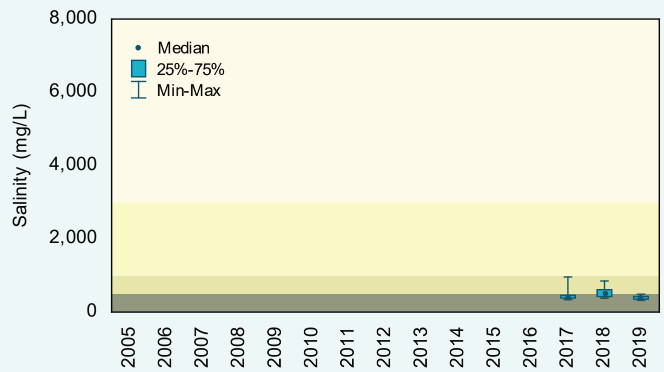
Where there are no data shown in the graphs, there was water present; however, the water levels were low and the river was not flowing.

Denmark Ag



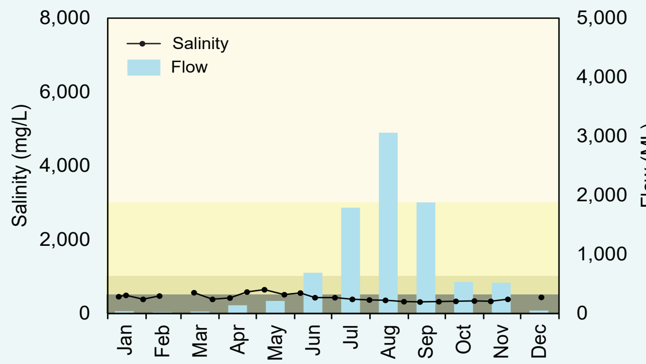
Salinity concentrations, 2005–19 at site 603021. The shading refers to the Water Resources Inventory 2014 salinity ranges.

Denmark ML

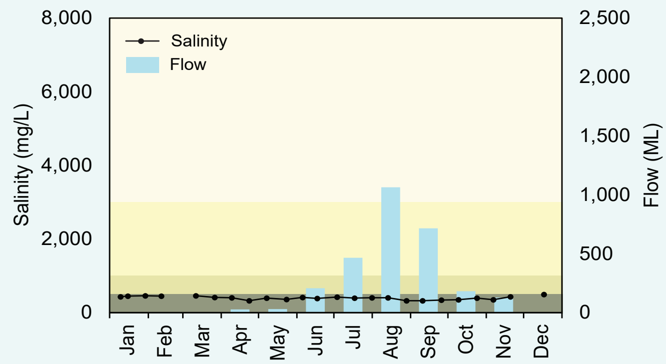


Salinity concentrations, 2005–19 at site 603136. The shading refers to the Water Resources Inventory 2014 salinity ranges.

fresh marginal brackish saline



2019 salinity concentrations and monthly flow at 603021. The shading refers to the Water Resources Inventory 2014 salinity ranges.



2019 salinity concentrations and monthly flow at 603136. The shading refers to the Water Resources Inventory 2014 salinity ranges.

Denmark 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 manangement 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.

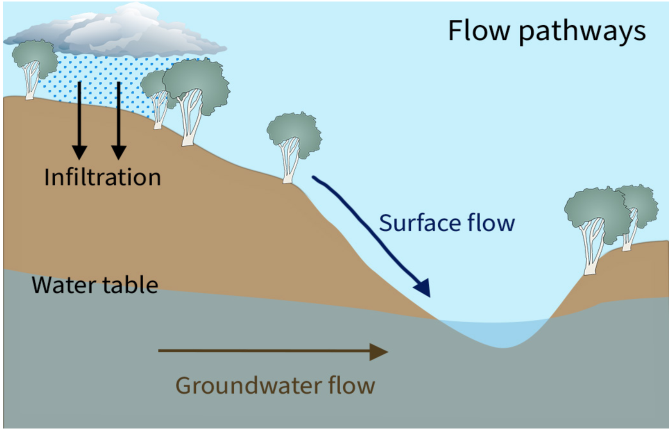
Laboratory limit of reporting: (LOR) this is the lowest concentration of an analyte that can be reported by a laboratory.

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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