Dirk Brook–Punrak Drain

This data report provides a summary of the nutrients at the Punrak Drain sampling site in 2018 as well as historical data from 2004–18. This report was produced as part of the Regional Estuaries Initiative. Downstream of this site the drain enters Lake Amarillo, before flowing into the Serpentine River and, from there, into the Peel 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 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

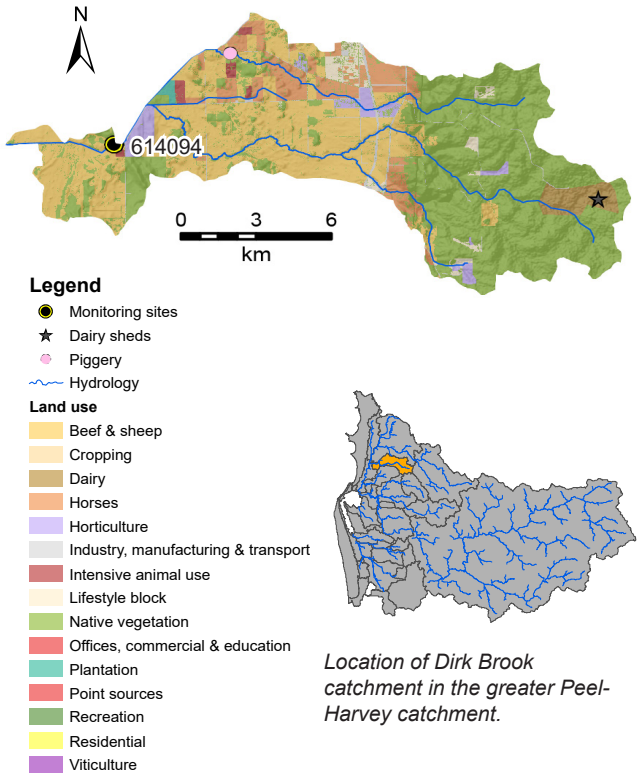
The Dirk Brook–Punrak Drain catchment has a total area of about 140 km^2 while the area upstream of the sampling site is about 125 km^2. There are two main waterways in the catchment, Karnet Brook and Dirk Brook, which combine to become Punrak Drain. While much of the brooks retain their natural form, there are many straight, man-made drains present and Punrak Drain itself is a highly modified, straight drain. Fringing vegetation is missing or highly modified along much of the waterways, particularly on the coastal plain.

The western portion of the catchment, which is on the coastal plain, has been extensively cleared for agriculture, predominantly beef and sheep grazing. This part of the catchment has soils with a low capacity to bind phosphorus, which is often so poor that any phosphorus applied to them can be quickly washed into drains and other waterways. A piggery and a dairy shed are also present in the catchment.

Water quality is sampled at site 614094, Yangedi Swamp, on Punrak Drain. This site is about 600 m downstream of the Punrak Road Bridge in Keysbrook.

Results summary

Nutrient concentrations (total nitrogen and total phosphorus) at the Punrak Drain sampling site were very high. The nutrient loads were moderate compared with the other monitored catchments, as were the loads per square kilometre. It is likely that the shallow groundwater close to the monitoring site had high nutrient concentrations and was one of the main drivers of the high nutrient concentrations recorded at this site as concentrations were highest in the drier, first half of the year.



Location of Dirk Brook catchment in the greater Peel-Harvey catchment.

Facts and figures

Sampling site code	614094
Catchment area	140 km^2
Per cent cleared area (2015)	51 per cent
River flow	Permanent
Annual flow (2018)	16.5 GL
Main land use (2015)	Native vegetation and beef and sheep grazing

Dirk Brook–Punrak Drain

Nitrogen over time (2004–18)

Concentrations

Total nitrogen (TN) concentrations fluctuated over the reporting period. Concentrations were high, with more than three-quarters of the samples collected over the Australian and New Zealand Environment and Conservation Council (ANZECC) trigger value for lowland rivers each year.

In 2018, the Punrak Drain sampling site had the fourth highest median of the 13 sites in the Peel-Harvey catchment (2 mg/L), the same as Coolup South Main Drain.

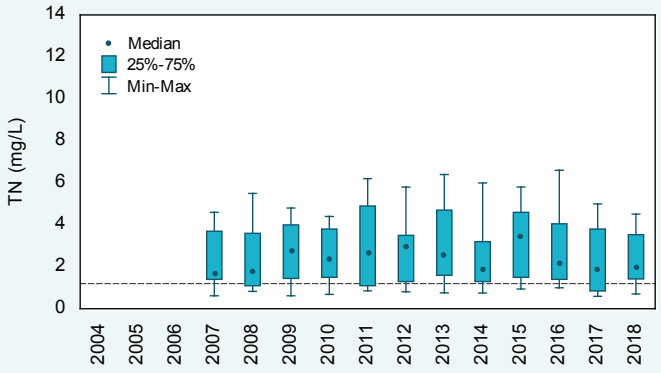
Trends

There was a short-term (2014–18) decreasing trend present in TN concentrations of 0.13 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 (2007–18) trend present.

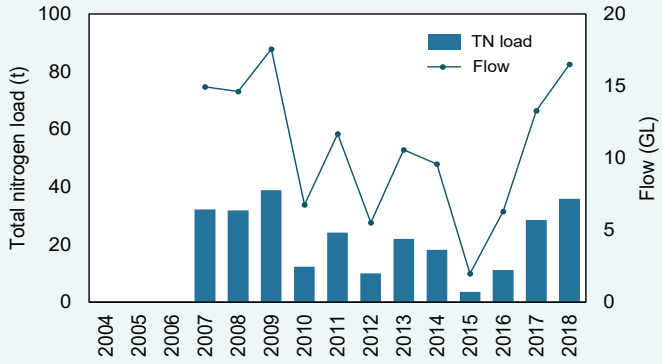
Estimated loads

Estimated TN loads at the Punrak Drain sampling site were moderate compared with the other sites in the Peel-Harvey catchment. In 2018, Punrak Drain had an estimated TN load of 36 t. The load per unit area was also moderate, at 289 kg/km^2. TN loads were closely related to flow volume, years with high annual flow having large TN loads and vice versa.

Punrak Drain



Total nitrogen concentrations, 2004–18 at site 614094. The dashed line is the ANZECC trigger value for lowland rivers.



Total nitrogen loads and annual flow, 2004–18 at site 614094.

Looking upstream during high flows at the Punrak Drain sampling site, August 2009.

Dirk Brook–Punrak Drain

Nitrogen (2018)

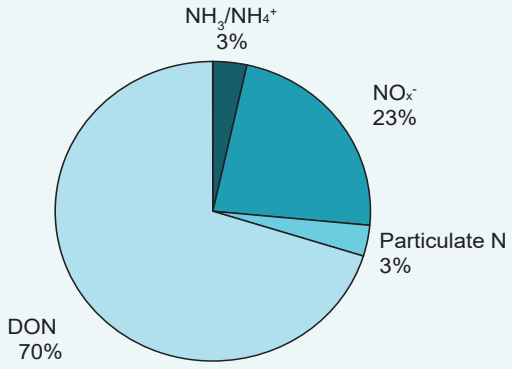
Types of nitrogen

Total N is made up of many different forms of N. Dissolved organic N (DON) was the dominant type at the Punrak Drain sampling site. This type of N consists of degrading plant and animal matter which needs to be further broken down before it becomes available to plants and algae, as well as more bioavailable forms. The percentage of N present as dissolved inorganic N (ammonia N, NH_3/NH_4^+ and oxides of N, NO_x^-) was high compared with the other Peel-Harvey catchment sites, with only the Drakes Brook Drain sampling site having a higher percentage (40 per cent). Likely sources of these kinds of N include fertilisers and animal wastes.

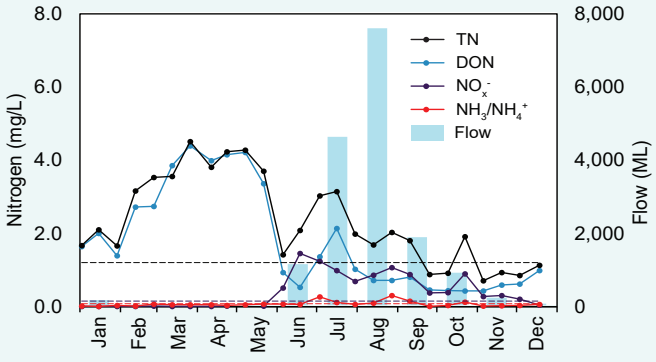
Concentrations

Total N and DON concentrations were highest in the early part of the year, when flow was at its lowest. Likely sources of DON at this time were shallow groundwater (which would be contributing most of the flow at this time of year) and possibly decaying plant matter in the drain (it sometimes gets choked with aquatic vegetation) and algal blooms. Evapoconcentration may be the main factor driving the change in DON concentrations at this time. NO_x^- concentrations showed a first-flush response, peaking in early June when N was being mobilised by heavy rainfall. Much of this N was probably the result of mineralisation of organic N in soils and drains over the summer period, and runoff of high concentration water from intensive land uses adjacent to the drain, which build up with fertiliser and animal waste over the summer. NO_x^- concentrations were well over the ANZECC trigger value from June to early December.

Punrak Drain



2018 average nitrogen fractions at site 614094.



2018 nitrogen concentrations and monthly flow at 614094. The dashed lines are the ANZECC trigger values for lowland rivers for the different N species.

Looking upstream during low flows at the Punrak Drain sampling site, March 2011.

Dirk Brook–Punrak Drain

Phosphorus over time (2004–18)

Concentrations

Total phosphorus (TP) concentrations at the Punrak Drain sampling site were high and fluctuated over the reporting period. The majority of the samples, and all the medians, were over the Peel-Harvey Water Quality Improvement Plan (WQIP) target. Why the range in TP concentrations was much larger in 2011 than other years is unclear.

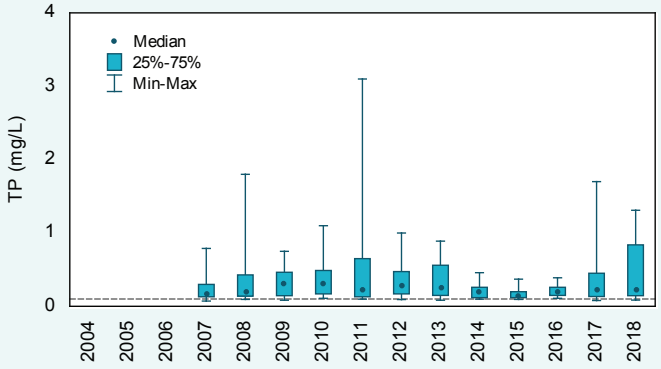
Trends

There was no trend in TP concentrations at Punrak Drain over either the short- (2014–18) or long-term (2006–18).

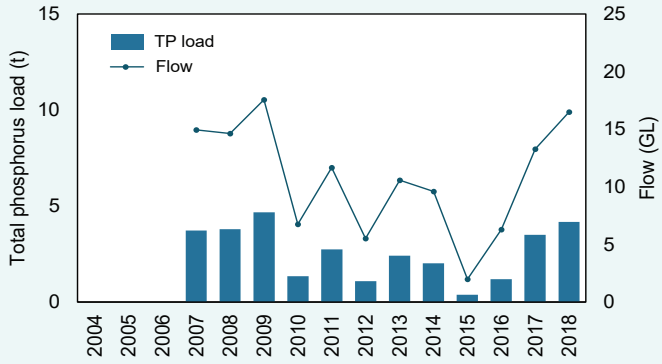
Estimated loads

Estimated TP loads at the Punrak Drain sampling site were moderate compared with the other sites in the Peel-Harvey catchment. In 2018, the site had an estimated TP load of 4.2 t. The load per unit area of 33.6 kg/km^2 was moderate compared with the other Peel-Harvey sites. TP loads were closely related to flow volume, years with high annual flow having large TP loads and vice versa.

Punrak Drain



Total phosphorus concentrations, 2004–18 at site 614094. The dashed line is the Peel-Harvey WQIP target for winter median TP concentrations.



Total phosphorus loads and annual flow, 2004–18 at site 614094.

High nutrient concentrations support plant growth. Here the drain is almost completely covered in vegetation, October 2010.

Dirk Brook–Punrak Drain

Phosphorus (2018)

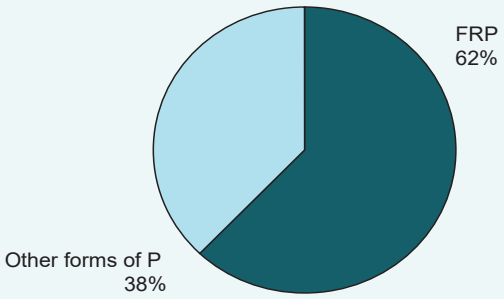
Types of phosphorus

Total P is made up of different types of P. The proportion of P present as filterable reactive P (FRP) was large, the third largest of the 13 sites in the Peel-Harvey catchment and similar to Peel Main Drain. This form of P is mainly sourced from animal waste and fertiliser and is readily available for algae to use to fuel growth. The remainder of the P was present as either particulate P or dissolved organic P (DOP). Particulate P generally needs to be broken down before becoming bioavailable to plants and algae. The bioavailability of DOP varies and is poorly understood.

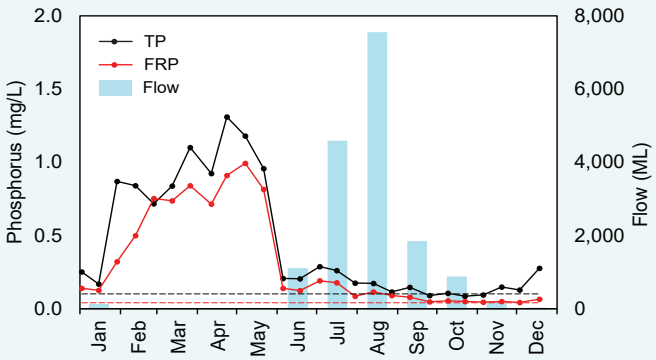
Concentrations

Total P and FRP concentrations were highest in the first part of the year, when the relative proportion of groundwater in the stream was largest and there was little or no surface flow. This suggests FRP was entering the drain via shallow groundwater and that concentrations in the groundwater were high. This was most likely because of a land use activity close to the measurement site, as FRP is typically rapidly used by algae in slow flowing waters. After the onset of winter rains, the concentrations of both TP and FRP fell quickly. This suggests the P rich groundwater was being diluted by surface flows which had lower P concentrations.

Punrak Drain



2018 average phosphorus fractions at site 614094.



2018 phosphorus concentrations and monthly flow at 614094. The dashed black line is the Peel-Harvey WQIP target, the red line is the ANZECC trigger values for lowland rivers.

Aerial view of a drainage water treatment trial site in Punrak Drain. Phosphorus binding clay is being added to the drain to remove phosphorus from the water, October 2017.

Dissolved organic carbon over time (2004–18)

Concentrations

There were only three years with sufficient data available to graph at the Punrak Drain sampling site. Using the Statewide River Water Quality Assessment (SWRWQA) bands, the annual medians for 2016–17 were very high and the 2018 median was high. Compared with the other sites sampled in the Peel-Harvey catchment, the annual range in DOC concentrations was large.

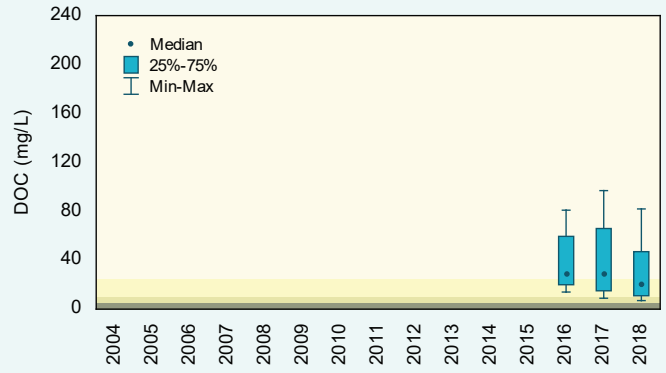
Trends

It was not possible to calculate trends in DOC concentrations at the Punrak Drain site as there were only three years of data present. A minimum of five years of data is required to test for trends.

Estimated loads

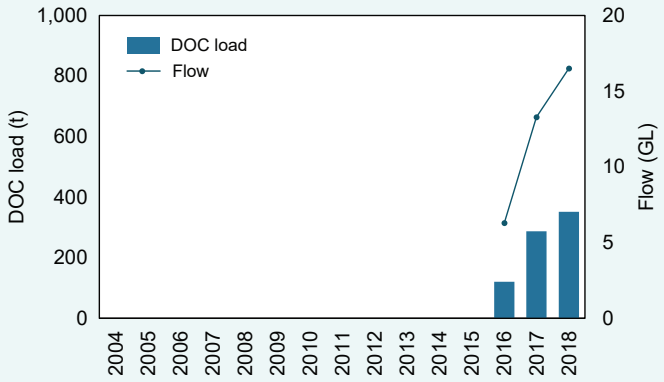
Estimated DOC loads at the Punrak Drain sampling site were moderate compared with the other sites in the Peel-Harvey catchment. In 2018, the estimated DOC load was 351 t. The load per unit area of 2,831 kg/km^2 was also moderate compared with the other Peel-Harvey catchment sites. DOC loads were closely related to flow volume, years with high annual flow having large DOC loads and vice versa.

Punrak Drain



Dissolved organic carbon concentrations, 2004–18 at site 614094. The shading refers to the SWRWQA classification bands.

very high high moderate low



Dissolved organic carbon loads and annual flow, 2004–18 at site 614094.

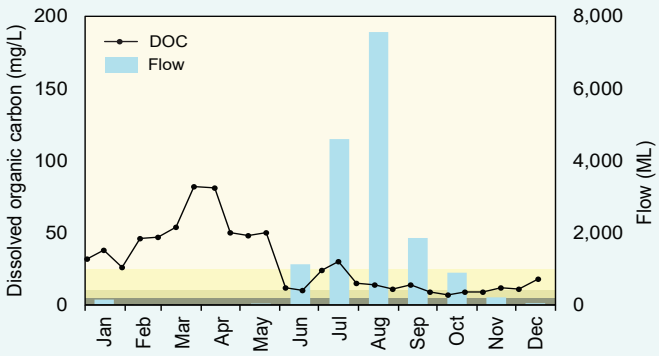
The Punrak Drain sampling site. Note the presence of almost entirely exotic species growing along the drain, December 2005.

Dissolved organic carbon (2018)

Concentrations

Dissolved organic C showed a similar seasonal pattern to N and P. Concentrations were higher in the first five months of the year, when flow was at its lowest. When rainfall and flow increased in June, DOC concentrations dropped, with the exception of a small peak in July. DOC is sourced mainly from degrading plant and animal matter, including natural organic matter in soils and wetlands, with many wetlands on deep sands typically generating high DOC concentrations. It varies widely in its bioavailability. At the Punrak Drain sampling site, DOC is likely coming from surface flow and groundwater as well as in-stream sources. The peak in the drier months suggest it may be entering the drain via groundwater. When surface flow increases, it dilutes the DOC present in the groundwater at this site.

Punrak Drain



2018 dissolved organic carbon concentrations and monthly flow at 614094. The shading refers to the SWRWQA classification bands.

very high high moderate low

An excavator removing excess plant growth from the drain close to the sampling site, May 2020.

Dirk Brook–Punrak Drain

Total suspended solids over time (2004–18)

Concentrations

While total suspended solids (TSS) concentrations fluctuated over the reporting period they were generally low compared with the other Peel-Harvey catchment sites. Using the SWRWQA classification bands, the medians were classified as low in all years except 2012–14 when they were moderate.

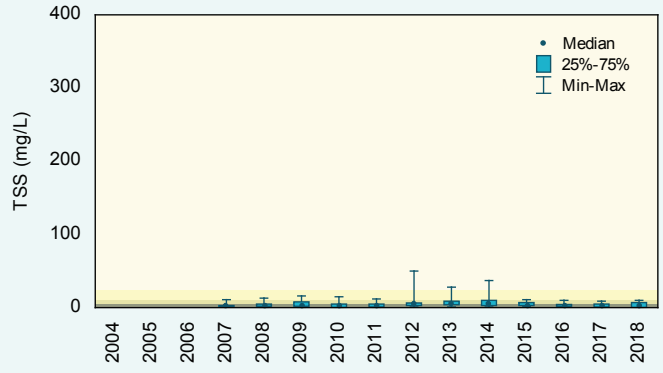
Trends

There was neither a short- (2014–18) or long-term (2007–18) trend in TSS concentrations at the Punrak Drain sampling site.

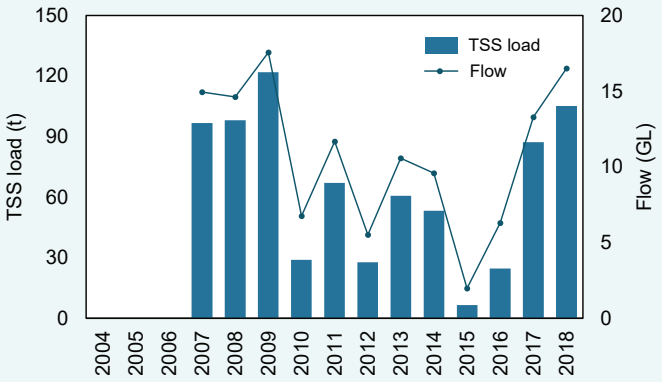
Estimated loads

Estimated TSS loads at the Punrak Drain sampling site were small to moderate compared with the other sites in the Peel-Harvey catchment. In 2018, the estimated TSS load at this site was 105 t. The load per unit area of 848 kg/km^2 was moderate compared with the other Peel-Harvey catchment sites. TSS loads were closely related to flow volume, years with high annual flow having large TSS loads and vice versa.

Punrak Drain



Total suspended solids concentrations, 2004–18 at site 614094. The shading refers to the SWRWQA classification bands.



Total suspended solids loads and annual flow, 2004–18 at site 614094.

very high high moderate low

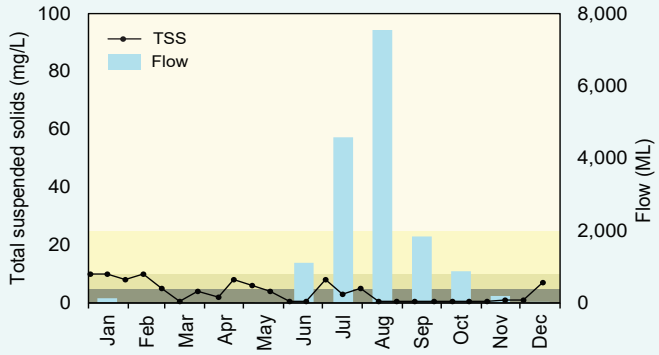
A Western Minnow, collected as part of a river health assessment carried out in the Punrak Drain, November 2017.

Total suspended solids (2018)

Concentrations

TSS concentrations fluctuated in 2018, though they were generally highest from about January to July, with a small peak in December. The higher TSS concentrations at these times is possibly because of a number of factors, including evapoconcentration and particles accumulating on in-stream vegetation which may be disturbed at the time of sampling. Most of the samples collected were classified as low, though there were some that were moderate early in the year.

Punrak Drain



2018 total suspended solids concentrations and monthly flow at 614094. The shading refers to the SWRWQA classification bands.

very high high moderate low

Freshwater mussels collected as part of a river health assessment carried out in the Punrak Drain, November 2017.

pH over time (2004–18)

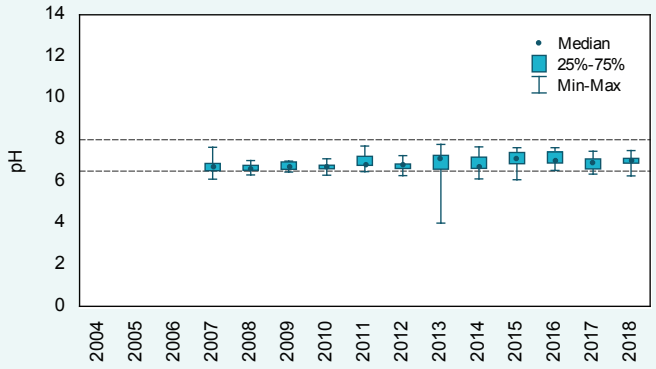
Levels
pH fluctuated over the reporting period. The annual median pH was between the upper and lower ANZECC trigger values, though many years had some samples which were below the lower ANZECC trigger value.

Trends
There was no trend in pH levels at the Punrak Drain site over either the short- (2014–18) or long-term (2007–18).

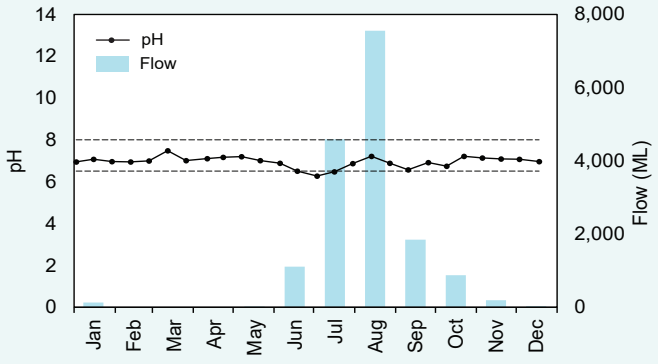
pH (2018)

Levels
There was no clear seasonal pattern in pH at the Punrak Drain sampling site in 2018. Levels fluctuated, and dipped below the lower ANZECC trigger value in early July on one sampling occasion. All other samples were between the upper and lower ANZECC trigger values.

Punrak Drain



pH levels, 2004–18 at site 614094. The dashed lines are the upper and lower ANZECC trigger values for lowland rivers.



2018 pH levels and monthly flow at 614094. The dashed lines are the upper and lower ANZECC trigger values for lowland rivers.

A sand deposit in Punrak Drain, downstream of the sampling site. Sand like this often comes from erosion along the drain and reduces the habitat available for aquatic animals, November 2017.

Dirk Brook–Punrak Drain

Salinity over time (2004–18)

Concentrations

Salinity fluctuated over the reporting period at Punrak Drain. Using the SWRWQA classification bands, annual medians ranged from fresh to brackish. All years had a wide range in salinity, also from fresh to brackish.

Trends

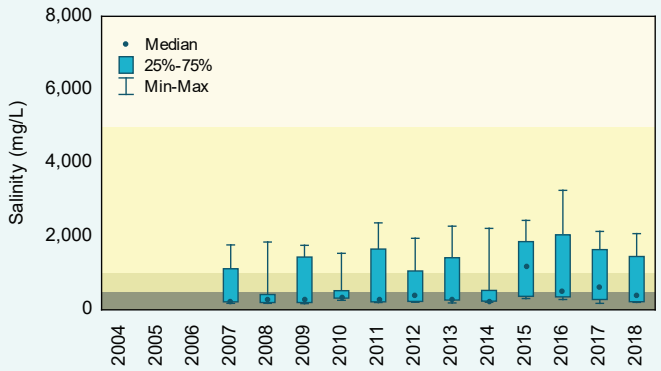
There was no trend in salinity at the Punrak Drain site over either the short- (2014–18) or long-term (2007–18).

Salinity (2018)

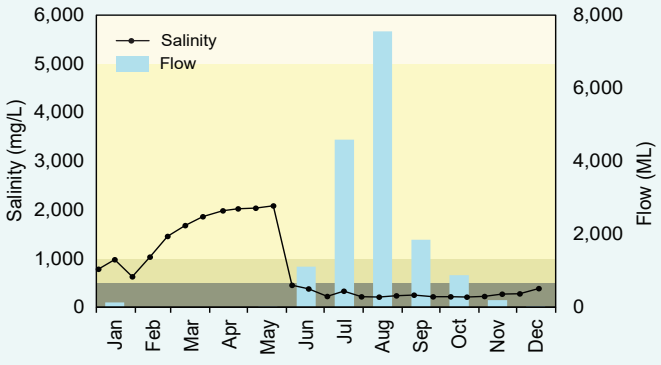
Concentrations

Salinity showed a similar pattern to TN, NO_x^-, TP and FRP in Punrak Drain. Concentrations were highest (marginal or brackish) at the start of the year when the relative proportion of groundwater was at its highest. After the onset of winter rains, when surface flow diluted the groundwater in the drain, salinity dropped rapidly and was then fresh for the remainder of the year. This suggests that the groundwater near this site is brackish as well as being high in nutrients and that salinity gradually concentrates with evaporation during summer-autumn. This also has a significant influence on the concentrations of nutrients at this site.

Punrak Drain



Salinity concentrations, 2004–18 at site 614094. The shading refers to the SWRWQA classification bands.



2018 salinity concentrations and monthly flow at site 614094. The shading refers to the SWRWQA classification bands.

saline brackish marginal fresh

The rock weir used for gauging at the Punrak Drain sampling site under construction, March 2006.

Dirk Brook–Punrak Drain

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 Peel-Harvey estuary at estuaries.dwer.wa.gov.au/estuary/peel-harvey-estuary/

The Regional Estuaries Initiative partners with the Peel-Harvey Catchment Council to fund best-practice fertilisers, 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 Peel-Harvey Catchment Council go to peel-harvey.org.au
- To find out more about the health of the rivers in the Peel-Harvey Catchment go to rivers.dwer.wa.gov.au/assessments/results

Methods

Total phosphorus concentrations were compared with the Peel-Harvey WQIP target. This target represents the median winter concentration that is required for each of the subcatchments to meet their load reduction target. Where possible, other 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 DOC, 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.

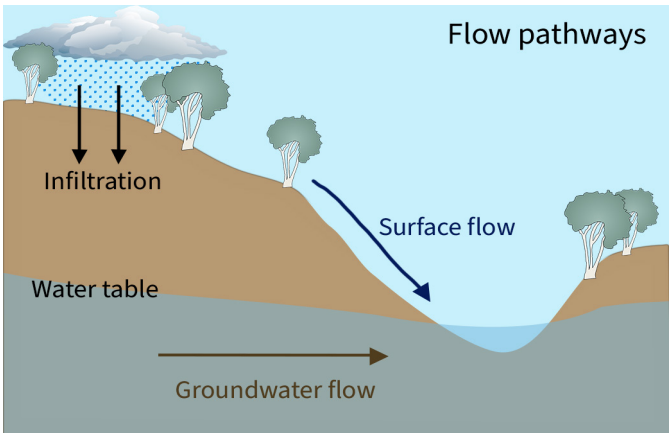
Evapoconcentration: the increase in concentration of a substance dissolved in water because of water being lost by evaporation.

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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