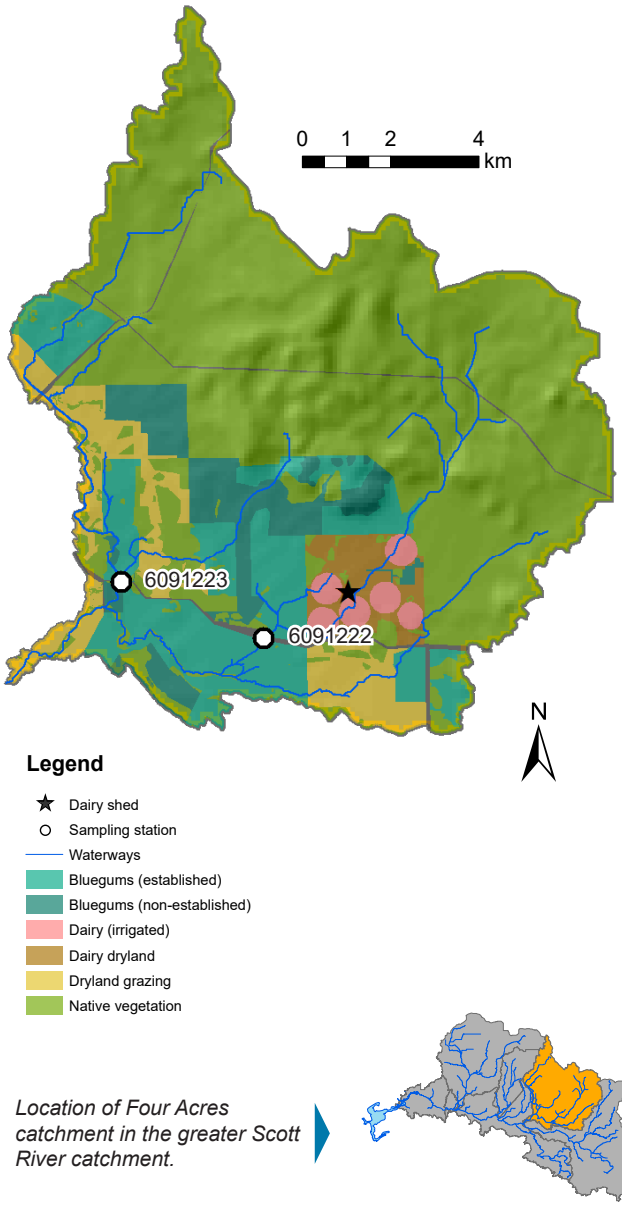
Four Acres

This data report provides a summary of the nutrients at the two Four Acres 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 these sites, the stream enters the Scott River and subsequently the Hardy 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

Four Acres has a catchment area of about 130 km^2, nearly two-thirds of which is covered in native vegetation. Other main land uses include bluegum plantations and dryland grazing. There are also areas of irrigated and dryland dairy present and a dairy shed. In some areas, drains have been constructed to help reduce waterlogging, which increases the speed that water leaves the catchment and enters the waterways. In the agricultural areas, much of the fringing vegetation has been lost along the waterways.

There are two sites monitored in the Four Acres catchment, on two different waterways. Site 6091223, Electric Fence – 4 Acres is downstream of where the stream passes under Four Acres Road. Upstream of this site are bluegum plantations and dryland beef grazing and then extensive areas of native vegetation. The second site, 6091222, S Bend, is on a different stream, just downstream of where it passes under Four Acres Road. Immediately upstream of this site are bluegum plantations then dryland and irrigated dairy as well as a dairy shed.



Location of Four Acres catchment in the greater Scott River catchment.

Results summary

Nutrient concentrations (total nitrogen and total phosphorus) at the two sites in the Four Acres catchment were very high, especially so at S Bend where concentrations of nitrogen and phosphorus were extremely high. The proportion of nitrogen present as ammonia nitrogen at S Bend was extremely high, suggesting that effluent from the upstream dairy shed is entering the waterway. The lack of fringing vegetation and the construction of drains to reduce surface water ponding means nutrients can be washed from soils to waterways and be transported downstream quickly rather than being assimilated.

Facts and figures

Sampling site code	6091223 (Electric Fence – 4 Acres) 6091222 (S Bend)
Rainfall at Brennans Ford (2018)	850 mm
Catchment area	130 km^2
Per cent cleared area (2009)	35 per cent
River flow	Ephemeral
Main land use (2009)	Native vegetation, bluegum plantations and dryland grazing

Nitrogen over time (2004–18)

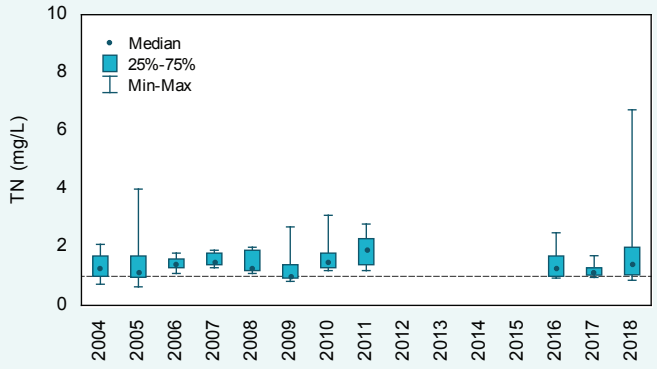
Concentrations

Total nitrogen (TN) concentrations were high at Electric Fence – 4 Acres and very high at S Bend (note the different scale on the vertical axes of the graphs). At both sites TN has fluctuated over time, with concentrations much higher after the break in monitoring at S Bend. The median TN concentration has been at, or over, the water quality improvement plan (WQIP) target every year at both sites. The 2018 median TN concentration at S Bend was substantially higher than the medians of the other eight sites sampled in the Scott River catchment (S Bend had a 2018 median of 8.83 mg/L and Woodhouse had the next highest median, of 2.67 mg/L).

Trends

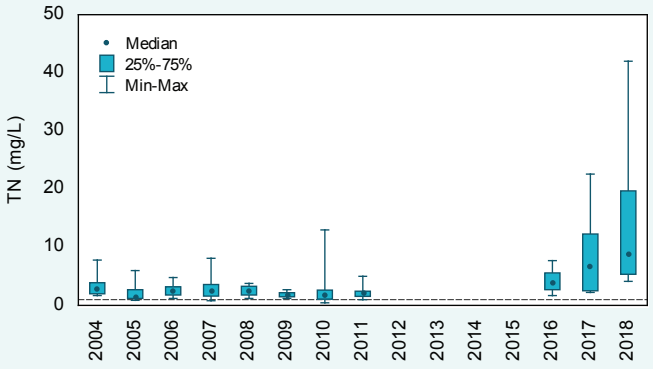
Because of the gap in monitoring between 2012 and 2015, it was not possible to test for trends at either site as a minimum of five years of data are required. It is clear from the graphs, however, that concentrations at S Bend are higher after the break in monitoring and increased between 2016 and 2018.

Electric Fence – 4 Acres



Total nitrogen concentrations, 2004–18 at site 6091223. The dashed line is the Scott River WQIP target for median TN concentrations.

S Bend



Total nitrogen concentrations, 2004–18 at site 6091222. The dashed line is the Scott River WQIP target for median TN concentrations.

The Electric Fence – 4 Acres sampling site in October. Note the lack of fringing vegetation.

Nitrogen (2018)

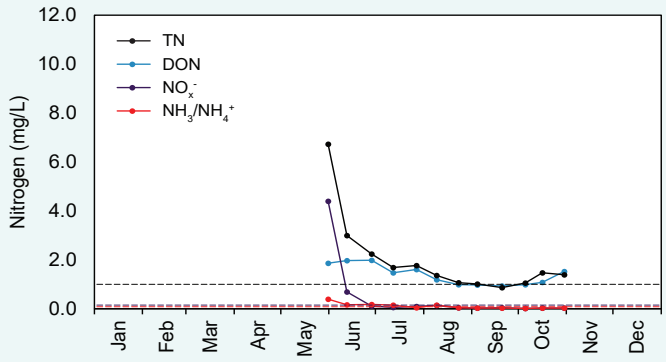
Concentrations

N concentrations at Electric Fence – 4 Acres showed evidence of a reverse seasonal pattern. That is, concentrations were highest at the beginning and end of the flow season. The peak in TN, oxides of nitrogen (NO_x^-), and, to a lesser extent, ammonia N (NH_3/NH_4^+) in May are likely because of the first-flush where N was mobilised following 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 waters from irrigated pasture which builds up with fertiliser and animal waste over the summer. At S Bend, a reverse seasonal pattern was also evident. It is likely the large peaks in TN and NH_3/NH_4^+ later in the year were because of dairy effluent entering the waterway. While this entered the waterway year round, it was diluted during the winter months when there was more water in the stream from other sources. The concentrations seen at S Bend are extremely high, and much higher than occurs in streams in the south-west of Western Australia.

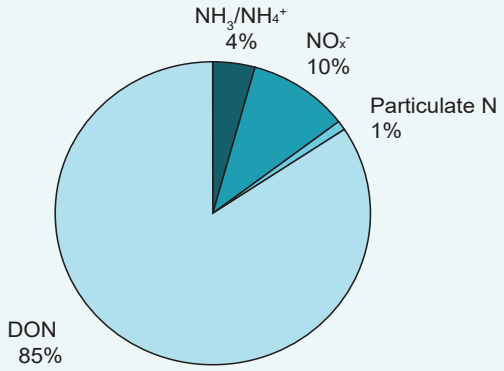
Types of nitrogen

Total N is made up of many different types of N. The relative proportions of N at the two sites in the Four Acres catchment were very different. The proportions present at Electric Fence – 4 Acres were similar to other waterways that have agricultural land use but no specific point sources of N. At S Bend, the proportion of NH_3/NH_4^+ was the highest of all the sites sampled in the Scott River catchment (66 per cent, the next highest proportion was present at Coonack Downs which had 42 per cent). This form of N is bioavailable to plants and algae and is used to fuel rapid growth. It is likely that this form of N was coming from the dairy farm upstream as it is found in high concentrations in animal waste. This site also had very low dissolved oxygen concentrations which is most likely because of the presence of dairy effluent entering the waterway. The proportions of N at this site are typical of sites where there is a point source present not far upstream.

Electric Fence – 4 Acres

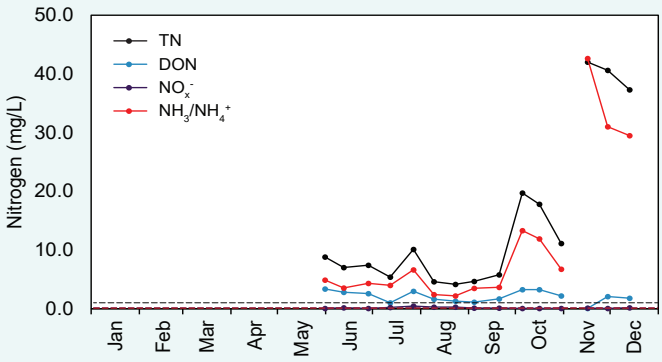


2018 nitrogen concentrations at 6091223. The black dashed line is the Scott River WQIP target for TN, the red and purple lines are the ANZECC trigger values for lowland rivers for NH_3/NH_4^+ and NO_x^-.

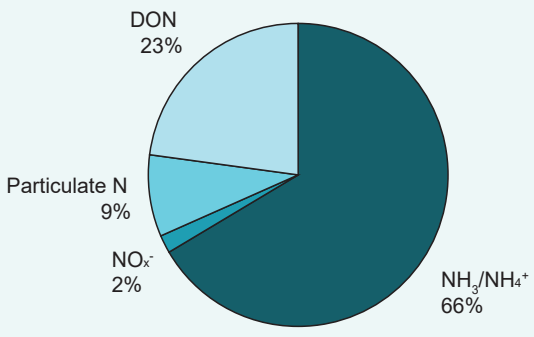


2018 average nitrogen fractions at site 6091223.

S Bend



2018 nitrogen concentrations at 6091222. The black dashed line is the Scott River WQIP target for TN the red and purple lines are the ANZECC trigger values for lowland rivers for NH_3/NH_4^+ and NO_x^-.



2018 average nitrogen fractions at site 6091222.

Phosphorus over time (2004–18)

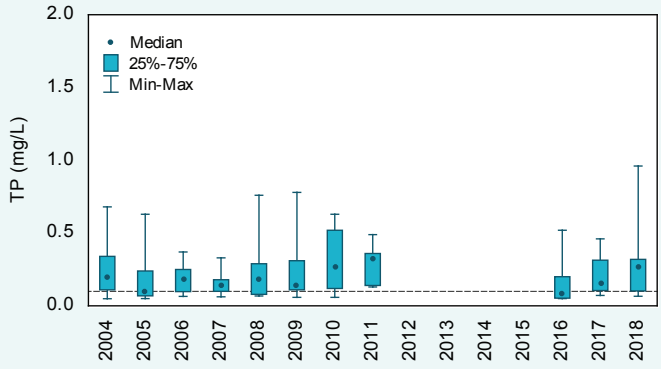
Concentrations

While TP concentrations were high at Electric Fence – 4 Acres, they were much higher again at S Bend (note that the vertical axes on the two graphs below are different). TP concentrations at both sites fluctuated over the past 15 years. At Electric Fence – 4 Acres, there were two years (2005 and 2016) where the median TP concentration was below the WQIP target and concentrations after the break in monitoring appear similar to before. At S Bend, there were only two years (2007 and 2010) when any of the samples were below the target and the median was consistently at least three times, and as much as 25 times, the target. TP concentrations at S Bend were also much higher after the break in monitoring.

Trends

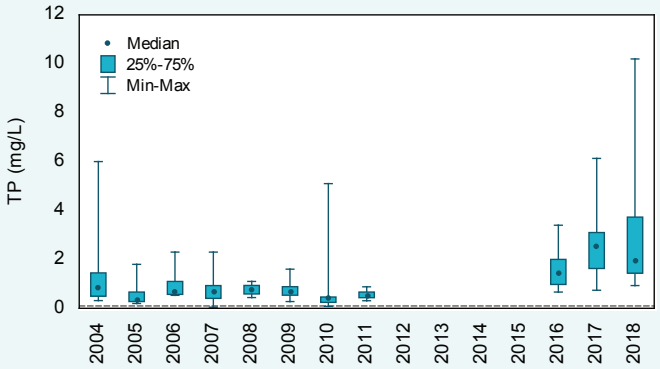
Because of the gap in monitoring between 2012 and 2015, it was not possible to test for trends at either site as a minimum of five years of data are required. It is clear from the graphs, however, that concentrations at S Bend are higher after the break in monitoring and increased between 2016 and 2018.

Electric Fence – 4 Acres



Total phosphorus concentrations, 2004–18 at site 6091223. The dashed line is the Scott River WQIP target for median TP concentrations.

S Bend



Total phosphorus concentrations, 2004–18 at site 6091222. The dashed line is the Scott River WQIP target for median TP concentrations.

The S Bend sampling site in August.

Phosphorus (2018)

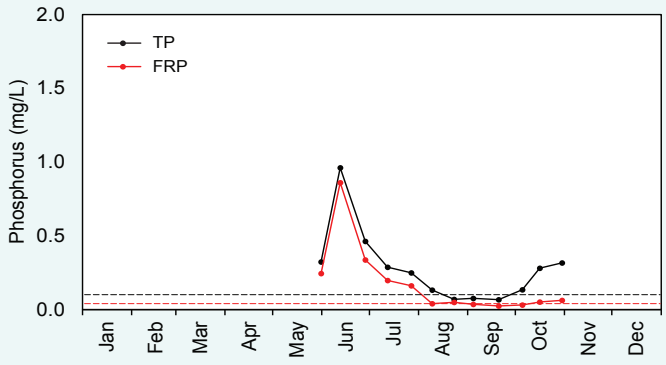
Concentrations

At both sites, TP and filterable reactive phosphorus (FRP) concentrations showed a slight reverse seasonal pattern, with higher concentrations at the beginning and end of the flow year. At Electric Fence – 4 Acres, the June peak was possibly because of a first-flush effect where rainfall washed P into the stream as well as mobilising any already present in the dry stream. During most of August and September, TP was below the WQIP target and FRP below the Australian and New Zealand Environment and Conservation Council (ANZECC) trigger value. At S Bend, all samples collected were well above their target and trigger values. Dairy effluent and irrigation returns were likely contributing to the extremely high concentrations at this site year-round. However, during the wetter months, when flow was higher, concentrations were lower because of dilution by the water already present in the stream. The extremely high concentrations at the end of the year were likely because of the relatively large proportion of dairy effluent and irrigation returns in the stream.

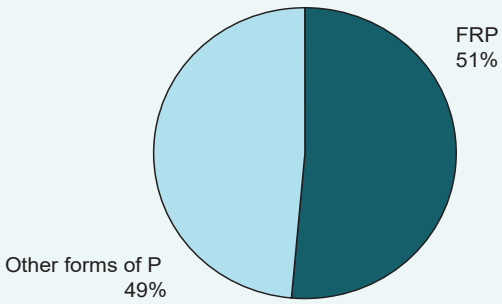
Types of phosphorus

Total P is made up of different types of P. The proportion of P present as FRP was high at both sites (greater than 50 per cent) and were the two highest of the Scott River sampling sites. The relatively large proportion of P present as the bioavailable FRP type is likely because of the presence of dairy effluent and irrigation returns in the streams. S Bend also had high TSS concentrations, which may explain why the proportion of FRP at this site was not even higher; FRP tends to bind to suspended sediments in the watercolumn so, if TSS concentrations were lower, then the proportion of P present as FRP at S Bend would likely have been higher. The remainder of the P was present as particulate P and dissolved organic P (DOP). Particulate P generally needs to be broken down before becoming bioavailable to algae. The bioavailability of DOP varies and is poorly understood.

Electric Fence – 4 Acres

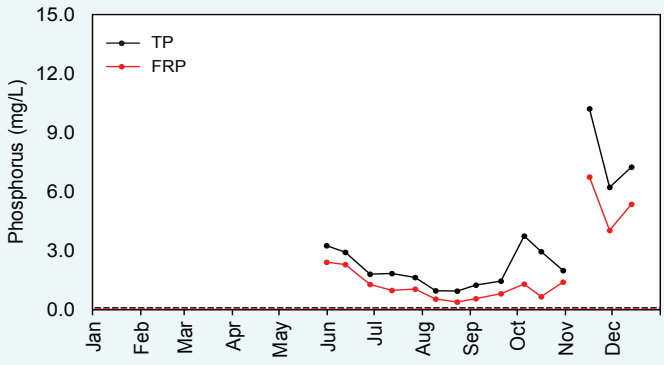


2018 phosphorus concentrations at 6091223. The black dashed line is the Scott River WQIP target for TP, the red is the ANZECC trigger value for lowland rivers for FRP.

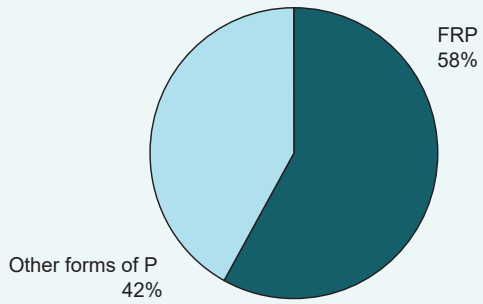


2018 average phosphorus fractions at site 6091223.

S Bend



2018 phosphorus concentrations at 6091222. The black dashed line is the Scott River WQIP target for TP, the red is the ANZECC trigger value for lowland rivers for FRP.



2018 average phosphorus fractions at site 6091222.

Total suspended solids over time (2004–18)

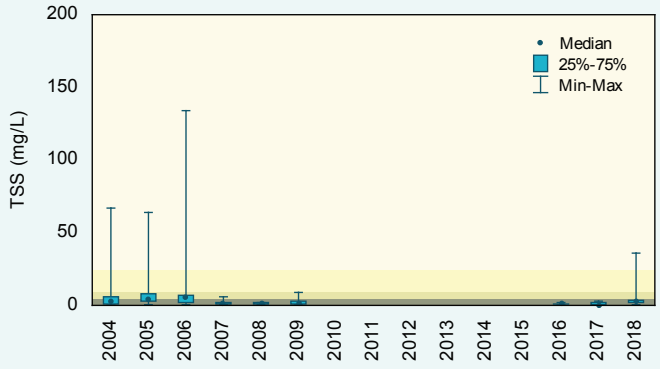
Concentrations

Total suspended solids (TSS) concentrations were moderate at Electric Fence – 4 Acres and high at S Bend compared with the other Scott River sampling sites. Annual median TSS concentrations were classified as low using the Statewide River Water Quality Assessment (SWRWQA) classification bands at Electric Fence – 4 Acres every year except 2006 when they were moderate. At S Bend, the median TSS concentration was classified as high for five years, with the other years being moderate except for 2009 when it was low. TSS concentrations at both sites have fluctuated over the reporting period. At S Bend, 2018 appeared to have higher TSS concentrations than previous years.

Trends

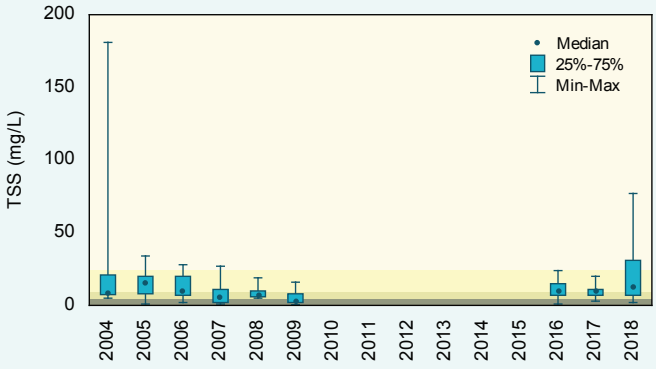
Because of the gap in monitoring between 2010 and 2015, it was not possible to test for trends at either site as a minimum of five years of data are required.

Electric Fence – 4 Acres



Total suspended solids concentrations, 2004–18 at site 6091223. The shading refers to the SWRWQA classification bands.

S Bend



Total suspended solids concentrations, 2004–18 at site 6091222. The shading refers to the SWRWQA classification bands.

very high high moderate low

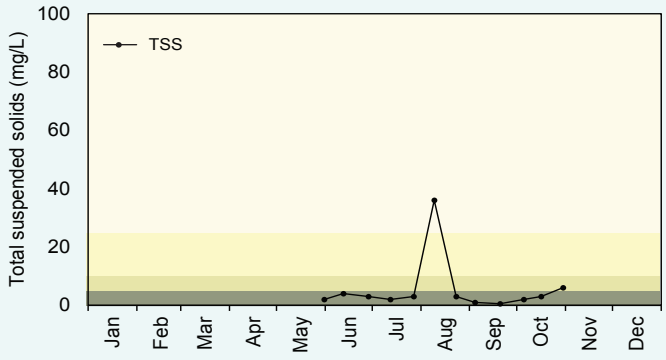
The extremely high nutrient levels found at the S Bend sampling site encourage prolific growth of the exotic vegetation lining the waterway as well as floating macrophytes such as the duckweed or lemna seen in this photograph.

Total suspended solids (2018)

Concentrations

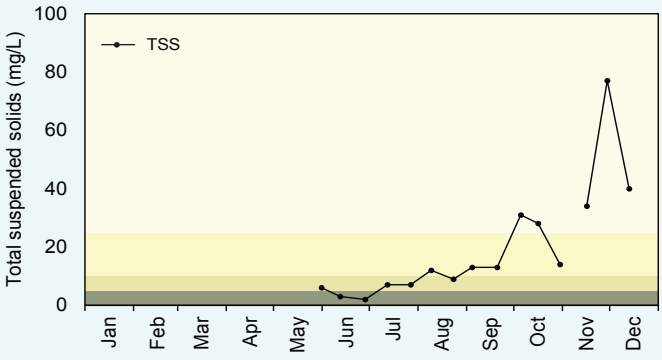
At Electric Fence – 4 Acres, TSS was classified as low throughout most of the year, with the exception of the peak in August and the sample collected at the end of October. It is difficult to determine the reason for the peak in August; perhaps there had been some disturbance upstream of the sampling site not long before the sample was taken. At S Bend, TSS concentrations appeared to get worse during the year, with early samples classified as moderate or low and later samples high or very high. It is likely most of the particulates at this site were entering the stream from dairy effluent.

Electric Fence – 4 Acres



2018 total suspended solids concentrations at 6091223. The shading refers to the SWRWQA classification bands.

S Bend



2018 total suspended solids concentrations at 6091222. The shading refers to the SWRWQA classification bands.

very high high moderate low

Looking upstream at the S Bend sampling site in October.

pH over time (2004–18)

pH values

pH at both sites fluctuated in a similar pattern over the past 15 years, though the variation was greater at S Bend than Electric Fence – 4 Acres. At both sites, the median pH was below the lower ANZECC trigger value on a number of years, though this was more frequent at S Bend (where the medians were often lower too).

Trends

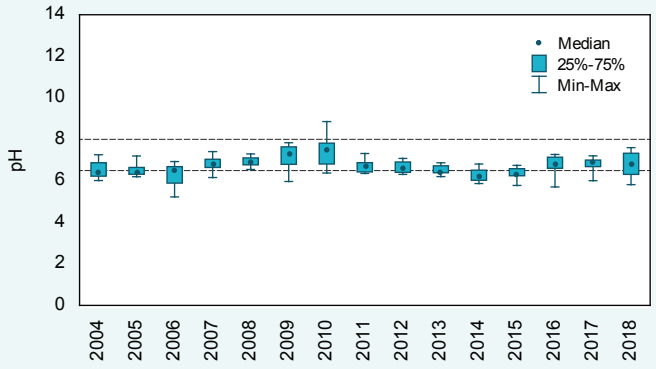
Both sites recorded a small short-term increasing trend over the 2014–18 monitoring period. At Electric Fence – 4 Acres the trend was 0.1 pH units per year and at S Bend it was 0.2 pH units per year. Given that pH levels fluctuated over the past 15 years at both sites it is likely these trends represent the background fluctuations in pH levels rather than an actual long-term change in pH. Ongoing monitoring of pH at these sites will help determine whether there has been an actual change in pH.

pH (2018)

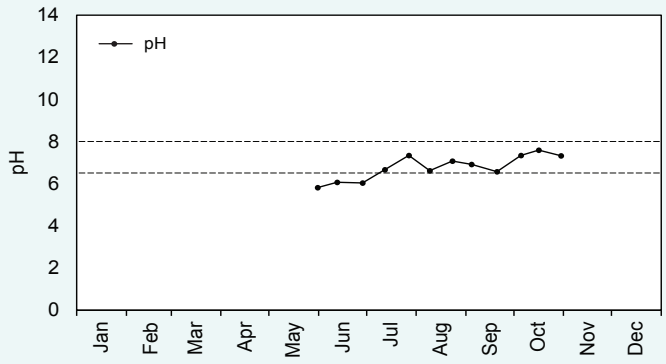
pH values

At Electric Fence – 4 Acres, pH slowly increased during the year, being below the lower ANZECC trigger value for the first three sampling occasions, before climbing to between the upper and lower ANZECC trigger values for the remainder of the year. At S Bend, this slow increase during the year was not as evident. Here, there were values below the lower ANZECC trigger value as late as September before pH slowly increased to between the lower and upper ANZECC trigger values.

Electric Fence – 4 Acres

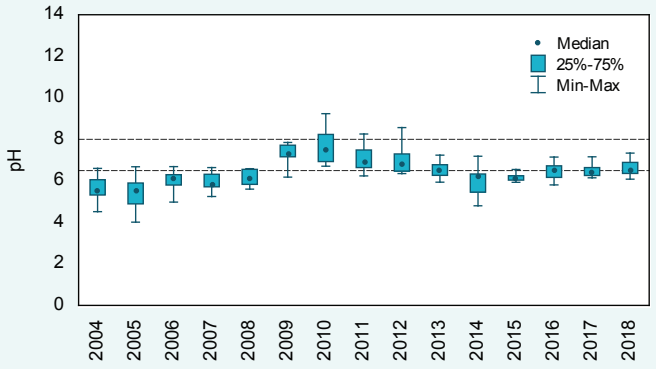


pH levels, 2004–18 at site 6091223. The dashed lines are the upper and lower ANZECC trigger values for lowland rivers.

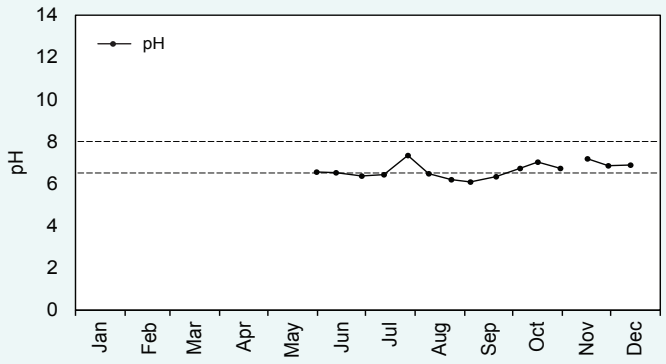


2018 pH levels at 6091223. The dashed lines are the upper and lower ANZECC trigger values for lowland rivers.

S Bend



pH levels, 2004–18 at site 6091222. The dashed lines are the upper and lower ANZECC trigger values for lowland rivers.



2018 pH levels at 6091222. The dashed lines are the upper and lower ANZECC trigger values for lowland rivers.

Four Acres

Salinity over time (2004–18)

Concentrations

Salinity at both sites fluctuated slightly over the past 15 years. Median salinities were classified as fresh using the SWRWQA classification bands at both sites for all years.

Trends

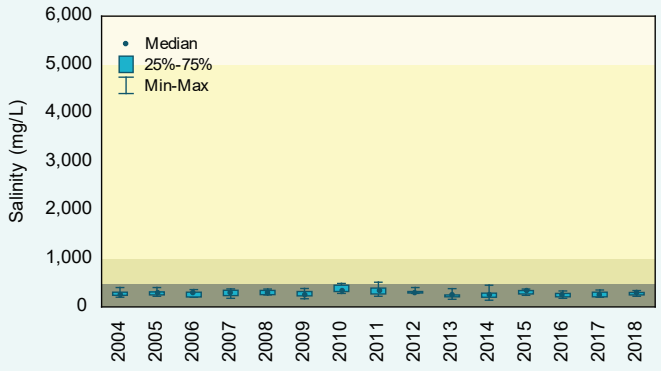
At Electric Fence – 4 Acres, there was neither a short- (2014–18) or long-term (2009–18) trend. S Bend had a long-term (2009–18) increasing trend of 8 mg/L per year and a short-term (2014–18) increasing trend of 10 mg/L/yr. If salinity continues to increase at these sites it may have negative impacts on the vegetation and biota. Salinity does not present as urgent an issue as the nutrient concentrations at these sites.

Salinity (2018)

Concentrations

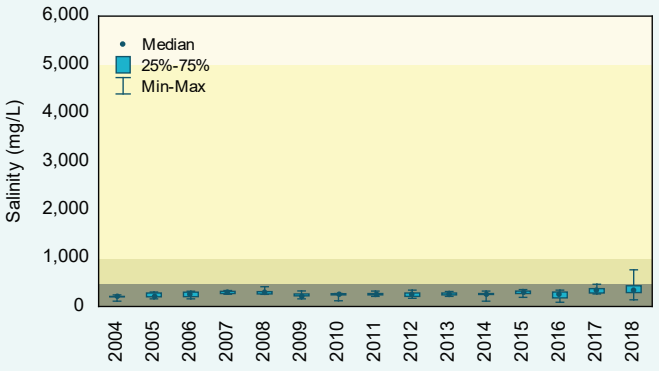
In 2018, all samples collected at Electric Fence – 4 Acres were classified as fresh. There was little change in salinity over the year at this site. Most of the samples at S Bend were also classified as fresh, with the exception of two samples collected in November which were marginal. It is likely when the stream was sampled at this time, most of the water present was from dairy effluent entering the stream not far above the sampling site. This water appears to be slightly more saline than the water that is otherwise present in the stream.

Electric Fence – 4 Acres

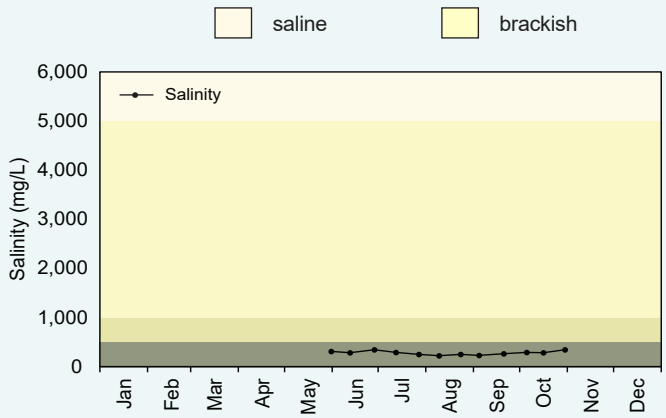


Salinity concentrations, 2004–18 at site 6091223. The shading refers to the SWRWQA classification bands.

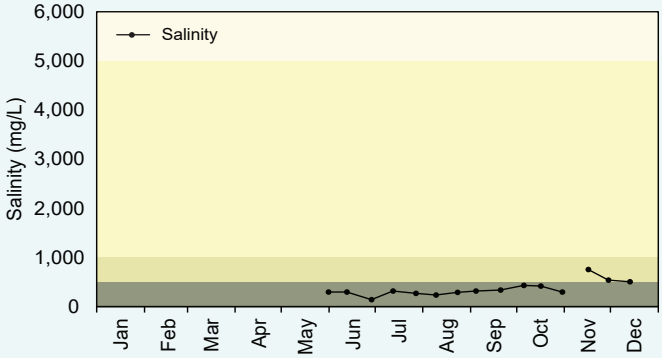
S Bend



Salinity concentrations, 2004–18 at site 6091222. The shading refers to the SWRWQA classification bands.



2018 salinity concentrations at 6091223. The shading refers to the SWRWQA classification bands.



2018 salinity concentrations at 6091222. The shading refers to the SWRWQA classification bands.

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 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 Hardy Inlet at estuaries.dwer.wa.gov.au/estuary/hardy-inlet/

The Regional Estuaries Initiative partners with the Lower Blackwood Land Conservation District Committee (Lower Blackwood LCDC) 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 Lower Blackwood LCDC go to lowerblackwood.com.au
- To find out more about the health of the rivers in the Hardy Inlet catchment go to rivers.dwer.wa.gov.au/assessments/results

Methods

Total nitrogen and TP concentrations were compared with the Scott River WQIP targets. These targets represent the historical median winter concentration where lyngbya blooms were not observed in the upper Hardy Inlet. They were developed for use at Brennans Ford but have been used at all Scott River sites to allow for comparisons between sites. 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 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 concentrations 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.

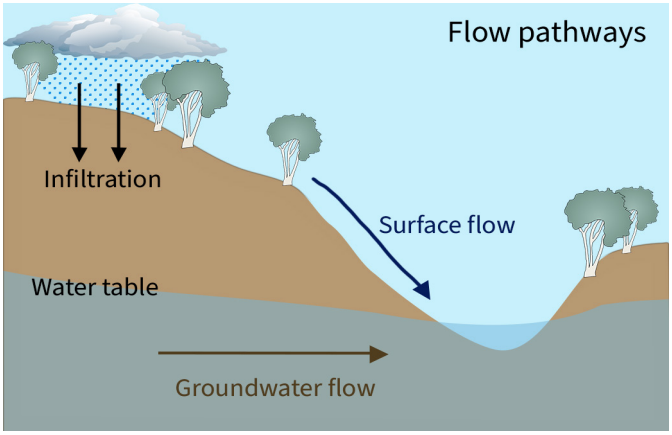
Evapoconcentration: the increase in concentration of a substance dissolved in water because of water being lost by evaporation.

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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