Upper Serpentine River

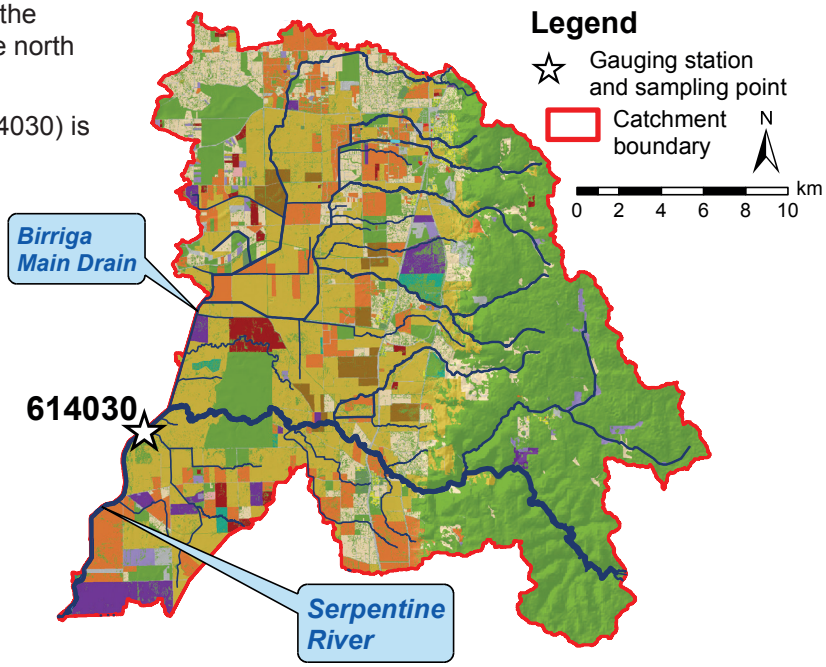
The Upper Serpentine catchment comprises land between Lake Amarillo and the Serpentine Dam draining to the Serpentine River. The Birriga Main Drain drains the north of the catchment.

The Serpentine River sampling site at Dog Hill (614030) is one of three long-term monitoring sites within the Peel-Harvey catchment. Flow has been measured since 1979 and nutrients monitored from 1983.

Historically, the Serpentine River flowed year-round at Dog Hill but, in February 1980 it stopped flowing for four days. In March 1988 it stopped for one day and between 2002 and 2011 flow regularly stopped during the summer or autumn with the exeption of 2009. From 2012 the river returned to flowing year-round.

A mixture of soil types is found within the catchment and only a small area is subject to flooding (5%). More than half the catchment has a low or very low risk of phosphorus leaching to the waterways (62%).

To the east of the Darling Scarp the catchment remains relatively undisturbed. West of the scarp the land has been cleared, mostly for agriculture (e.g. stock grazing) and lifestyle blocks. More intensive land uses such as sheep feedlots, poultry farms and piggeries are also present.



Land use classification (2006)[1]	Area (km²)	Area (%)
Animal keeping – non-farming (horses)	47	9.3
Cattle for beef (predominantly)	120	24
Cattle for dairy	8.6	1.7
Conservation and natural	235	47
Horticulture	5.2	1.0
Industry, manufacturing and transport	17	3.4
Intensive animal use	6.6	1.3
Lifestyle block	43	8.6
Mixed grazing	13	2.5
Offices, commercial and education	0.34	0.07
Plantation	2.5	0.50
Recreation	1.4	0.28
Residential	2.1	0.42
Viticulture	0.36	0.07
Total	**502**	**100**

Serpentine River at Dog Hill – August 2001

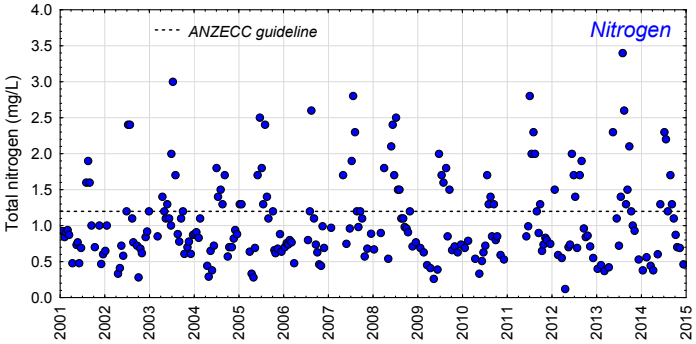
Nutrient summary: median concentrations, loads and status classification at 614030

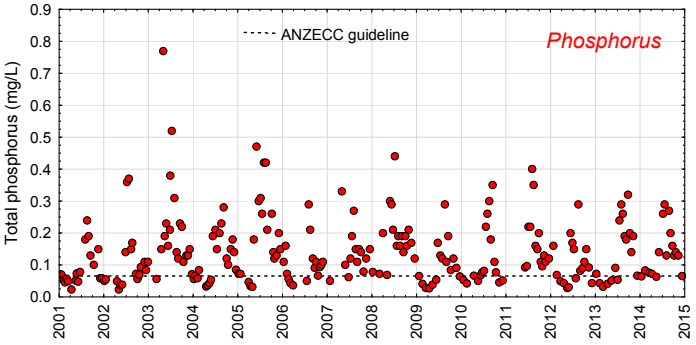
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Annual flow (GL)	17	31	59	34	63	9.7	35	49	51	7.7	46	16	38	28
TN median (mg/L)	0.91	0.75	1.1	0.86	1.2	0.75	1.0	1.1	0.70	0.76	0.95	0.84	1.1	0.79
TP median (mg/L)	0.07	0.08	0.19	0.11	0.20	0.10	0.13	0.18	0.09	0.08	0.14	0.09	0.14	0.13
TN load (t/yr)	26	51	110	59	111	14	63	88	93	10	83	21	70	47
TP load (t/yr)	3.8	7.8	18	9.0	19	2.0	9.4	16	15	1.4	14	2.9	11	7.0

Status classification[2] Low Moderate High Very high

Status reported for three-year period end (i.e. 2012–14 reported in 2014)
TN = total nitrogen TP = total phosphorus

Total nitrogen (TN) and total phosphorus (TP) concentrations (2001–14) at 614030





TN concentration:

The annual percentage of TN samples that exceeded the ANZECC[3] guideline for lowland rivers (1.2 mg/L) ranged between 6% (2006) and 42% (2005).

Between 2005 and 2009, 30% of samples exceeded the guideline. This value increased slightly to 34% for the period between 2010 and 2014.

TN trend:

Trend analysis[2] used data from 2010 to 2014 inclusive.

Once the data were adjusted for flow no trend was detected.

Winter flow at Dog Hill – August 2001

TP concentration:

The annual percentage of TP samples that exceeded the ANZECC[3] guideline for lowland rivers (0.065 mg/L) ranged between 53% (2001) and 100% (2008 and 2011).

Between 2005 and 2009, 81% of samples exceeded the guideline. This value decreased to 76% for the period between 2010 and 2014.

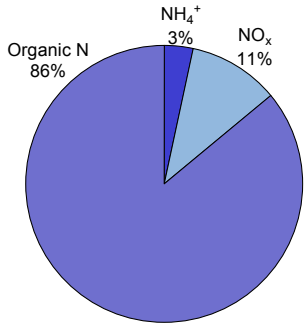
TP trend:

Trend analysis[2] used data from 2010 to 2014 inclusive.

Once the data were adjusted for flow no trend was detected.

Downstream of Dog Hill showing in-stream vegetation and sediment – September 2008

Nutrient fractions (2010–14) at 614030



Nitrogen:

Most of the nitrogen (N) was organic in nature. Organic N consists of both dissolved organic and particulate N. It is derived from degrading plant and animal matter and fertilisers. It often needs to be further broken down before it can be used by plants and algae.

The remaining N was dissolved inorganic N (DIN) such as ammonium (NH_4^+) and N oxides (NO_x).

DIN is also derived from animal wastes and fertilisers but is readily available to plants and algae.

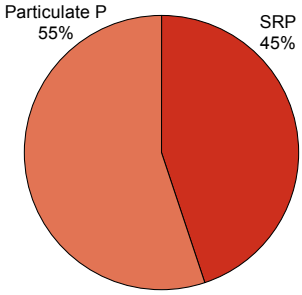
While the percentage of NH_4^+ remained the same as for the previously reported 2005–09 period (3%), it was no longer the lowest of the sampled sites.

Upstream view at Dog Hill showing weir and gauging station – December 2006

Phosphorus:

Just over half of the phosphorus (P) was present as particulate P, which consists of sediment-bound forms of P and organic waste materials.

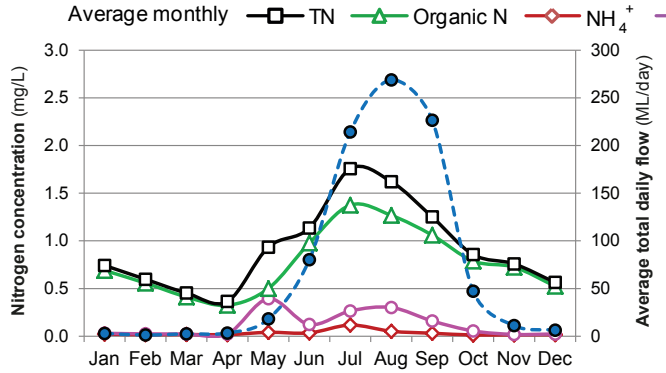
Particulate P is not readily available for uptake by plants and algae, but may become available over time as organic matter decomposes or soil particles release bound P.

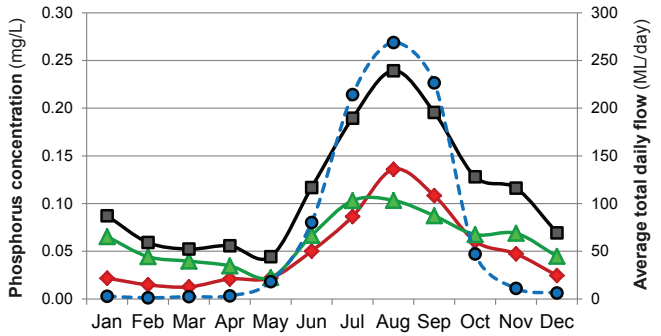


The remaining P was present as soluble reactive phosphorus (SRP). SRP is derived from fertilisers and animal wastes and is readily available for uptake by plants and algae.

Five sites had a higher percentage of SRP than the Serpentine River (Dog Hill). All but one (Meredith Main Drain) discharge to the Serpentine River downstream of Dog Hill.

Seasonal variations in nutrient concentrations and riverine flow (2010–14) at 614030





Nitrogen:

Average monthly N concentrations showed a seasonal pattern, increasing with the first-flush in May and being highest during winter.

Increases in total and organic N during summer (January) were possibly caused by algae, decaying plant matter and evapo-concentration.

Average monthly concentrations of TN and NO_x exceeded ANZECC[3] guidelines throughout the winter months.

Average monthly NH_4^+ concentrations only exceeded the guideline concentration in July.

August 2005

Phosphorus:

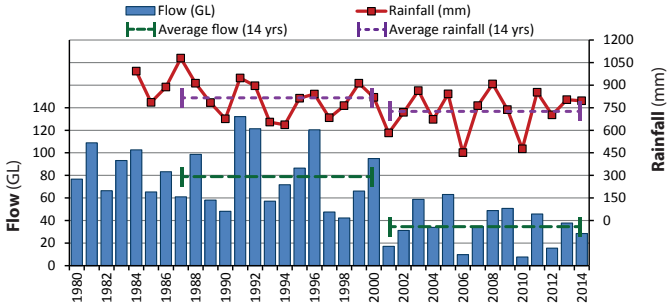
Average monthly P concentrations showed a seasonal pattern with flows and concentrations being greatest at the end of winter.

P concentrations were dominated by particulate P for most of the year except during August and September when flow was at its highest.

Average monthly TP concentrations exceeded ANZECC[3] guideline values for most of the year while SRP exceeded throughout winter and autumn.

	ANZECC 2000[3]	Months exceeded
TN	1.2 mg/L	Jul–Sept
NH_4^+	0.08 mg/L	July
NO_x	0.15 mg/L	May, Jul–Sept
TP	0.065 mg/L	Jun–Jan
SRP	0.04 mg/L	Jun–Nov

Long-term annual flow and rainfall (1980–2014)



Flow has been measured at Dog Hill since February 1979, and rainfall from June 1983. Average total annual flow decreased from 78 GL (1987–2000) to 34 GL (2001–14), while average total annual rainfall decreased from 815 to 726 mm/yr over the same periods.

Total annual flow ranged from 7.7 GL in 2010 to 132 GL in 1991. Total annual rainfall ranged from 451 mm in 2006 to 1079 mm in 1987.

Years with low total annual flow and rainfall (2001, 2006 and 2010) were followed by extended periods of no flow during the next summer or autumn (2002, 2007 and 2011). In 2011 the river ceased to flow from 2 January to 13 May (except for a week in March).

	Months when flow stopped	Number of days
1980	Feb	4
1988	Mar	1
2002	Feb–Mar	53
2003	Jan–Mar	46
2004	Mar	16
2005	Jan–Mar	37
2006	Dec	3
2007	Jan–Apr	82
2008	Feb	1
2010	Mar	19
2011	Jan–May	123

Ecological condition of the Serpentine River

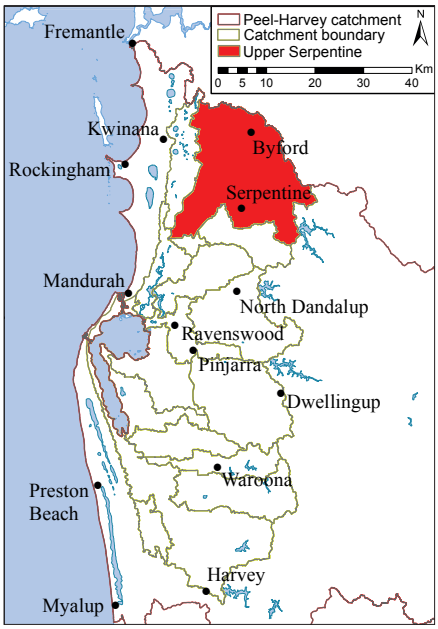
Ecological condition was assessed across three reaches of the Serpentine River between the Serpentine Dam and the Birriga Main Drain confluence. The assessments were made with the South West Index of River Condition using data collected at field sites in summer 2014 and desktop data.

Six native fish and crayfish species were found: western minnow, western pygmy perch, nightfish, Swan River goby, freshwater cobbler and gilgie. But there was a greater abundance of the two exotic species found (mosquito fish and yabby).

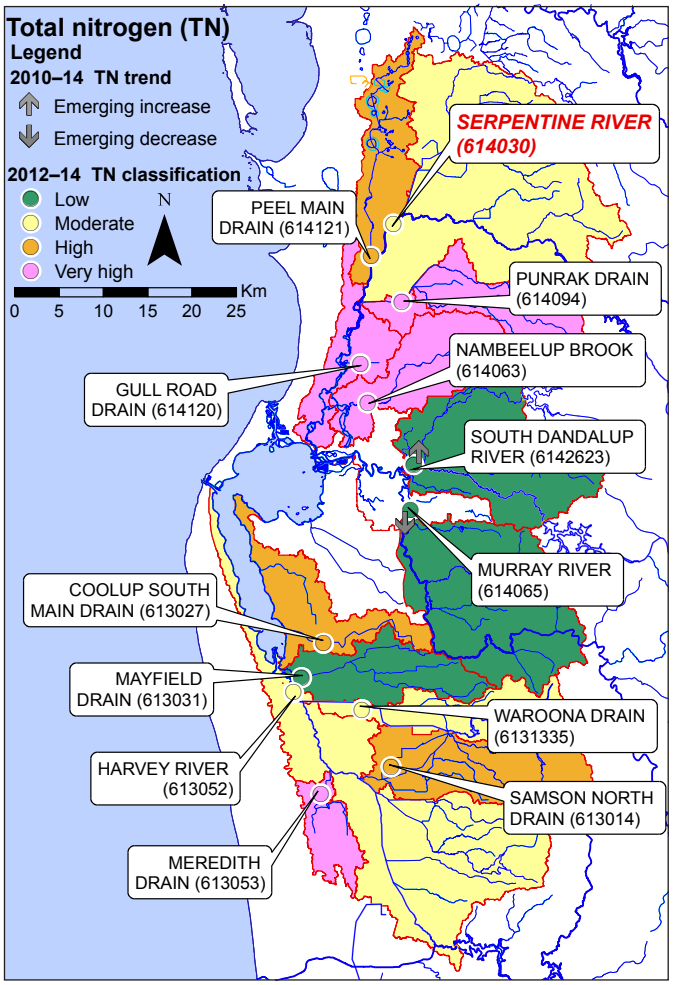
Dissolved oxygen at two sites on the downstream reach (below the Darling Scarp) was at the lower end of optimal conditions for around half of the-24 hour sampling period. Temperature and salinity were within acceptable ranges. Water quality data were not available for the upper two reaches on the scarp.

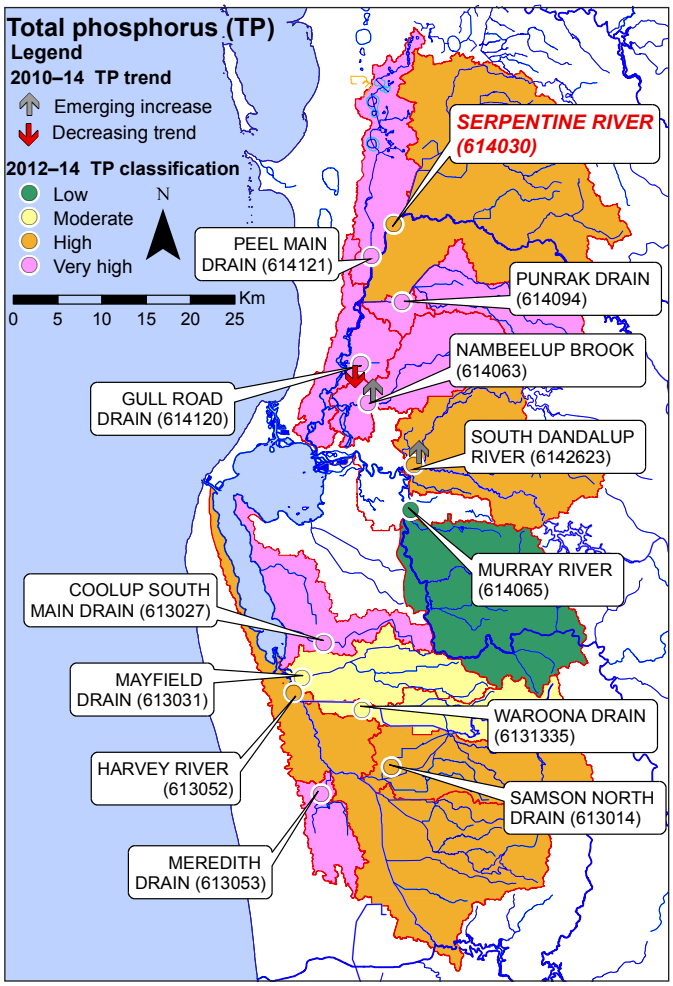
Over 95% of the length of all three reaches was vegetated to an average width of between 38 m (lower reach) to > 50 m (upper reach) on each river bank. But over 75% of the groundcover at field sites assessed was non-native. Erosion was variable, with between 5% and > 50% of the bank length affected, with sites on the downstream reach having more erosion. No data were available for the upper reach, but given that is in a national park the proportion of exotic species and erosion would be expected to be minimal.

How the upper Serpentine fits within the Peel-Harvey catchment: location and statistics



Catchment	Receiving waterbody	Sample site (AWRC)	Area (km²)	2014 Flow (GL)	2014 TN median (mg/L)	2014 TP median (mg/L)
Peel Main Drain	Serpentine River	614121	120	5.0	1.7	0.19
Upper Serpentine River	**Serpentine River**	**614030**	**502**	**28**	**0.79**	**0.13**
Dirk Brook – Punrak Drain	Serpentine River	614094	134	9.6	1.9	0.21
Nambeelup Brook	Serpentine River	614063	143	9.7	3.7	0.60
Lower Serpentine River - Gull Road Drain	Peel Inlet	614120	94	-	4.4	0.93
South Dandalup River	Murray River	6142623	243	-	1.1	0.11
Mid Murray River	Murray River	614065	293	153	0.57	0.01
Coolup South Main Drain	Harvey Estuary	613027	113	2.1	2.1	0.31
Mayfield Drain	Harvey Estuary	613031	119	15	0.73	0.03
Harvey River	Harvey Estuary	613052	408	98	1.4	0.15
Drakes Brook – Waroona Drain	Harvey River	6131335	107	-	0.99	0.07
Samson North Drain	Harvey River	613014	195	-	1.5	0.18
Meredith Drain	Harvey River	613053	56	-	2.8	0.38





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[1] Kelsey, P, Hall, J, Kretschmer, P, Quinton, B & Shakya, D 2010, *Hydrological and nutrient modelling of the Peel-Harvey catchment*, Water Science Technical Series, Report no. 33, Department of Water, Western Australia.

[2] Department of Water 2015, *Catchment nutrient reports* (methods for the analysis of status classification, loads and trends), <http://www.water.wa.gov.au/water-topics/waterways/assessing-waterway-health/catchment-nutirent-reports>.

[3] ANZECC & ARMCANZ 2000, *Australian guidelines for water quality monitoring and reporting,* National Water Quality Management Strategy, Paper no. 7, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

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