Wilson Inlet 3

Report to the Community

GOVERNMENT OF WESTERN AUSTRALIA

WATER AND RIVERS COMMISSION
WILSON INLET MANAGEMENT AUTHORITY

OCTOBER 2000

Summary of Wilson Inlet Catchment Monitoring Program

Over the past decade the excessive growth of the seagrass *Ruppia megacarpa* and regular Spring phytoplankton blooms have caused concerns that Wilson Inlet is becoming enriched with nutrients (eutrophication). If the input of nutrients continues to occur unchecked then water quality in Wilson Inlet can be expected to deteriorate in a similar manner to that which has occurred in the Albany Harbours, Peel-Harvey and Swan-Canning estuarine systems. An understanding of the nutrient sources and processes from the catchment is required to effectively manage eutrophication.

To begin to gain an understanding of nutrient inputs, a catchment monitoring program was instigated by Agriculture WA in the early 1990s. Initially, the goals of monitoring were to estimate nutrient loads being discharged from the catchment to the inlet. In 1994, the Wilson Inlet Management Authority in partnership with the Water and Rivers Commission commenced water quality monitoring with the goal of obtaining information on the various processes and trends operating in the catchment. Routine water quality monitoring of the rivers discharging to Wilson Inlet is still continuing.

This pamphlet summarises the results of the monitoring data that has been collected to date. A full report by the Water and Rivers Commission entitled ‘Nitrogen and phosphorus in tributary inflows to the Wilson Inlet, Western Australia’ (WRT 21, 1999) is available and presents a more detailed analysis and discussion of the results of monitoring. A previous pamphlet (Wilson Inlet 2, September 1999) presented the results of estuarine monitoring in Wilson Inlet and complements most of the information presented in this pamphlet.

What information does the Water and Rivers Commission collect for the tributary inflows to Wilson Inlet?

Water quality monitoring is regularly carried out in the tributary inflows (rivers, creeks and drains) that flow into Wilson Inlet. When the Water and Rivers Commission commenced routine water quality monitoring in the Wilson Inlet catchment in 1994, six tributary inflows were monitored on a weekly basis. In 1997 water quality monitoring at Mitchell River ceased and several more tributary inflows that flow directly to the inlet were added to the monitoring program. Figure 1 shows the locations of all the monitoring sites in the catchment that have been used to date. In 1998, routine monitoring at the sites began to be carried out fortnightly to be consistent with other Commission monitoring programs. The water quality information collected at each site is shown below.

Data collected from the tributary inflows

Chemical data: water samples were collected from the rivers and drains and analysed for total nitrogen (TN), ammonium (NH_4^+), oxidised nitrogen (NO_3^- and NO_2^-), total phosphorus (TP), phosphate (PO_4^{3-}), dissolved organic carbon (DOC) and silicon (Si) as silicon dioxide (SiO_2).

Physical data: a probe was used to measure salinity, dissolved oxygen, pH (acidity) and turbidity in the river. Total suspended solids (TSS) samples were also taken and analysed.

Gauging stations are located close to the monitoring sites and were used to obtain flow and volume information (see Figure 1).

Results of the Monitoring Program

Comparison between monitored sites

The result of sampling a river over a period of time is a set of data containing a range of values, some of which will be relatively high, some low, and the rest in between. The distribution of the sampled data is considered to approximate what is actually occurring in the sampled river. The spread of the data across a range of concentrations for a chemical is called the data distribution, as shown in Figure 2. The same information

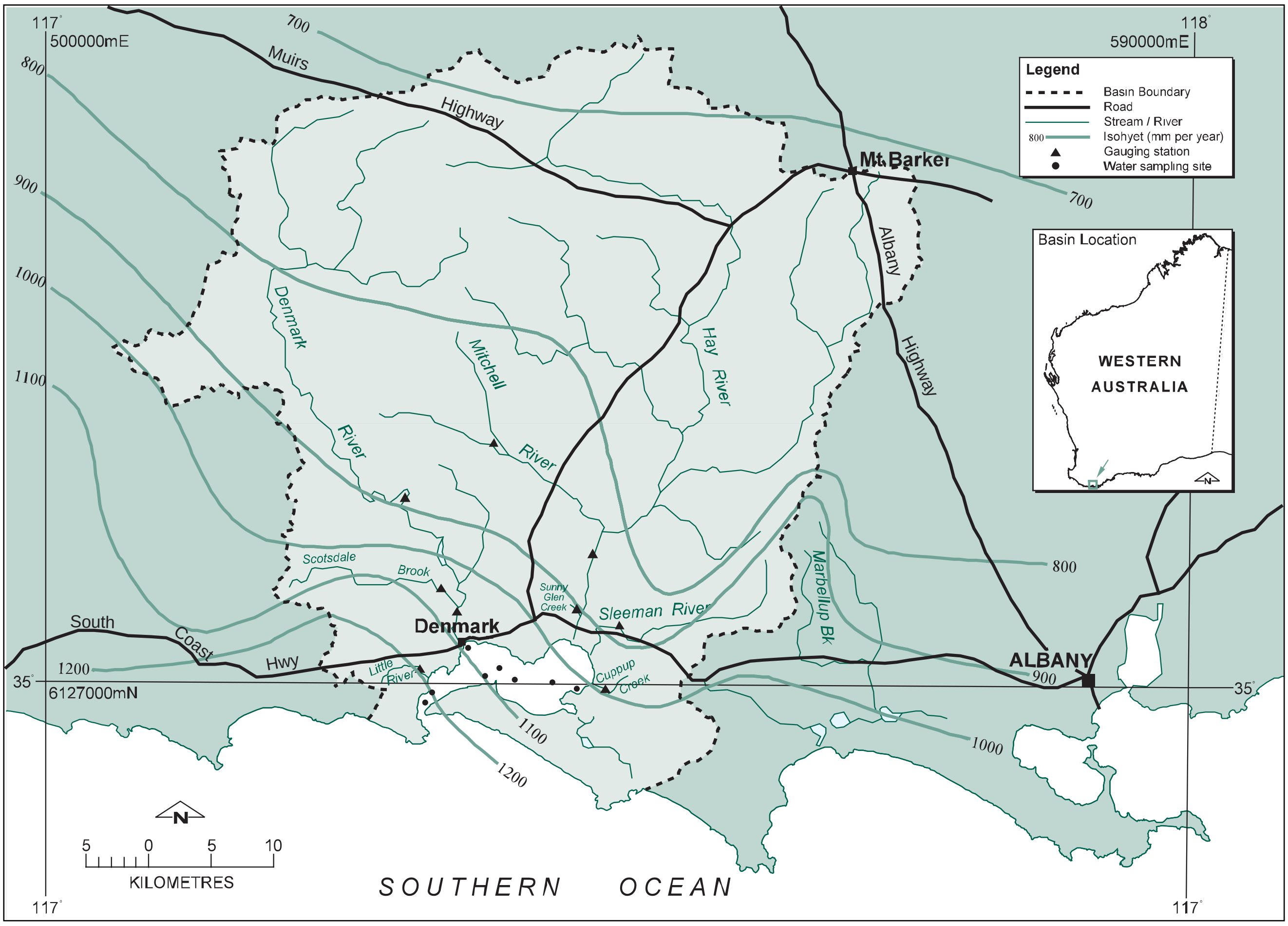

Figure 1: Map of the Wilson Inlet basin with monitored catchment sites.

can also be shown in a box plot where certain features of the data distribution are used, such as medians and percentiles. Medians represent the middle concentration and the percentiles represent a percentage proportion of the distribution that falls below a certain concentration.

Box plots are used to summarise the results of water quality monitoring. The box plots in Figure 3 shows the combined data distribution of total nitrogen and total phosphorus in the rivers since monitoring commenced. The median nutrient concentrations for Mitchell, Denmark, Hay, Scotsdale and Little rivers were all below the 1.0 mg/L TN guideline and the 0.1 mg/L TP guideline concentrations (WRC guidelines). This indicates that most of these rivers have good nutrient water quality for most of the time. The Sleeman River, Cuppup Creek and Sunny Glen Creek show signs of being enriched with nitrogen and/or phosphorus with generally more than half of the

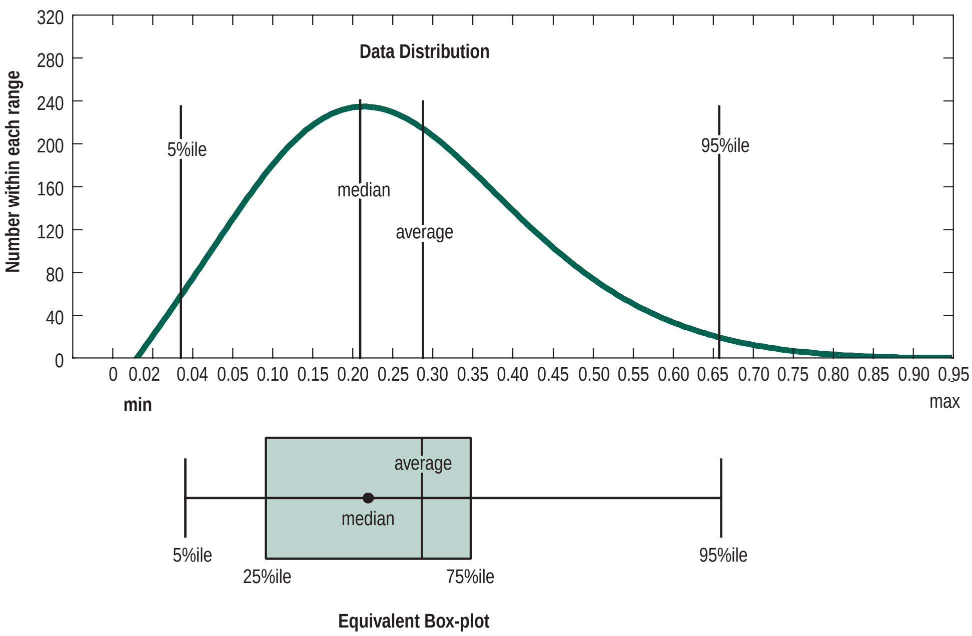

Figure 2. An example of a typical data distribution curve of total phosphorus concentrations for a monitored river. The box plot also describes the data distribution and can represent specific points, such as median and percentiles, of the data distribution curve.

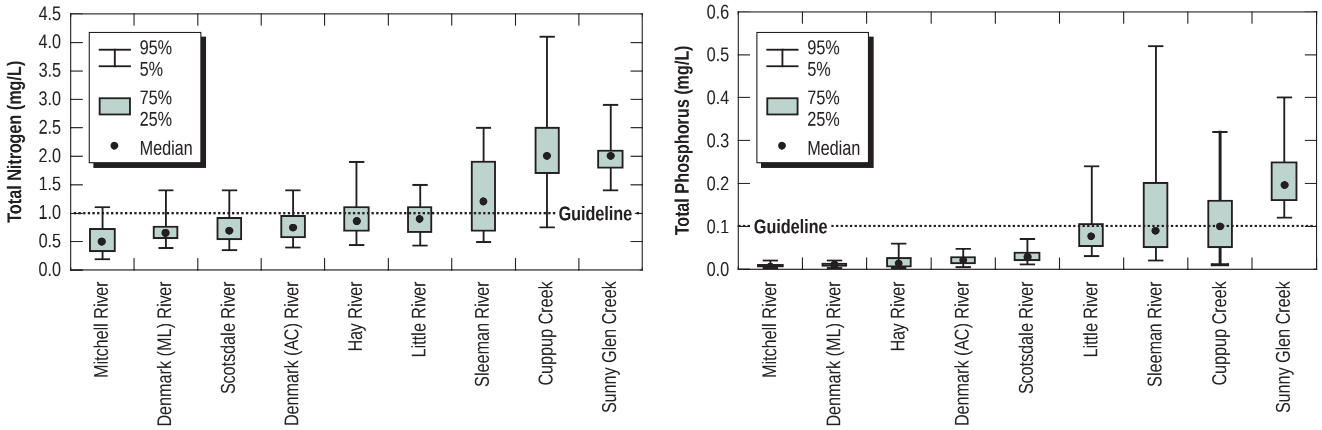

Figure 3: Box plots showing the combined distribution of nutrient (TN and TP) concentration data for rivers in Wilson Inlet catchment since monitoring commenced. The guideline concentrations are 1.0 mg/L for TN and 0.1 mg/L for TP.

A segment of the Hay River where riparian vegetation has been left undisturbed. Photo by Brad Jakowyna.

collected samples exceeding the guideline concentrations. Fertiliser runoff, uncontrolled stock access to waterways or lack of fringing vegetation may contribute to elevated nutrient concentrations in these rivers.

Measuring total suspended solids (TSS) in a river provides a good indication of how much sediment is being eroded from the catchment. Fine sediments also provide a good

A segment of the Sleeman River which lacks riparian vegetation and fencing. Stock would have easy access to the river contributing nutrients via faecal waste and bank slumps. Photo by Robyn Paice.

means of transport for phosphorus in the rivers and drains. Figure 4 shows that the median TSS concentrations for many monitored sites were below the WRC guideline level (6 mg/L). The Sleeman River, Sunny Glen Creek, Little River and Cuppup Creek exceeded the guideline concentration and may indicate that high levels of erosion are occurring in these catchments. Over clearing of land, lack of fringing vegetation, unstable banks, and uncontrolled stock access to waterways may contribute to elevated TSS levels in these rivers.

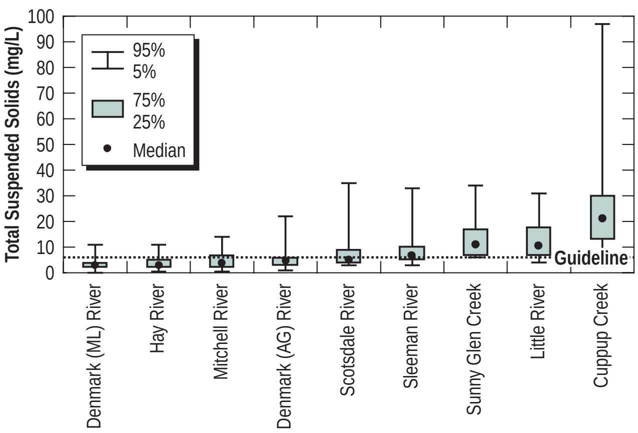

Figure 4: Box plots showing the distribution of TSS data for monitored sites in Wilson Inlet catchment. The guideline TSS concentration is 6 mg/L.

A segment of Cuppup Creek where severe bank erosion and undercutting has occurred. This would lead to the input of sediments and nutrients to the drain. Photo by Photo by Robyn Paice.

Seasonal patterns

Seasonal patterns represent any predictable changes that occur within a year. Figure 5 shows a typical seasonal pattern in rainfall for Denmark (near the coast) and Mount Barker (inland areas of Wilson Inlet catchment) where rainfall rises and falls according to the time of the year. Most of the rainfall occurs during the winter period (May to August) and less during the summer period (December to March).

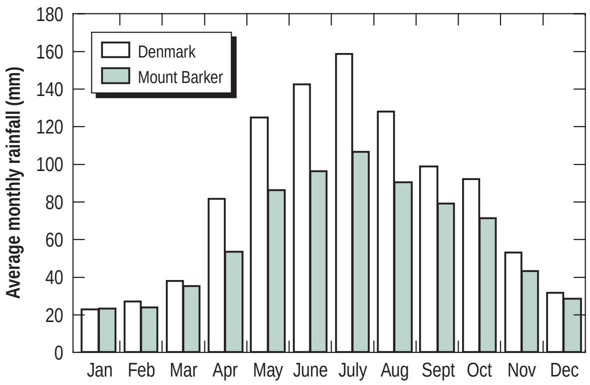

Figure 5: Average monthly rainfall for Denmark and Mount Barker weather stations (source: Bureau of Meteorology).

Seasonal cycles in nutrient concentration are also common in south-west WA river systems and are somewhat linked to rainfall. The cycles are important ecologically because they mean that nutrient delivery to Wilson Inlet is predictable and life cycles of some aquatic plants are dependent on a reliable source of nutrients. Results from monitoring show that storm events in the catchment deliver the bulk of nutrients to the inlet. Figures 6 and 7 shows the typical seasonal pattern for nutrients and their fractions being delivered to Wilson Inlet. Total nitrogen and total phosphorus have organic fractions consisting of biological (plant and animal) material and inorganic fractions consisting of dissolved forms in water.

Figure 6 shows that TN levels increase during winter and peak between June and August. Most of the nitrogen in the rivers and drains throughout the year is organic, which may be linked to natural plant material or animal waste. This form of nitrogen is not directly available for plant growth in the inlet. Organic nitrogen peaked between August to September due to the delayed transport of biological material from areas higher in the catchment. Levels of inorganic or dissolved nitrogen peaked earlier (June to July) coinciding with the onset of winter rains and the flushing of fertilisers from agricultural soils.

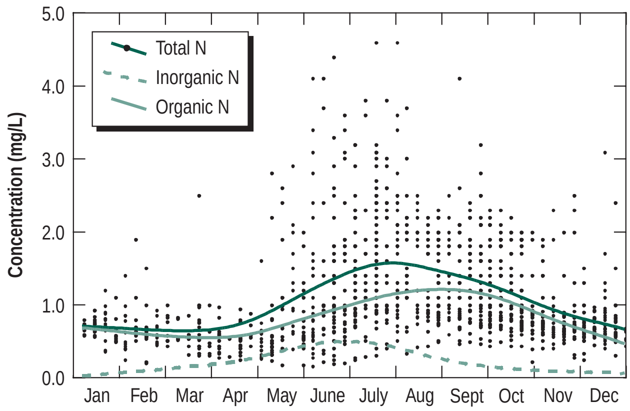

Figure 6: Seasonal variation in total nitrogen and fractions for all monitored sites in the Wilson Inlet catchment.

Figure 7 shows that TP levels increased during winter to peak around July or August. Most of the phosphorus in the rivers and drains throughout the year is particulate phosphorus (organic plus sediment-bound forms). Particulate phosphorus peaks around August coinciding with the flushing of organic material and sediment from erosion processes. This form of phosphorus is not directly available for plant growth in the inlet. Inorganic or dissolved phosphorus peaks around July or August and is linked to the flushing of fertilisers from agricultural soils.

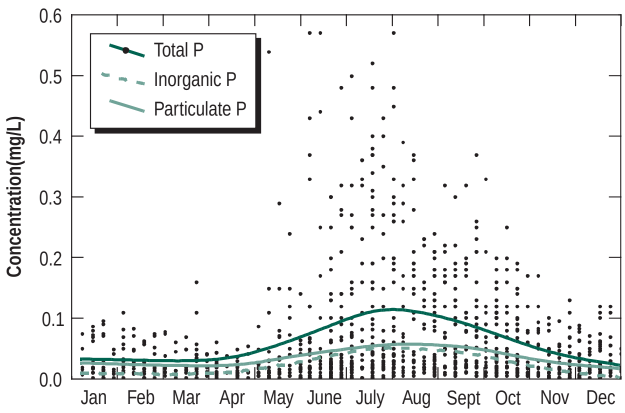

Figure 7: Seasonal variation in total phosphorus and fractions for all monitored sites in the Wilson Inlet catchment.

More detailed plots of each river and drain can be found in the report "Nitrogen and phosphorus in tributary inflows to the Wilson Inlet, Western Australia, WRT 21".

The relationship of flow to nutrient concentrations

The amount of nutrients being delivered to Wilson Inlet from rivers is largely related to flow. Nutrients are higher during winter, because nutrients are flushed from the catchment's soils with rainfall and transported by groundwater and surface runoff to the rivers. A hydrograph is a record of water flow in a river showing peaks following storm events and base flow between rainfall events. The time the samples are taken in comparison to the hydrograph helps to provide clues about when nutrients are entering the rivers. Figure 8 shows an example of when samples were taken during the 1995 flow year in the Hay River. Due to the fixed-interval monitoring program, samples were taken on various stages of the hydrograph. The samples were then classed according to whether they were collected during storm events (rising and falling limbs) or base flows (inter-event) which represent groundwater.

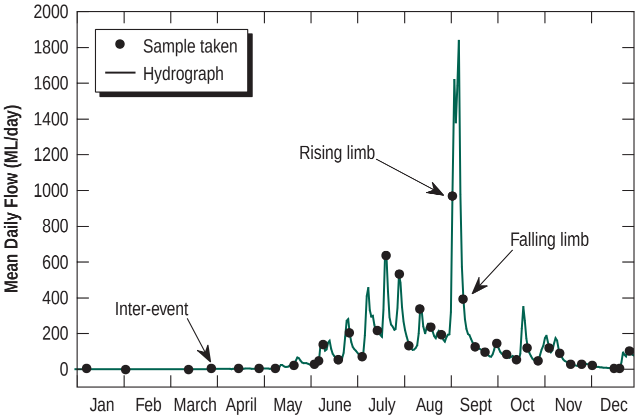

Figure 8: A comparison of when samples were taken relative to the 1995 Hay River hydrograph. According to the time the samples were taken, they were classed either as rising limbs (rising flow), falling limbs (falling flow) or inter-event (steady or base flows).

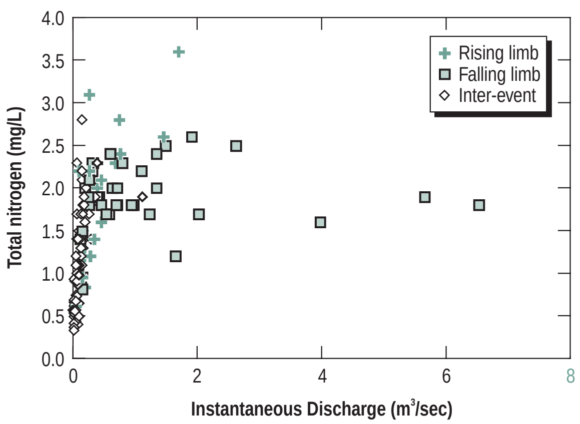

Figure 9: A positive flow response in TN for Sleeman River. This plot is typical of the rivers of Wilson Inlet catchment.

The time the samples (nutrient concentration) were collected was compared to the flow to obtain a flow-concentration response plot. The relationship shown in the plots can be positive (positive slope), negative (negative slope), independent (not related to flow) or a combination thereof. Most rivers of the Wilson Inlet catchment showed a positive flow response, where nutrient concentrations collected during storm events (rising and falling limbs) were higher than those collected during baseflows (inter-events). Figure 9 provides an example of a positive flow response where high levels of nutrients in the river occurred during storm events. The positive slope for the inter-event samples also means that the groundwater contributes nutrients.

Cuppup Creek was the only river where there was not a positive flow response. Figure 10 shows a combination of positive and negative flow responses for TN in Cuppup Creek. A negative flow response means that high levels of nutrients occurred during baseflows and lower levels occurred during storm events. This type of response plot may indicate that a point source is contributing nutrients to the creek, in addition to diffuse groundwater and surface runoff sources.

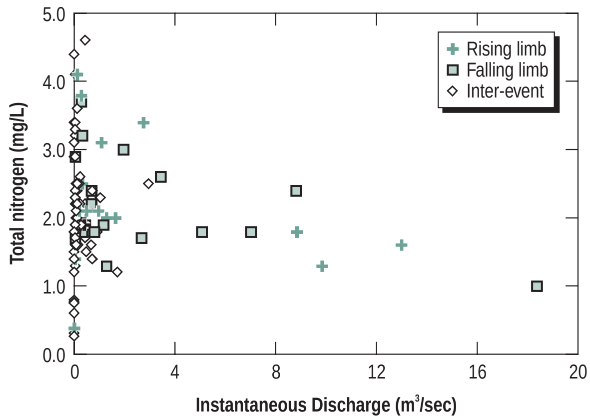

Figure 10: A combined positive and negative flow response in TN for Cuppup Creek.

Trends in nutrient concentration

Trends are useful for determining whether nutrient concentrations in rivers improved or got worse over time. Trends can be also be influenced by a number of factors including pollution, climate, sampling methods or chance. Trends in water quality in rivers brought about by human activity are of most interest. This sort of trend is usually hidden by natural sources of variation in the data, namely flow and seasonal patterns. Once the data is adjusted for flow and seasonal patterns and is statistically analysed, trends that represent changes brought about by human activity can be detected.

Trend tests showed an increasing trend in TN for the Sleeman River (+0.1 mg/L) between 1995-99. The increasing trend in nitrogen in the Sleeman River may be due to a change in land use in the catchment (such as land clearing or a shift to legumous pastures) or altered land practices (such as an increase in fertiliser application rates). Sleeman River is the third largest tributory inflow (Table 1) discharging to the eastern region of Wilson Inlet, which is shallow and poorly flushed. Nutrients discharged to this area of the inlet will have longer residence times and a greater chance of being consumed by aquatic vegetation or adsorbed onto sediments. An increasing trend in a tributory inflow discharging to Wilson Inlet is therefore regarded as a serious environmental problem that requires urgent action.

Other tributory inflows in Wilson Inlet catchment that have been continuously monitored since 1994 showed no trends in nutrients over the past five years. The more recently monitored sites, such as the Scotsdale Brook, Little River and Sunny Glen Creek will require at least another two years of monitoring before trends can be detected.

Table 1: Average annual flows for the major rivers flowing into Wilson Inlet.

River	Average Annual Flow (Megalitres)
Hay River	75 000
Denmark River	55 000
Sleeman River	15 000
Cuppup Creek	12 000
Little River	6 000
TOTAL	**~160 000**

What is the current situation and what can we do to improve?

Over 70% of the Hay River, Sleeman River and Cuppup Creek catchments have been cleared for agriculture, while a large portion of the Denmark River catchment remains forested. Levels of nutrients and suspended solids in the Denmark and Hay rivers indicate that they are in a good condition compared to other large river systems of south-west WA. Both rivers deliver the largest nutrient loads to Wilson Inlet and must therefore be actively managed to prevent a further deterioration in water quality. Some of the smaller river systems, such as Cuppup Creek, Sleeman River and Sunny Glen Creek, are nutrient enriched and have high levels of suspended solids. These smaller, but nutrient rich, inflows are believed to be important sources for biological productivity in the inlet during the drier months and therefore require urgent attention. An increasing trend in nitrogen for Sleeman River from 1995-99 is also of concern and is indicative of a degrading river system. Other monitored river systems, such as Little River and Scotsdale Brook, are also important given that land use in the catchments is rapidly changing.

Understanding the information generated from the monitoring helps to highlight the work that needs to be done to protect the tributory inflows and Wilson Inlet from the effects of nutrient enrichment. The most important work involves the community using the information to make changes about the way urban and rural land is managed. Activities such as fencing rivers and creeks will help to prevent stock from degrading foreshore vegetation and banks and will help reduce the nutrient input from faecal waste and soil erosion. Revegetating low-lying areas and river-banks will help to increase nutrient uptake by plants, trap pollutants, and stabilise the banks. Soil testing can help farmers optimise fertiliser application rates and timing so excess nutrients are not lost to rivers. Implementation of BMPs (Best Management Practices) by industries and intensive agriculture and horticulture practices (such as piggeries, feed-lots, viticulture, dairies, etc.) can also help to substantially reduce nutrient input to rivers.

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Recommended further reading:
WRC (1999) *Nitrogen and phosphorus in tributary inflows to the Wilson Inlet, Western Australia*, WRT 21.

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