Department of Water
Government of Western Australia

Wilson Inlet 8

Report to the community

July 2008

Wilson Inlet catchment water quality year to year

Figure 1 A largely natural site on the Denmark River Photo by Ben Boardman

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This newsletter is the eighth in a series of community reports on Wilson Inlet produced by the Department of Water (formerly the Water and Rivers Commission). It summarises the results of the Department of Water's catchment monitoring program from the early 1990s to the present. This program focuses on determining nutrient trends and input to the inlet from the seven major tributary inflows. The following water quality parameters have been measured: nutrients, salinity, dissolved oxygen, pH, turbidity, total suspended solids and flow. This report deals with nutrients and total suspended solids.

The third Wilson Inlet Report to the Community reported on the data to 1999, this publication updates that report to cover up to and including 2005 data.

Some background on the inlet and its catchment

Wilson Inlet is a seasonally closed estuary which lies on the south coast of Western Australia. It has a surface area of 48 km^2, is 14 km long from east to west and is approximately four-kilometres wide. The average depth of the estuary is 1.8 m below mean sea level (mean sea level is roughly 0 m AHD – Australian height datum). The sand bar which separates the inlet from the ocean is artificially breached each year and remains open for about six months (usually about February to July). Breaching the bar prevents flooding of the low-lying agricultural land near the estuary.

The catchment of the Wilson Inlet covers some 2300 km^2 and experiences a marked rainfall gradient. At the coast, average annual rainfall is approximately 1000 mm, this drops to about 600 mm near the inland catchment boundary. Since the 1950s roughly 54% of the catchment has been cleared for agriculture. The Denmark and Hay rivers are the two major rivers draining into Wilson Inlet however there are a number of other tributaries including Scotsdale Brook, Sunny Glen Creek, Sleeman River and Cuppup Creek. The predominant landuse in the catchment is grazing (sheep and cattle) with other uses including horticulture (potatoes, fruit and vegetables), plantations, viticulture, small urban areas and intensive agriculture (i.e. dairies, piggeries).

Landuse in the catchments is changing. There is a shift from grazing to plantations and viticulture (though there

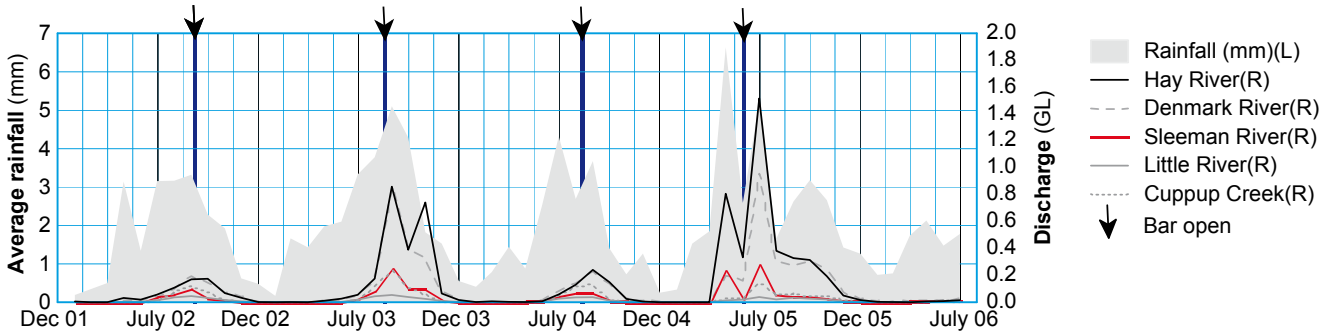


Figure 2 Flow and average rainfall for the catchment of Wilson Inlet.

are still large areas being grazed and this is unlikely to change). Viticulture is especially prevalent around Mt Barker and the Lower Denmark River Catchment.

Figure 3 Aerial view of the Hay River as it flows into Wilson Inlet.

The last census identified Denmark Shire as the Shire with the highest rate of population growth in the State, this trend is expected to continue. To accommodate the increasing populations twelve new special rural areas have been created in the Shire of Denmark comprising 270 lots of 1 to 10 ha in size. Approximately 25% of this area has been developed to date.

Due to the landuse changes in the catchment since the 1950s Wilson Inlet has become increasingly nutrient enriched. The symptoms of eutrophication shown by the inlet are an increase in submerged aquatic vegetation, especially the seagrass *Ruppia megacarpa* and attached and free-floating algae. The potential nutrient sources to the inlet which have been identified are:

1. nutrients entering the inlet from the catchment via the tributaries;
2. nutrients from groundwater flowing directly into the inlet (this does not include groundwater flowing into the tributaries and then into the inlet); and
3. nutrients stored in the sediments of the inlet. These can be released under certain circumstances (i.e. when dissolved oxygen levels are low).

Figure 4 Ruppia

Catchment sourced nutrients represent the single largest nutrient source to the inlet and possibly one of the easiest sources to tackle. There is some concern amongst the community that Wilson Inlet will continue to deteriorate in the future and end up like the Peel–Harvey estuary prior to the construction of the Dawesville Channel.

Figure 5 Ruppia (brown colour) and macroalgae (green colour) on the shore of Wilson Inlet.

To help better understand the nutrients entering the inlet from the catchment, monitoring has been occurring at a number of sites since the early 1990s. The monitoring network was initially set up by the Department of Agriculture to determine nutrient loads. In 1994 the network was taken on by the Wilson Inlet Management Authority (WIMA) and the Water and Rivers Commission (now the Department of Water) with the changed aim of determining processes and trends operating in the catchment. Monitoring was initially conducted weekly but was dropped back to fortnightly in 1998 to be consistent with other Department of Water monitoring programs.

Sampling is conducted at gauging stations which have been constructed upstream of the tidal reaches of the estuary. This means that there is an area downstream of the gauging stations in each catchment which is not sampled. These areas tend to be close to the inlet and have high nutrient-loss landuses and consequently should be target areas for catchment management initiatives. To better understand nutrients in the catchments above the routine monitoring sites a couple of snapshots have been run which collected data from a large number of sites on a few sampling occasions. Figure 6 shows the location of the routine monitoring sites in the Wilson Inlet catchment.

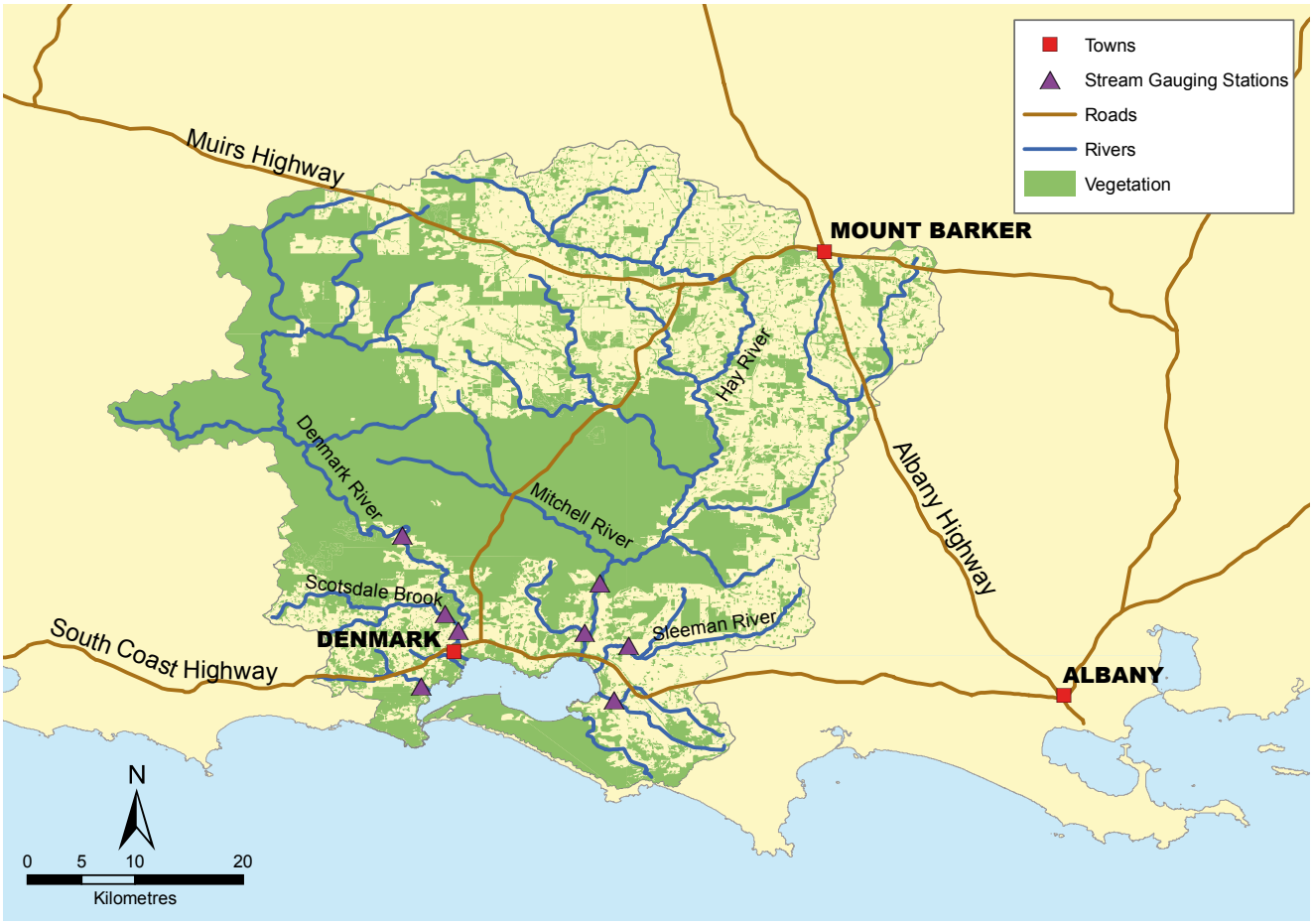


Figure 6 Map of the Wilson Inlet catchment showing location of catchment monitoring sites.

Why nutrients?

The availability of nutrients, especially nitrogen and phosphorus is of key importance to plants and algae in waterbodies. If there are not enough nutrients available then they cannot grow, and where there is an abundance of nutrients they can grow to such an extent that they become a problem. In Wilson Inlet studies have shown that the growth of *Ruppia* is probably limited mainly by the availability of phosphorus and that phytoplankton growth is limited mainly by the availability of nitrogen.

Not only is the total amount of nitrogen and phosphorus entering the inlet important, the actual form the nutrient is in is also very important. Some forms of nutrients are much more readily used by plants and algae than others.

Nutrient	Forms readily available to plants and algae	Forms less available to plants and algae
Phosphorus	Orthophosphate, also known as filterable reactive phosphorus	Particulate phosphorus and dissolved organic phosphorus
Nitrogen	Dissolved inorganic nitrogen (consists of ammonium and nitrate)	Particulate nitrogen and dissolved organic nitrogen.

Comparing the tributaries

Nutrient concentrations and total suspended solids vary markedly between the eight sites monitored (See figures 7–9). Both Cuppup and Sunny Glen Creek are currently over the interim guideline value for total nitrogen and have noticeably higher total nitrogen concentrations than the other six monitored sites. Total phosphorus concentrations are below the interim guideline value at all sites except for Sunny Glen Creek; and Cuppup Creek is the only site above the interim total suspended solids guideline.

Both Cuppup and Sunny Glen Creek's catchments are largely cleared and stock accessing the creeks is a problem. Further, Cuppup Creek had extensive drainage works implemented in the 1950s to drain water from the low lying agricultural lands in its catchment. Erosion along the banks of Cuppup Creek is a real issue and may be contributing to the total suspended solids (TSS) values seen here.

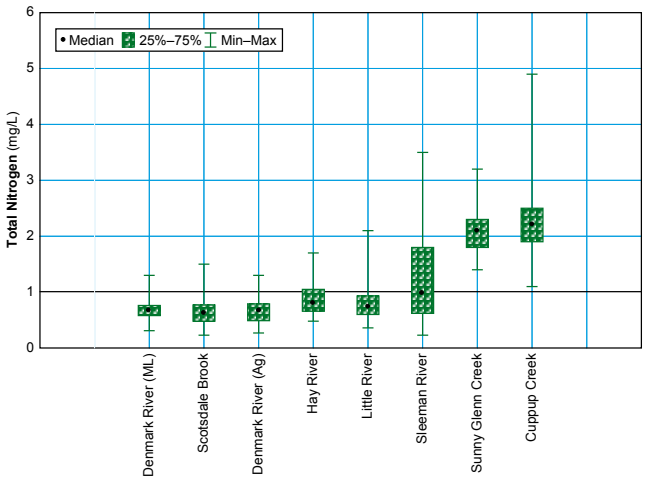


Figure 7 Box plot showing nitrogen data from 2003 to 2005 inclusive at all catchment sites. Note that the interim guideline value is set at 1.0 mg/L.

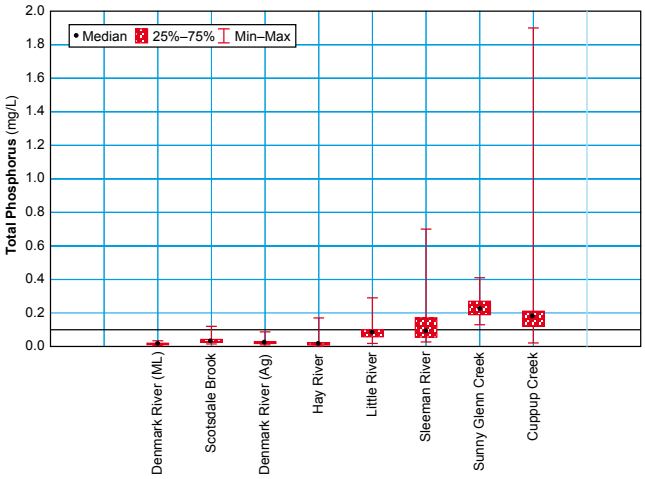


Figure 8 Box plot showing phosphorus data from 2003 to 2005 inclusive at all catchment sites. Note that the interim guideline value is set at 0.1 mg/L.

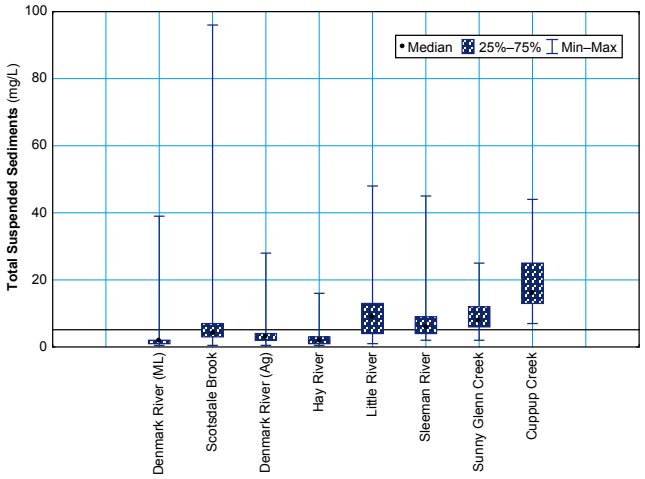


Figure 9 Box plot showing total suspended solids data from 2003 to 2005 inclusive at all catchment sites. Note that the interim guideline value is set at 5 mg/L.

Figure10 A dry Cuppup Creek. Note the visible erosion along the bank at the right of the picture.

What the snapshots show us

Snapshot sampling is used to sample a large number of sites within a catchment or area during a single time period to give a better indication as to the distribution of pollutants such as nutrients throughout the catchment. Snapshots can be used to help target on-ground works such as stream revegetation to areas where they will produce the largest net benefit. To be effective, snapshots should ideally be carried out over a range of flows. Snapshots have been carried out in the Hay, Sleeman, Cuppup and Lake Saide catchments within the Wilson Inlet catchment.

The series of three maps in Figure 11 show the nutrient and TSS classifications at sites sampled during the snapshot events in the Hay, Sleeman, Cuppup and Lake Saide catchments. Classifications are also shown for the routine monitoring sites at the bottom of each catchment.

The snapshots show that concentrations of nutrients and TSS varies throughout the catchments. Very high concentrations of TN were found at various sites in the Hay catchment as well as in the Sleeman and Cuppup Creek catchments. The Lake Saide catchment did not exhibit similarly high concentrations though the two sampling points with high concentrations are of concern. The Hay River catchment was the only one with very high TP concentrations. Sleeman River and Cuppup Creek catchments had a number of sites with high TP concentrations whereas most of the sites in the Lake Saide catchment had low to moderate TP concentrations. TSS concentrations were very high at a few sites in the Hay River catchment and at one in the Sleeman River catchment. High concentrations of TSS were recorded at a number of sites in the Hay and Sleeman River catchments as well as one site in both the Cuppup Creek and Lake Saide Catchments.

Given this high variability in nutrient and TSS concentrations it is very important that any on-ground works are carefully situated to target problem areas.

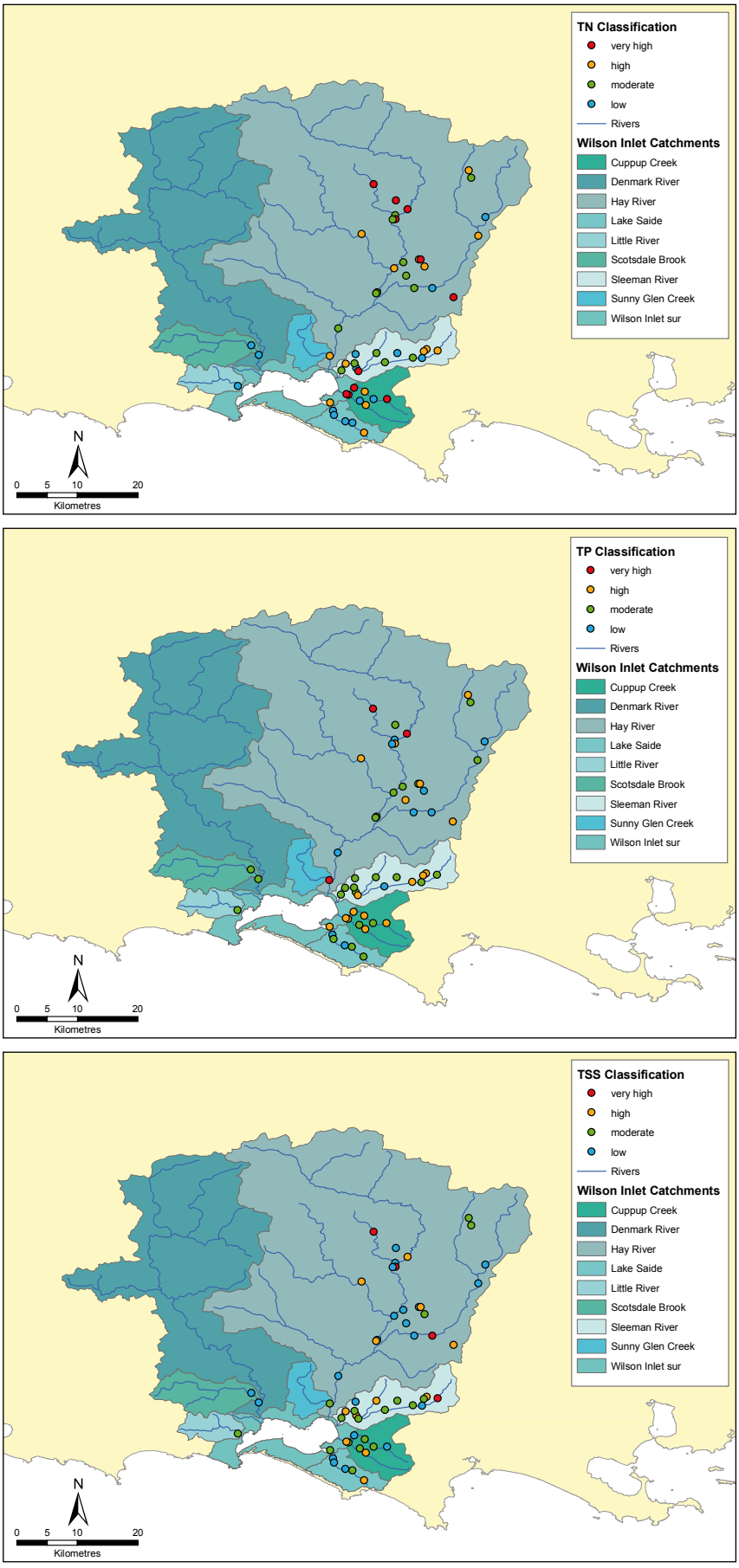


Figure 11 Nutrient and TSS classifications from snapshots conducted in the Hay, Sleeman, Cuppup and Lake Saide catchments.

Nutrient concentrations have changed over time

To determine if nutrient concentrations are changing over time we calculate trends which tell us whether the nutrient concentrations at a site are increasing, decreasing, or remaining stable. This is useful as it can help target on-ground works to catchments where conditions are deteriorating. Over the last five years TN and TP concentrations have remained relatively stable with only one site recording an actual trend, this was Scotsdale Brook which has an increasing trend in TP concentrations of 0.002 mg/L/year. It is important to remember that the lowest concentration of TP that the laboratory can detect in a sample is 0.005 mg/L. Therefore, whilst there is an apparent trend in the data it is so small that it is almost meaningless. Two sites also recorded emerging trends. This is where a trend is detected during the analysis but there are not yet enough independent samples in the dataset to confirm that the trend is real. The two sites that recorded emerging trends were Little River (an increasing emerging trend of 0.003 mg/L/year in TP and Cuppup Creek which had a decreasing emerging trend of 0.20 mg/L/year in TN).

The previous version of this report detected only one trend which was an increasing trend in TN in the Sleeman River of 0.1 mg/L/year.

Pinpointing the exact reason for a trend is difficult. For changes to be noticed in the inlet downward trends will need to be more significant and will need to occur in catchments which are contributing a large amount (load) of nutrients.

Figure 12 The monitoring site on Little River.

The relationship between nutrients and flow

Most of the monitored tributaries in the Wilson Inlet catchment show a positive flow response with nitrogen and phosphorus concentrations (see Figure 14). A combination of a positive and negative flow response was recorded in total nitrogen concentrations at Cuppup Creek (see Figure 15). Total suspended solids at Hay River was unique in that it was the only site concentration combination that showed no flow response (see Figure 16).

A positive flow response indicates that the majority of the nutrients and suspended solids are entering the waterways during storm events and therefore will be reaching the inlet in pulses, associated with storm events. Where there is a combination of positive and negative flow responses it indicates that nutrients are entering the waterways both during storm events and during base flows. Combination flow responses indicate that the groundwater feeding the waterways have high nutrient concentrations. This type of flow response was observed in Cuppup creek's nitrogen concentrations and Denmark river's (ML) phosphorus concentrations. A negative flow response (not encountered in the Wilson Inlet catchment) may be associated with a point source located near the monitoring site, meaning that nutrient concentrations decrease when flow levels increase. The type of flow response is important to consider when trying to implement management actions and design more specific monitoring programs. If there is a negative flow response it is important to determine if the concentrations are due to groundwater or a localised point source.

Sampling events on the hydrograph

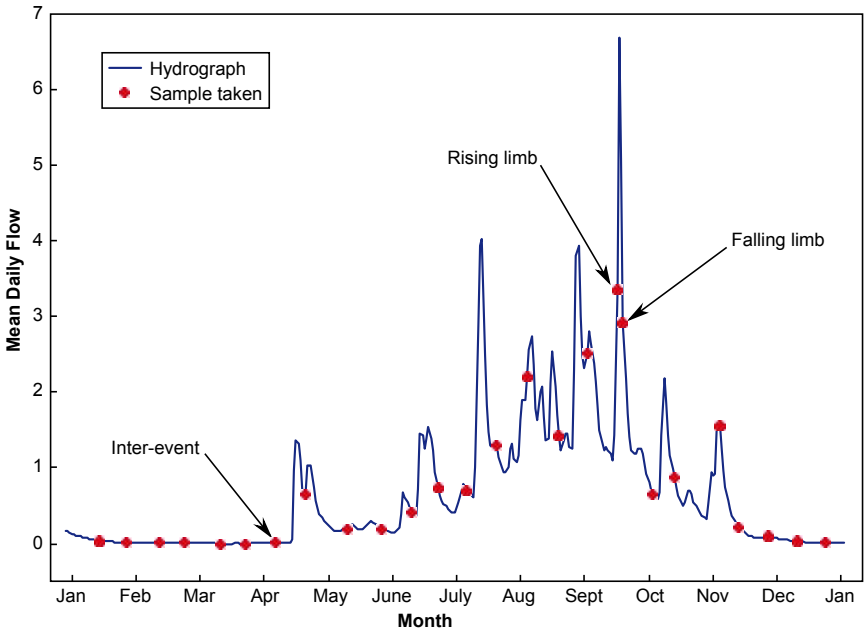


Figure 13 A comparison of sample location relative to the hydrograph for Hay River in 2002.

During any one year there will be any number of rainfall events in a catchment. This means that the water levels in a stream are constantly changing, as is the speed that the water is travelling down the stream. They rise in response to a storm in the catchment and fall as the storm passes, rising again with the arrival of the following storm.

Routine fortnightly sampling as conducted in the Wilson Inlet catchment will sometimes occur when water levels are rising (the rising limb), sometimes when water levels are falling (the falling limb) and sometimes in-between (inter-events). Further, if there has been no rainfall in the catchment for a while then the water in the stream will be coming from the groundwater, this type of flow is known as base flow. The hydrograph above shows when the samples were taken in 2002 at the Hay River.

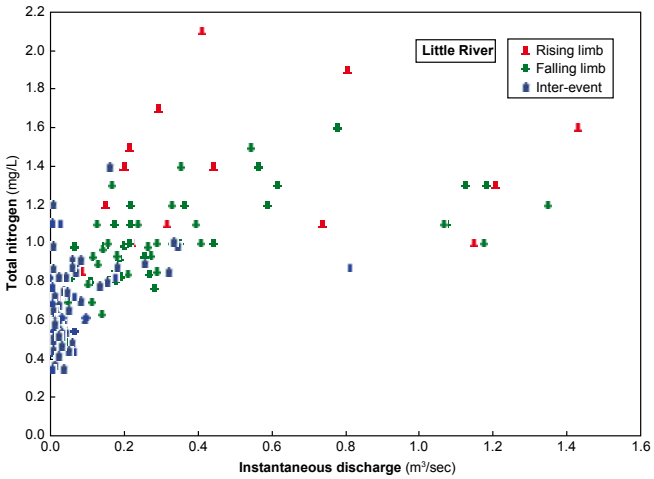


Figure 14 Total nitrogen concentration in Little River plotted against flow. A strong positive flow response is evident.

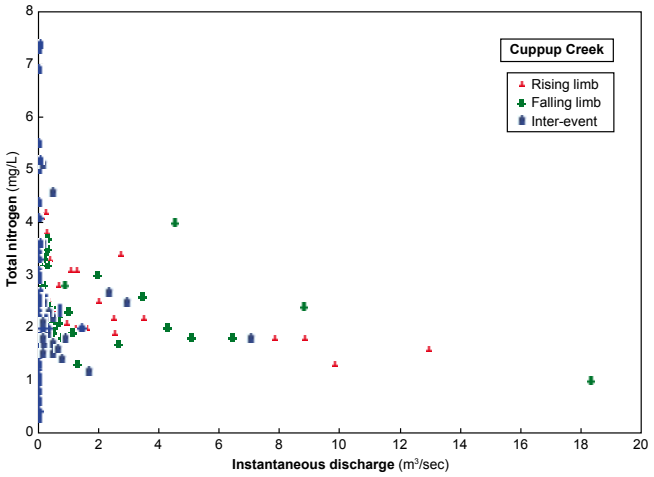


Figure 15 Total nitrogen concentrations in Cuppup Creek plotted against flow. A combined positive and negative flow response is evident.

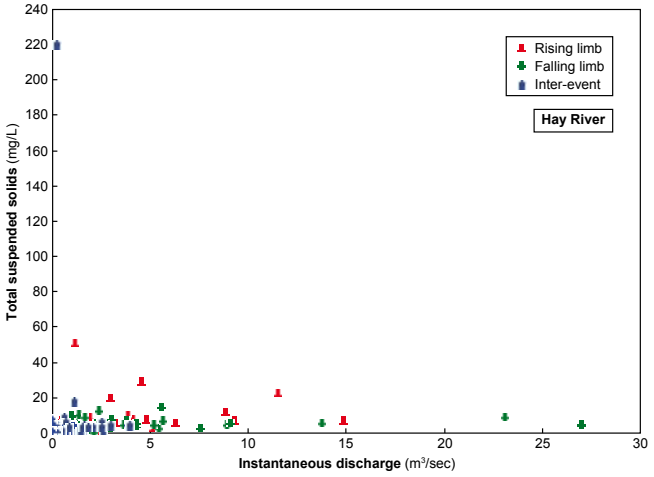


Figure 16 Total suspended solids in the Hay River plotted against flow. No flow response is evident.

Nutrient loads entering the inlet

Knowing what the concentrations are in the rivers and streams is important as this indicates the amount of nutrient immediately available for plant growth when the catchment water enters the estuary. Loads, on the other hand, tells us how much nutrient (in kilograms or tonnes) enters the inlet over time and the relative contribution from each catchment to the overall inventory of nutrients in the inlet.

As can be seen in Figure 13, collecting routine grab samples at fixed intervals tends to produce a large number of samples taken during baseflow conditions and only very few during storm flows. Studies have found that in most catchments the majority of nutrients and other contaminants leave the catchment during storm events. Therefore when loads are calculated using routine grab sample data the resulting number tends to be an underestimate of the total load leaving the catchment and entering the inlet. A way to get around this problem is by the use of automated samplers which can be programmed to take samples in response to changes in water level or flow rate. By using automated samplers it is possible to focus sampling effort during storm events and therefore gain a better understanding of how nutrients concentrations respond to changes in flow as well as calculating a more robust load number. To this end three autosamplers were installed in the Wilson Inlet catchment, one on the Denmark River, one on the Hay and one on Sleeman River. These have been operated for a number of years and in response to a recent data review the samplers situated on the Sleeman and Denmark rivers have now been shut down as sufficient data has been collected to model the flow concentration response in these catchments.

Figure 17 An autosampler located in the Wilson Inlet Catchment

The pie charts in Figure 18 show the percent inflow for each of the seven gauged catchments during the wet season (June to November inclusive) and the dry season (December to May inclusive) as well as total contributions to Wilson Inlet. Most catchments contribute a similar proportion of the total water input to the inlet all year round with a few exceptions. Cuppup Creek contributes proportionately very little during the dry months (in fact it often dries up completely over summer). Overall, the Denmark and Hay Rivers contribute by far the greatest volume of water to the inlet (64% between the two of them).

The nutrient and TSS loads for the seven gauged catchments are displayed in the maps in Figure 19. Each pie chart shows the proportion of load entering the inlet during the dry season and the wet season.

The largest TN loads are entering the inlet from the Sleeman River and Cuppup Creek catchments with most of the load being recorded during winter. The Hay River is unusual in that almost half of the nitrogen load is entering the inlet during summer. The Denmark and Little Rivers also contribute a relatively large amount of nitrogen over summer.

The variability in TP loads is greater than that exhibited by the TN loads with the Sleeman and Little Rivers and Sunny Glen Creek all contributing high TP loads and Cuppup Creek contributing only marginally less. Most of the load is entering the inlet in the winter months with the exception of Scotsdale Brook where the majority of the load is entering in summer. It is concerning that the smaller catchments are contributing a substantially larger load than the two large catchments of the Denmark and Hay Rivers.

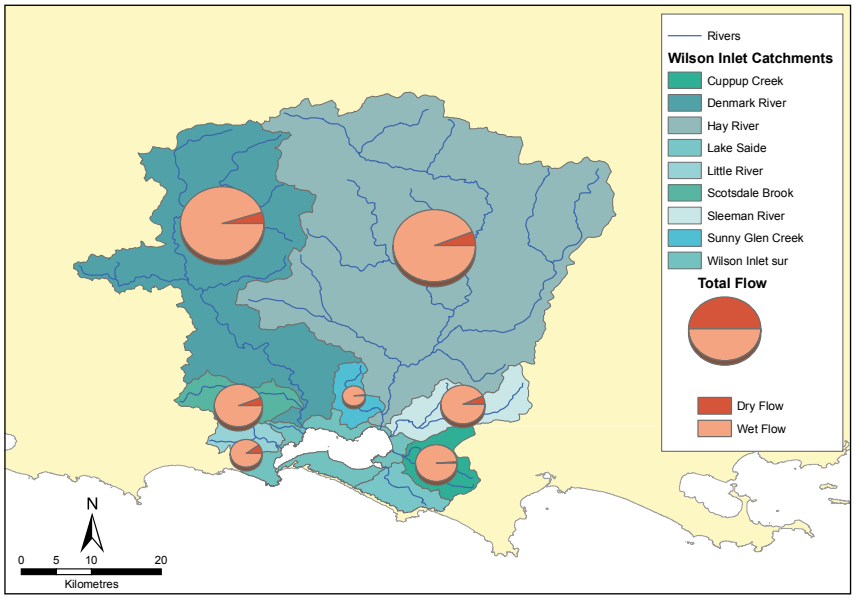


Figure 18 Flows entering Wilson Inlet from the seven gauged catchments. The size of the pie chart gives an indication as to what the total flow from that catchment is in comparison to the other catchments. Therefore catchments with large pie charts contribute more flow than catchments with small pie charts.

Cuppup Creek contributes the largest TSS load to the inlet, followed by Little River. The similarity between the TSS pie charts and the TP pie charts both in terms of the size of the loads entering the inlet and the relative dry and wet flow contributions indicates a close link between the two variables and suggests that a lot of the P may be transported to the inlet as particulate phosphorus bound to the suspended sediments.

Putting it all together

From a catchment management viewpoint having a good grasp on the information presented above is very important. It allows managers to identify areas which would most benefit from management intervention and have the greatest net effect on the receiving water body, in this case Wilson Inlet.

The four catchments of concern identified are the Sleeman and Little Rivers and Cuppup and Sunny Glen Creeks. These catchments all have comparatively high TN, TP and TSS concentrations and contribute large loads to the inlet. Further, these are all relatively small catchments (and therefore have a high nutrient export in proportion to their size) they are important focus catchments.

What is being done to address the problems

Agriculture Western Australia has carried out a good deal of modelling to determine which landuses are the biggest sources of nitrogen and phosphorus to the inlet as well as testing the effectiveness of different best management practices on nutrient export to the inlet. They did this using the WIN CMSS export coefficient model which estimates nutrient export based on land use and has been calibrated/validated with the data collected from the Department of Water catchment monitoring program. Their research has shown that currently grazing is the single largest nitrogen and phosphorus exporter, whilst dairies occupy only 1% of the catchment and yet contribute 10.7% of the phosphorus. (see Table 1). Of the nutrients entering the inlet the dissolved fraction is of most concern. This is because particulate N and P tend to get trapped by the Ruppia beds and do not travel further out into the inlet. The dissolved N and P do where they are available for use.

Table 1 Nutrient exports from different land uses in the Wilson Inlet catchment

Land Use	% P export	% N export
Remnant vegetation	3.0	3.5
Grazing	59.5	62.4
Cropping	0.1	0.1
Annual horticulture	8.7	8.2
Perennial horticulture	1.0	0.9
Plantation	11.5	14.1
Sewered urban	0.1	0.1
Un-Sewered urban	0.4	0.3
Peri-urban	2.6	2.4
Wetland	0.1	0.1
Dairying	10.7	6.0
Mt Barker saleyards	0.2	0.3
Piggery – extensive/weaners	1.6	0.8
STP – Denmark	0.4	0.7
Sullage – Denmark	0.1	0.1

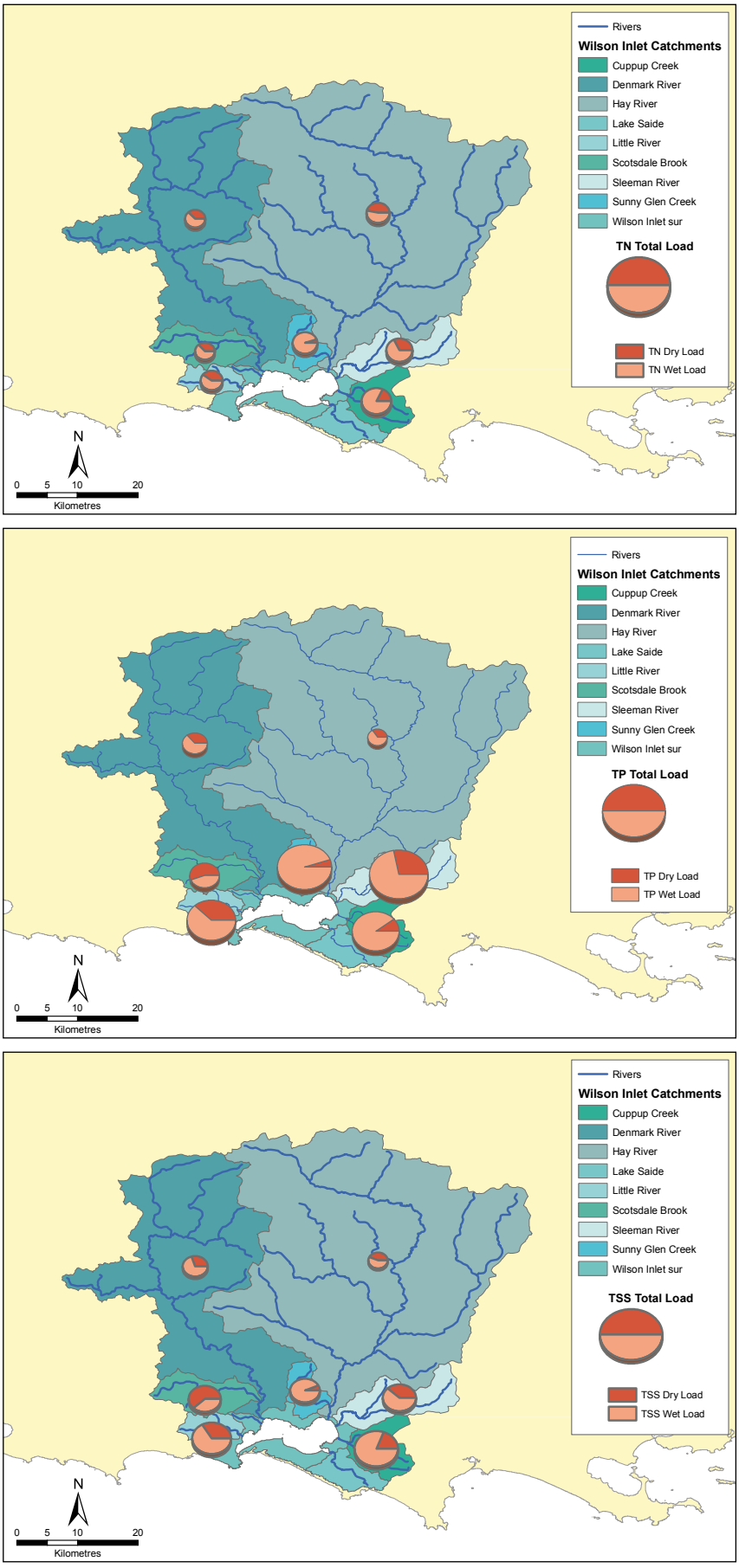


Figure 19 Nutrient and TSS loads entering Wilson Inlet from the seven gauged catchments. The size of the pie chart gives an indication as to what the total load from that catchment is in comparison to the other catchments. Therefore catchments with large pie charts contribute a greater load than catchments with small pie charts.

This would suggest that in those catchments where nutrient exports are currently high (Sleeman and Little rivers and Cuppup and Sunny Glen Creeks predominantly) nutrient reduction measures should focus on 'problem' landuse such as grazing as well as the identification and amelioration of any point sources in the catchment (such as dairies).

Agriculture Western Australia also assessed the cost effectiveness of a range of best management practices and produced a cost benefit analysis on a number of options (see Table 2)

From Table 2, to gain the maximum results for the amount of money spent focus activities should include encouraging perennial pasture uptake and effective fertiliser use. Both of these options will reduce phosphorus and nitrogen concentrations and provide a net cost benefit to the landholder (after the initial cost of establishing annual pasture yearly sowing will no longer be necessary and after the initial cost associated with soil testing effective fertiliser use will reduce the amount of fertiliser being used and hence the cost to the farmer).

Ideally however best management practices should not be viewed in isolation as in the Table 2 but rather as a component of an integrated approach to catchment management which would include a number of actions. This was identified by the Steering Group which prepared the Wilson Inlet Nutrient Reduction Action Plan (WINRAP). This plan contains a number of recommended actions to help restore and protect the inlet and it's catchments. See the boxed text for more information on this plan and its implementation.

Estimated rates of implementation of the best management practices mentioned in Table 1 at 2002 were as shown in Table 3 (taken from Agriculure Western Australia 2002)

Management actions should therefore be targeted at areas where the uptake of BMPs is currently low (in the upper areas of the problem catchments) and where the implementation of BMPs will have the greatest net benefit for the smallest outlay (again, in the upper areas of the problem catchments). This does not mean that other areas in the catchment should be ignored however, especially if there are any potential point sources.

Figure 20 Sunny Glen Creek sampling site, cattle have access to this site.

Figure 21 Revegetation work being undertaken on Cuppup Creek. The matting helps stabilise the banks whilst the plants grow.

Table 2 Cost effectiveness of selected best management practices.

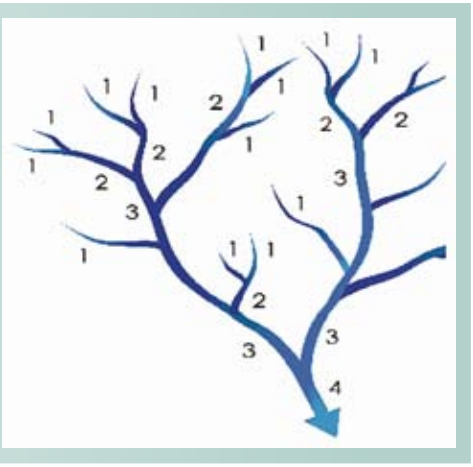
Individual BMP	Phosphorus removal (%)	Nitrogen removal (%)	Productivity (net ongoing cost)	Combined cost benefit
Perennial pasture	High	Moderate	High benefit	High
Effective fertiliser use only – grazing and horticulture	Moderate	Low	High benefit	High
Riparian fencing and revegetation	Low–moderate	High	High cost	Low
Stock control/water management on streams	Moderate	Low	Low cost	Low–moderate
Effluent management – point sources only	High	Low	Low cost	Moderate

Table 3 Estimated rates of implementation of the BMPs outlined in Table 1.

BMP	Applied to	% implementation
Perennial pasture in grazing	500–700 mm rainfall zone > 750 mm rainfall zone	10% 50%
Effective fertiliser use	Grazing horticulture	15% 25%
Stock control/water management (grazing)	2nd order streams 3rd order streams	10% 10%
Vegetation buffer/filter strips	1st order streams 2nd order streams 3rd order streams	5% 10% 50%

Determining stream order

To assist managers and scientists when talking about streams the concept of stream order was developed. There are a number of different stream order classification methodologies available but the one most commonly used is Strahler's method. Using this method the streams the furthest away from the discharge point (in this case Wilson Inlet) are the first-order streams. Two first-order streams combine to form a second order stream, two second-order streams combine to make a third order stream and so on.



Wilson Inlet Nutrient Reduction Action Plan

The Wilson Inlet Nutrient Reduction Action Plan (WINRAP) is a five-year plan to reduce nutrient export from agricultural and urban areas. The plan was released in April 2003 with the support of eight lead organisations. Implementation of the plan is coordinated by the Wilson Inlet Catchment Committee (WICC) and the Department of Water (DoW).

The WINRAP partners work with farmers in the catchment to better manage fertiliser use and movement. This includes creating nutrient and sediment interception buffers, protecting and enhancing native vegetation and excluding stock from entering waterways. By the end of 2006 the WICC had funded the infrastructure set out in the table below.

Activity	Fencing of waterways (km)	Stock crossings	Alternate water points	Revegetation (ha)
Completed	87.5	59	29	94.5
In progress	53.0	35	10	24.8
Total	140.5	94	39	119.3

In addition to this, intensive agricultural activities have also been a focus. Effluent management plans were undertaken for five dairies in the catchment. Funding was provided for farmers to undertake work outlined in these planes enabling nutrients to be recycled on the properties rather than viewed as a waste to be disposed of.

Working smarter with fertilisers and pastures is another focus of the plan. The Department of Agriculture and Food WA has been working with WICC and landowners to promote soil testing, soil health and perennial pastures in the catchment. This includes workshops, site visits and subsidies.

For more information on the WINRAP call the Department of Water Office on 9842 5760 or WICC on 9848 2955.

Figure 22 The Upper Hay catchment showing the extent of clearing in the catchment.

Other work taking place in the catchment

Further investigative work is also being undertaken in the catchment to better understand nutrient input into the inlet. A year-long project investigating groundwater flow and the impact of urban land use on nutrients discharged from groundwater to Wilson Inlet is nearing completion. This involves sampling thirteen bores in the residential ares of Weedon Hill, Little River and Minsterly Road.

Wilson Inlet Catchment Waterway Foreshore Project – 2006

The Wilson Inlet Catchment Committee (WICC) and Greenskills have received funding through LotteryWest and the Department of Water to continue the foreshore assessment surveys in the catchment. This project will focus on areas of the upper Hay River catchment and lower order streams in the Sleeman River, Cuppup Creek and Lake Saide sub-catchments.

These studies use a mixture of desktop study (with aerial photographs) and ground-truthing to map the condition of the waterways including bank stability, the amount of native vegetation, weeds and the presence of fences to protect the waterway.

Mapping projects like these are a crucial part of the planning process when revegetating waterways as well as helping to target locations that need nutrient-reduction measures such as fences and stock crossings. They also allow managers to monitor and evaluate changes to the catchment and waterways.

Landuse change in the future

Future land-use changes in the catchments will have an impact on the nutrient loads entering the inlet. Modelling conducted by Agriculture Western Australia has shown that most of the expected land-use changes will have little impact with the notable exceptions of;

- the conversion of grazing land to plantations which has been occurring in the catchment – this will cause a substantial decrease in nutrient export (however if other landuses than grazing are converted to plantations then there may be an increase in nutrient export). Whilst plantations still require the inputs of fertilisers they tend to leach less nutrients to the surrounding landscape and hence, ultimately, the inlet.
- the implementation of BMPs by piggeries and dairies which will result in a significant decrease in nutrient export.
- the phasing out of intensive agriculture which will cause a significant decrease in nutrient export
- doubling the area under annual horticulture in those sub-catchments where horticulture already exists which will lead to a significant decrease in nutrient export.

In summary

The Wilson Inlet and its catchment is showing signs of degradation related to human impact. The level of degradation of the inlet is not yet severe and through careful management the values of the inlet prized by the community can be protected. An important component of this management will be targeting catchment nutrient sources to improve the quality of the water entering the inlet. The Wilson Inlet Nutrient Reduction Action Plan lists the actions required to reduce nutrient inputs to the inlet. Ongoing monitoring in the catchment will allow the Department of Water to gauge the effectiveness of management actions undertaken in the catchment in reducing nutrient inflows to the inlet.

Recommended further reading

Agriculture Western Australia 2002, *Best management practices for nutrient reduction in Wilson Inlet and Torbay catchments* Australia, Agriculture Western Australia, Perth, Western Australia.

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Water and Rivers Commission 2000, *Wilson Inlet report to the community 3, summary of Wilson Inlet catchment monitoring program*, Water and Rivers Commission, Perth, Western Australia.

Water and Rivers Commission 1999, *Nitrogen and phosphorus in tributary inflows to the Wilson Inlet, Western Australia*, WRT 21, Water and Rivers Commission, Perth, Western Australia.

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Glossary of terms

Base flow – flow in a river which is sourced from groundwater rather than runoff from rainfall.

Best management practice (BMP) – the best practicable method of achieving water resource management needs at the present time.

Diffuse source pollution – a pollutant that is entering the waterway from a large area. For example, fertiliser run-off from farmland

Negative flow response – where nutrient concentrations decrease with increasing flow. That is, at low flows nutrient concentrations are high, as the flow rate increases, nutrient concentrations decrease. This occurs up to a certain flow rate after which nutrient concentrations level out and do not change anymore, even if flow levels continue to increase.

Point source pollution – a pollutant coming from a single source such as a dairy.

Positive flow response – where nutrient concentrations increase with increasing flow. That is, at low flows, nutrient concentrations are low. As flows increase nutrient concentrations also increase. This occurs up to a certain flow rate after which nutrient concentrations level out and do not change anymore, even if flow levels continue to increase. See Figure 14 for an example of this kind of flow response.

Storm flow – flow in a river which is sourced directly from rainfall. Storm flow will generally be faster, and water levels higher, than during base flow.

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