# Wilson Inlet 4

## Report to the Community

Government of Western Australia
Water and Rivers Commission
Wilson Inlet Management Authority
October 2001

# NEMP in Wilson Inlet

The National Eutrophication Management Program (NEMP) studies in Wilson Inlet have now been completed and the findings were presented at a public meeting in Denmark in December 2000. Detailed summaries of each of the studies and a synthesis view of how the inlet works will be presented in future newsletters. This Report to the Community provides a summary of how NEMP came to be in Wilson Inlet, what studies were conducted and what are the preliminary findings.

Studies undertaken since the establishment of WIMA in 1994 can be grouped in two main periods. During the first period, 1994 to 1997, the studies defined what we thought the risks were to the health of Wilson Inlet (problem definition). In the second period (problem understanding) from 1997 to 2000 we have developed an understanding of the processes controlling both algal and *Ruppia* growth in Wilson Inlet.

At the end of 1997 there were still a number of key questions (summarised in Report to the Community Number 1) which were critical to answer if we were to understand the processes operating in Wilson Inlet. These were:

- How much of the nutrient entering the inlet from the catchment ends up in the sediment and are the sediments an important source of nutrients to drive algal blooms? If they are, what conditions are necessary to release those nutrients?
- How much of the nutrient entering the inlet are taken up by the *Ruppia* seagrass and at what rate does this happen? At what rate does the *Ruppia* recycle those nutrients to the water? What would be the ecological (and water quality) consequence if the *Ruppia* were lost from the Inlet?
- Should we be concerned about phytoplankton blooms in the inlet? What are the key triggers to blooms?

## NEMP—National Eutrophication Management Program 1997–2000

At about the same time as we were formulating these questions, the NEMP was established at the national level where similar questions were being asked. NEMP is jointly funded by the Land and Water Resources Research and Development Corporation (LWRRDC) and the Murray-Darling Basin Commission (MDBC) to provide the scientific underpinning needed for the effective management of algal blooms. The NEMP work “...aims to develop an understanding of the causes of excessive algal activity in Australian fresh and estuarine waters, and to help managers use that understanding to reduce algal blooms”.

It was logical therefore to propose Wilson Inlet as a NEMP focus catchment representing estuarine eutrophication, since the other three focus catchments in the program, the Namoi (NSW), the Goulbourn-Broken (Vic) and the Fitzroy (Qld), relate to inland water issues.

## NEMP and Wilson Inlet

To examine the questions outlined above, three projects were selected by the NEMP and integrated into one overall program coordinated by the WRC. The Commission also established a catchment sampling program to complement the NEMP work. Additional flow measurement sites were established and weekly sampling of nutrient concentrations instituted. The results of this work were summarised in Report number 3 of this series. A comprehensive estuary sampling program was also established by the Commission to support the NEMP program, the results of which will be reported later in this series.

Prominent Australian researchers were invited to submit project proposals, which were then reviewed by the NEMP committee to make the final selection. A brief overview of the selected projects is given below and subsequent issues of this report will describe the work in more detail.

***Phytoplankton (microalgae) and nutrients***

Peter Thompson of the University of Tasmania and Luke Twomey, a postgraduate student from Curtin University were selected to examine the relationship between nutrient supply from the catchment and nutrient release from the sediment. Their first step was to analyse the water quality and phytoplankton data collected by the WRC in the previous 3 years. Wasele Hosja of the WRC in Perth provided phytoplankton identifications from the inlet each week.

Having determined the seasonal changes and differences from year to year, the researchers turned their attention to laboratory based work to understand what promotes or limits algal growth in the inlet. This is why Luke's many visits (over 20) over all seasons were short since he had to rush water samples back to the laboratory at Curtin. By growing the algae in water where temperature and light were controlled, bioassays were conducted to find out which nutrient was limiting growth.

Like all plants, algae will grow until they run out of a key nutrient such as N or P; when growth slows or ceases we talk of nutrient limitation. Growth can also be limited by light and temperature which happens in the winter. Each phytoplankton species will be limited in slightly different ways and have different strategies to deal with limitation. For example, dinoflagellates, the common red brown species in Wilson Inlet, can swim to the bottom of the inlet and take up nutrient released from the sediment.

Additional lab work determined which form of nitrogen was most important to different species of phytoplankton and at what rate it was taken up under a range of typical conditions. From all these data a much clearer understanding of the dynamics of phytoplankton growth has been gained and, integrated with the other studies provides clear directions for management actions.

***Are sediments a source of nutrients?***

The most prominent NEMP researchers in Denmark over the last three years have been the large AGSO (Australian Geological Survey Organisation) team led by David Heggie and David Fredericks. Their team was selected to:

- estimate the quantity and release rates of dissolved nutrients from the estuary bed to the overlying water and assess their importance in providing a nutrient source for both macrophytes (e.g. *Ruppia*) and algae;
- determine the microbiological processes breaking down organic matter in the sediments and controlling the production and nature of dissolved nutrients cycled from the estuary bed to the water;
- identify the most important sources of organic matter found in the estuary bed in Wilson Inlet;
- investigate the role of groundwater and sea water intrusion as processes controlling the release of dissolved nutrients found in the estuary bed.

As managers we are keen to know what conditions in the estuary lead to nutrient release from the sediments, what form those nutrients will take and whether the timing (in terms of available light and temperature) of release is such that blooms will form.

Most of these questions were answered by placing chambers on the sediment at various parts of the inlet and measuring the amount of N and P coming from the sediment as light and oxygen concentrations changed. In this way the amount of N and P and also carbon entering and leaving the sediment was determined over a number of seasons. Cores of sediment were also taken from various parts of the inlet and squeezed in bags containing nitrogen to extract the pore water or simply the water contained in the soft sediment. This nutrient rich water and all the other samples collected were analysed in portable laboratories set up in the caravan park.

Over the five approximately 2 week field programs a large area of the inlet was sampled during all seasons with the bar open and closed.

***And now the Ruppia***

*Ruppia megacarpa*, the main underwater flowering plant or seagrass in Wilson Inlet, is considered by some as a major nuisance and by others as an important habitat and nursery for fish and invertebrates. It is also a major part of the nutrient cycle in the inlet. Most nutrients enter the inlet from the catchment streams and *Ruppia* is found around the edge of the inlet at the mouths of these streams. Clearly it is in an ideal position to filter nutrients from the incoming waters but it can also cycle nutrients into the inlet when it breaks apart and spreads around.

Professor Di Walker and postgraduate student Bernard Dudley from the University of Western Australia were selected to examine the role of *Ruppia*, in the nutrient cycle in Wilson Inlet.

Their objectives were:

- to investigate the relationships between *Ruppia* growth, and its epiphytes (the algae growing on it), and the nutrient levels in Wilson Inlet;
- to use these nutrient data to determine whether nutrient limitation of growth in *Ruppia* or its epiphytes occurs on both a seasonal and an annual basis;
- to determine whether *Ruppia megacarpa* is thriving or declining, on either a seasonal or annual basis, due to excessive algal activity in Wilson Inlet.

They set about answering these questions through a combination of field experiments and laboratory growth experiments similar to those run for phytoplankton. Cores from the inlet containing both sediment and seagrass were transported back to the growth labs at the University of Western Australia where different levels of nutrients were added to determine which affected growth.

Bernard Dudley also constructed chambers (considerably less sophisticated than the AGSO ones) to place over the seagrass in the inlet to measure the rates of nutrient removal at a range of actual conditions of light, temperature and salinity. From this work we will be able to estimate how important the epiphytic algae are in both absorbing and releasing nutrients compared to the *Ruppia*. This knowledge allows us to understand the implications of increased nutrient loading to the estuary and estimate what would happen if for some reason the *Ruppia* was lost from the estuary.

### *Putting the story together*

These three studies were designed as an integrated program to provide the key to understanding the processes involved in the many cycles of uptake and loss of nutrients as they move through the inlet. Now that these studies are complete the major task is to integrate the findings of the NEMP funded work with complementary catchment and estuary sampling conducted by the WRC, and with previous studies. Synthesis workshops have been held throughout the project to bring the three groups together to discuss their findings. A final report was presented to the community during a public meeting in December 2000.

### *Not only the estuary*

*Wilson Inlet Catchment Compendium*

Following comments made at the first NEMP workshop in Narrikup in 1996, a project was funded by NEMP locally to compile all of the existing information on the catchment. Staff from the WRC and AgWest, assisted by the Wilson Inlet Catchment Committee and Jack Mercer, completed the resulting Compendium in 1999.

The Wilson Inlet Catchment Compendium contains descriptive information on the catchment such as climate, soils, flora and fauna, hydrology and geology. The Compendium outlines some of the land and water management issues in the catchment and discusses some of the techniques being used to manage the problems. It is designed to provide information to the community about the catchment where they live and is available to community groups to assist in catchment management activities. It will be updated as new material becomes available.

Insert Communication day photo here **[What phot?????]**

### *Communicating the NEMP*

NEMP projects were conducted in four catchments around Australia representing different facets of algal bloom problems. Full details can be found on the NEMP website http://www.nemp.aus.net/. Communicating the process of research in Wilson Inlet NEMP projects is an important part of the overall program and Greenskills of Denmark were contracted for this role. Many of you will be aware of the community open days down at the River Mouth Caravan Park and the NEMP annual meeting held at the Cove.

Study findings will guide management actions

More detailed accounts of the findings will be discussed in subsequent reports; the key findings for management as summarised below will be incorporated into the Wilson Inlet Action Plan.

### *Phytoplankton*

The amount of phytoplankton in the inlet was stable between 1995 to 2000. Major spring blooms occur most years approximately 50 days after the bar is opened and are triggered by the sequence:

Bar opening ⇒ Stratification ⇒ Anoxia ⇒ Nutrients

The spring bloom of either harmless diatoms or, rarely, dinoflagellates captures a large proportion of dissolved nutrients from the estuary water.

Any increase in available N or P in the estuary will lead to more blooms which will in turn increase the probability of toxic blooms. With the current nutrient inputs there is a relatively low risk of toxic blooms.

### *Sediments*

The sediments were found to be the largest pool of nutrients and a very large source of nitrogen compared to other sources. Nitrogen in the form of ammonia was continuously released from the sediments through all seasons. Most of the phosphorus entering the inlet was trapped in the sediments making them a source of phosphorus.

Denitrification is the process where nitrogen is converted into nitrogen gas by bacteria and lost to the atmosphere. This was found to be the most important means of removing nitrogen from the inlet so any action which causes a decrease in the rate at which nitrogen is removed would make more nitrogen available for algal growth. Low oxygen levels (anoxia) on the bottom will slow this process.


*AGSO benthic chamber being lowered into the inlet (to accompany sediments results section)*

We use the term stratification to describe the condition where the denser incoming sea water from the open bar slides under the outgoing fresher and therefore lighter estuary waters. Because of the high amount of organic matter in the sediments the oxygen in the bottom water is quickly depleted when stratification sets in.

Nitrogen and phosphorus release from he sediment stores will be increased if the inlet becomes more stratified (and anoxic) compared to what we have observed in these studies and therefore any activities which increase either the extent or duration of stratification should be avoided.

***Seagrass and epiphytes***

At all times of the year *Ruppia* and the attached epiphytes extract nitrogen in the form of ammonia ($NH_3$) and nitrate ($NO_3$), and phosphorus in the form of phosphate ($PO_4$) from the inlet, and as a result the *Ruppia* beds are a net sink of N and P.

*Ruppia* growth increases in September with peak growth occurring in November and breakdown of the summer's growth in March to May. The biomass (amount) of *Ruppia* is therefore about twice as high in summer as in winter.

*Ruppia* growth appears to be controlled by the amount of available phosphorus, so more phosphorus in the inlet will lead to the growth of more *Ruppia*. *Ruppia* growth responds very rapidly to changes in conditions so it is not a good measure of long term estuarine health.

To germinate, *Ruppia* requires freshwater which is provided by the winter rains, and provide valuable habitat for fish and invertebrates. Loss of Ruppia in the inlet for some reason would mean loss of that habitat and that the nutrients now taken up by Ruppia would cause some other aquatic plant to grow, most likely macroalgae and/or phytoplankton.

## Signs of Deterioration

From these studies we now understand what changes would signal a deterioration in the system. They may be summarised as follows.

- Increases in both the duration and extent of anoxic events
- Increased phosphate and nitrate in estuary waters during the spring and summer
- Increased frequency and duration of algal blooms
- Increased occurrence of toxic phytoplankton species
- Permanent loss of Ruppia from the inlet
- Permanent increase of macroalgae in the inlet

## Guidelines for Estuary Management

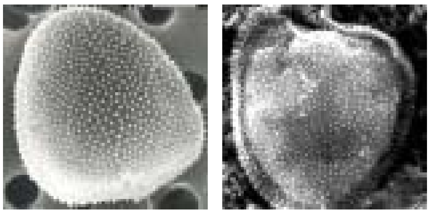
A comprehensive Action Plan for the inlet is being developed which will take into account the community needs for the use of the inlet, the findings from the NEMP studies as well as other work on and around the inlet. The latter includes a comprehensive review of the coastal processes and bar opening options and a review of the Wilson Inlet fisheries. From the NEMP work, there are some clear initial guidelines.

Since any increase in available N or P will lead to more algal growth, including potentially harmful phytoplankton, reduction in nutrient losses from the catchment are essential to the long term health of the inlet. Losses of soil and organic matter from the catchment should also be reduced.

Any activities which would increase the frequency and extent of anoxic periods in the bottom water should be avoided since anoxia both slows down the process of denitrification that is essential to removing the excess nitrogen from the estuary and allows phosphorus release from sediments. Bar openings will be managed with this in mind.

*Ruppia* and associated epiphytes are an important control on the amount of nutrient available for phytoplankton growth and provide important habitat for both invertebrates and fish. Therefore the estuary should be managed where possible to maintain the *Ruppia* habitat. Excess *Ruppia* growth is best prevented by the reduction in P from both the urban and rural catchment. Removal of dead *Ruppia* and other algae from beaches is recommended.

*Nutrient uptake measurements of* Ruppia *in the laboratory at UWA*



Prorocentrum minimum *under the electron microscope. Spring blooms involve this solitary Dinoflagellate and occasionally other species of Prorocentum.*
*(length = 20 to 40µm, width = 15 to 25µm)*

*No caption supplied for the picture above.*

*These pictures are the only ones supplied that are suitable for use in Wilson 4 (at a push!!!) and they are shown at the maximum size at which they will decently reproduce.*

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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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ISSN 1444-6200