



City to Sea

OFFICIAL NEWSLETTER OF THE ADELAIDE COASTAL WATERS STUDY

Introduction

Welcome to this, the sixth issue of *City to Sea*. Our research teams have been kept busy over the past few months with field sampling programs, data collection and analysis, and preparation of technical reports. Interest in the Study and its outcomes continues to grow and recent media articles have reported on the findings of our wastewater treatment plant and stormwater audits. These investigations are showing a generally improved quality of the metropolitan coastal waters over the past decade and this is no doubt linked to the concerted efforts of state government, industry, and catchment management boards in reducing contaminant loads.

A significant research program is currently underway at SARDI's West Beach facility where scientists are conducting a series of carefully controlled mesocosm experiments that are designed to investigate the effects of different salinity, light and temperature regimes on seagrass growth, development and survival. Preliminary results are challenging generally accepted models of seagrass decline. Seagrass health and survival is critically dependent on the plants receiving adequate amounts of light which in turn is a function of suspended matter and water clarity. As the water quality deteriorates, it is usually the seagrasses in the deeper waters which are first affected. We hope to have determined by the end of the Study why Adelaide has observed a reversal of this phenomenon. Our SARDI scientists are also being challenged on another front. Being a marine species, it is commonly thought that seagrasses are relatively sensitive to changes in salinity levels. Thus, discharges of effluent from wastewater treatment plants and urban and agricultural runoff into the marine environment are typically implicated in seagrass loss. Recent preliminary experiments at SARDI have shown that this factor may not be as significant for the seagrasses off Adelaide as



first thought. Much more work needs to be done however before we can confidently assert why and how seagrass loss is occurring.

Our colleagues at the Centre for Water Studies at the University of Western Australia continue to make good progress on the construction of a sophisticated computer model which will faithfully reproduce the physical 'forcings' of winds, currents, and tides that move Adelaide's coastal waters around. Once complete, we will use this model in conjunction with other study outputs to determine the impacts on water quality, sediments, and seagrasses under a number of scenarios. A suite of some 9 scenarios has been carefully developed by our researchers in collaboration with other agencies so that the critical stakeholder issues that were identified in Stage 1 of the ACWS will be addressed. The next 6 months will certainly be an exciting time when most of our research outcomes will come together to deliver answers to key questions.

This issue of *City to Sea* provides a report on the Study's status and provides an overview of current research work. I trust you find it informative.

**ACWS Project
Director**



Since our last newsletter, we have seen important progress with all key Study tasks. Outputs from these activities continue to promote discussion amongst research teams and the ACWS Scientific Committee and we have the opportunity to share key points with the wider community, as they emerge, through forums such as this newsletter.

The main deliverables of the Input Studies task and the Ecological Processes task are examined in some detail in this newsletter. The Remote Sensing task has made important progress towards a detailed and accurate marine habitat map for the coastal waters. The ACWS Scientific Committee got the first chance to review a preliminary draft of this during the meeting on June 29, 2004. The sediment budget team at Adelaide University have all but completed their planned field work and have more than 250 sediment samples to analyse for grain size, source, mineralogy and physical parameters. Results will underpin construction of a facies map later this year, and provide valuable sediment characteristics to the physical processes and modeling team at the University of Western Australia.

The Flinders University Oceanography group has completed field data collection activities on schedule, and is investigating options to obtain physical and water quality information from the Port Adelaide river channel to better inform coastal modeling. The CSIRO Mathematics and Information Sciences team charged with proposing long term environmental monitoring program have delivered a draft Needs Analysis Report, which will be refined prior to hand over of the Pilot Monitoring Program report.

We are currently experiencing one of the wettest winters in 30 years. Flows of stormwater from Adelaide's streets to the ocean are frequent and large, so it is fortunate that our research teams are working collaboratively to ensure that the quality and quantity characteristics of these flows to Gulf St Vincent are captured.

Summary of literature review and stormwater audit

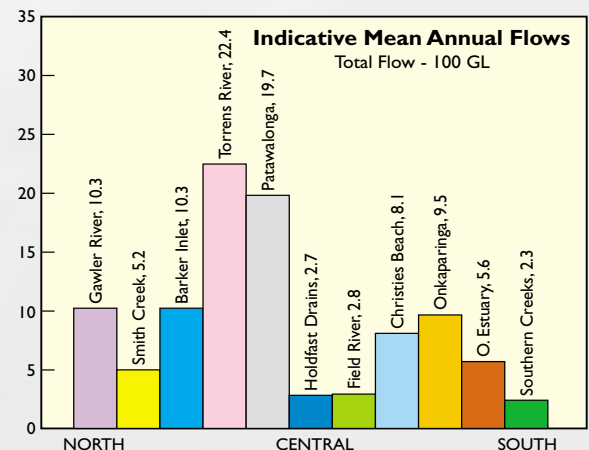
Two separate landmark reports have been delivered to the managers of the Adelaide Coastal Waters Study. Flinders University's report titled 'Audit of contemporary and historical quality and quantity data of stormwater discharging into the marine environment, and field work program' characterizes the various catchments draining to the coastal waters. The availability of data for model inputs is assessed, and gaps in previous and current monitoring are examined in order to define the field collection program for 2004.

The second technical report summarized here is a literature review titled "A review of seagrass loss on the Adelaide metropolitan coastline" prepared by SARDI Aquatic Sciences at West Beach. It is timely to consider the key points of these two reports simultaneously as we are seeking to understand cause and effect relationships between terrestrial inputs and the nearshore seagrass meadows.

Coastal Adelaide has been used as a dumping ground for urban runoff almost since the time of European settlement in 1836. Inputs to the coastal waters include a diverse array of sewage and sludge outfalls, stormwater drains and vastly altered riverine inputs.

Irrespective of source, nearly all inputs are of low salinity and contain varying levels of nutrients, heavy metals, petrochemicals, pesticides and herbicides as well as sediments.

The Flinders University audit concluded that there are 23 major and minor stormwater drainage systems in the Adelaide Coastal Waters Study area, including those contributing to the water supply system and therefore not necessarily discharging to the ocean. Combined flows to the Gulf St Vincent are estimated at 100 GL / pa. Of this, the Torrens River contributes 23%, Patawalonga River (20%), Onkaparinga River (16%), Gawler River (10%) and Smith Creek (5%). Christies Creek produces on average 8% of total runoff from only 1.6% of the total land area.



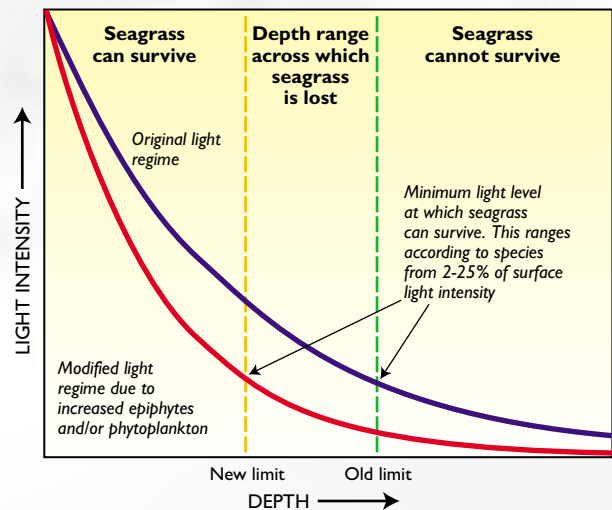
Project funded by:



The Torrens and Patawalonga River's catchments are highly urbanized and therefore a high percentage of rainfall 'runs off'. Combined, they contribute 40% of the total ocean discharges with year round flows. Peak flows in storms are significant and rainfall events of 6 mm or greater in the Sturt catchment produce a storm runoff response within 20 minutes. In 1996, 81 % of the annual load of suspended solids, 50% of nitrogen and 67% of phosphorous from the Torrens was discharged within a 2-week period.

These inputs lead to eutrophication (nutrient enrichment of originally nutrient poor Gulf St Vincent waters), sedimentation, turbidity and salinity changes. Seagrass loss along the metro coastline has most consistently been linked to eutrophication, but the pattern of loss doesn't comply with the nutrient/seagrass loss model as it is currently understood. Seagrass is decreasing in nearshore areas, whereas, seagrass in deeper waters appears in reasonable to good health. If epiphyte or phytoplankton blooms as a result of eutrophication limits light availability, then seagrass in deeper water would be expected to be affected first, providing the nutrient load is similar to nearshore areas. The bulk of seagrass loss has occurred in Holdfast Bay.

The Adelaide Coastal Waters Study (ACWS) seeks to understand why Adelaide's seagrass decline is different from that seen in other regions of the world.



Model of the decline in maximum viable depth for seagrasses due to increased nutrient loads in the water column.
Source: Westphalen et al (2004)

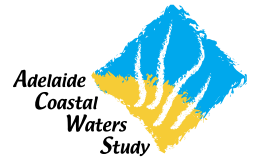
Causal mechanisms

The SARDI literature review suggests that the primary causal mechanisms for seagrass decline in the Adelaide region are likely to be a complex interaction of factors including nutrient levels, salinity changes, turbidity and sedimentation that vary both spatially and temporally in both composition and magnitude. Physical erosion is also recognized to be playing a key role in ongoing declines. The Gulf St Vincent water pollution studies conducted in the mid 1970s investigated the impact of the Torrens and Patawalonga catchments in relation to declines in seagrass. A strong correlation was identified between stormwater discharge plumes and seagrass decline, however, this overlooked the fact that the Glenelg Waste Water Treatment Plant (WWTP) discharged high nutrient waters in the same region as the river outflows. Elevated nutrients from the WWTP had led to excessive epiphyte growth, and this effectively reduces the amount of sunlight available for plant photosynthesis. When this is combined with turbid water entering the system from the catchments, the light passing through the water column to the plants is further reduced. The combined effects of wastewater and stormwater are therefore potentially more damaging than either source alone.

Toxicants are unlikely to be a significant factor in large-scale declines of seagrass along the metro coast, given the doses required to affect seagrass health. Flinders University investigated levels of toxicants in catchment flows and found that water quality data are patchier than flow (volume) data. Levels of metals (Lead, Copper, Zinc, Cadmium and Iron) have been recorded in road runoff. The predictable trend is that levels are higher the longer it has been since a previous rain event. Pesticides have been identified in the Gawler, Torrens and Onkaparinga Rivers. Herbicides Lindane and Dacthal were detected in the Gawler and Torrens River, with none detected in the Onkaparinga (the latter being a very small data set). Pesticides are present in storm waters in detectable concentrations. At certain sites (e.g. Brownhill Creek and the Torrens River) the rate of detection has been relatively high. However, this conclusion is tentatively drawn from a very small and patchy dataset and levels are unlikely to be indicative of the long-term ambient conditions.



There is little published literature that reports on investigations of multiple factors potentially affecting seagrass. The SARDI literature review noted that there is still no understanding of what nutrient levels can be tolerated by seagrass communities. Carefully controlled experiments exploring the effects of multiple factors are required as several factors may impact on Adelaide's coastal ecosystems. SARDI Aquatic Sciences, Flinders University and Adelaide University are preparing such experiments at West Beach as part of the Adelaide Coastal Waters Study.



Large scale losses of seagrass meadows result in an alteration of the system to one where phytoplankton are the dominant primary producers (with no habitat available for most of the original fauna), culminating in a dramatic loss of biodiversity. These losses also decrease the baffling of wave energy by seagrass causing sediment instability and large scale sand movement. The increased wave energy and/or mobile sediments may threaten the health of remaining seagrass, thereby creating a feedback loop; whatever mechanism caused the original loss, the seagrass, once damaged, is at higher risk of further degradation.



SARDI's literature review concludes with a statement that recent actions to improve coastal water quality (i.e. closure of sludge outfalls) and improvements in sewage treatment and catchment management are to be applauded, however, the amelioration of historical causes of decline may not affect the ongoing rate of decline and we may need to focus attention on discovering more of what encourages seagrass recruitment/succession thereby slowing water movement and promoting sediment stabilization.

How will we use this information

The knowledge gained from this stormwater audit (in parallel with the previous audit of wastewater treatment plant discharges) and ecological literature review will allow researchers to begin to confirm the ecological impacts of all historical and current marine discharges on seagrass. The effects of the key contaminants (e.g. nutrients, suspended matter and potentially one or more heavy metals) on seagrass health and dynamics will be determined through seafloor and laboratory experimentation. Among other outcomes, such experiments will assist managers to determine if the WWTP Environmental Improvement Programs, Catchment Water Management Board and Local Government/Council initiatives have resulted in lasting ecological benefits. An understanding of what is entering the system, and consequently, what impacts these inputs have will confirm which water quality parameters will best predict future ecological conditions.

Acknowledgement

Information, data interpretations and figures presented in this newsletter are sourced from ACWS Stage 2 Technical Reports:

Westphalen, G., Collings, G., Wear, R., Fernandes, M., Bryars, S., and Cheshire, A. (2004). A review of seagrass loss on the Adelaide metropolitan coastline. Adelaide Coastal Waters Study Technical Report No. 2. South Australian Research and Development Institute (Aquatic sciences) Publication Number RD04/0073, Adelaide; and

Wilkinson, J., Hutson, J., Bestland, E., and Fallowfield, H. (2004). Audit of contemporary and historical quality and quantity data of stormwater discharging to the marine environment, and field work programme. Adelaide Coastal Waters Study Technical Report No. 3. Flinders University Department of Environmental Health.

About this newsletter

This quarterly newsletter has been prepared on behalf of the ACWS Steering Committee to communicate Study status, progress, results and interesting observations as they become available. This and future issues of City to Sea will be available from the Study website: <http://www.clw.csiro.au/acws/>

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