

Dr Mike Grace: Honours Projects for 2009

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The focus of many of these projects can be modified to suit the interests of the student – from physical, analytical and/or environmental chemistry and biogeochemistry through to aquatic and/or restoration ecology.

To get a flavour of other projects currently being done or recently completed in the Water Studies Centre, please download the WSC 2007 Annual report from the WSC Home Page:

<http://www.sci.monash.edu.au/wsc/>

1/ Effects of Urbanization on Stream Metabolism

Urbanization severely and detrimentally affects the ecology of many urban streams. Such effects are most obvious in low diversity of fish and insect communities. A large amount of effort is now directed to understanding urbanization effects and developing strategies to rehabilitate impacted urban streams. The ecosystem functions gross primary production (GPP) and community respiration (CR) provide a food and energy base to sustain aquatic food webs and are the focus of this project. Key questions to be answered include: i) “How do rates of GPP and CR vary across an urbanization gradient?” and ii) “Can these ecosystem function measures be used as responsive indicators of stream health?” The project will measure oxygen metabolism in several streams across an urban gradient in the east of Melbourne and up into the Dandenongs. Field work will be augmented by laboratory measurements to identify the role of sediments and biofilms in GPP and CR.



2/ Developing an Ion-Exchange Medium with High Nitrate Affinity *with Prof Steve Langford*

Nitrate pollution is one of the greatest threats to many coastal waterways, including Port Phillip Bay. Excess nitrate can initiate major algal blooms with devastating effects. New isotope-based techniques can identify the origins of the nitrate e.g. does it come from industrial effluent, or agricultural practices? These isotope techniques require concentrated nitrate solutions, which are not often found in the natural environment, hence difficult and expensive preconcentration methods are required, to obtain sufficient nitrate without also getting high concentrations of chloride. Our joint research groups have been working towards a solution. We have recently prepared resins that show promise in nitrate selectivity and hence an ion-exchange-like material. The resins formed in this project will be derivatives of our lead and will be tested for nitrate exchange capacity, specificity for nitrate over other common anions (especially chloride) and then used for preconcentrating nitrate from a range of natural water samples.

3/ Measuring Small Lake Metabolism

with Dr Ross Thompson (Biology)

The recent development of dissolved oxygen probes based on fluorescence based detection has the potential to revolutionize aquatic ecosystem health assessments based on rates of fundamental processes such as primary production and respiration. The enhanced accuracy and precision of these new probes mean that understanding biological energy transformations in lentic systems, such as small lakes, is now feasible.

The fundamental question underlying this project is “What is a ‘healthy’ gross primary production rate – or community respiration rate – for a small lake?” Such knowledge is essential if effects of rehabilitation actions are to be assessed.

This project will examine the metabolism of the experimental lake in the enclosed Jock Marshall Reserve at Monash. This lake has recently been dredged and hence the ecosystem has been “reset”. Measurements of whole lake metabolism will be compared to primary production and respiration in specific compartments of the lake – the water column and the surface sediments. Stable isotope measurements may be used to identify the origin of the organic matter fueling respiration. The focus of this project can be modified to suit the interests of the student – from analytical and/or environmental chemistry through to restoration ecology.



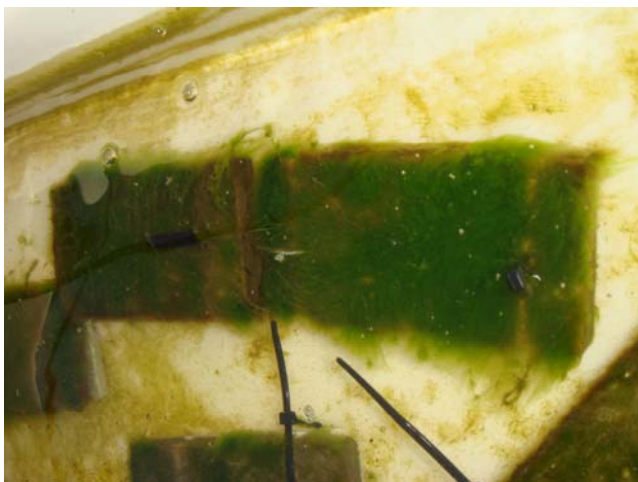
More information about the Jock Marshall reserve can be found at:

<http://www.biolsci.monash.edu.au/resources/jmr/index.html>

4/ Epiphytic algae as a site for denitrification in urban streams

with Dr Perran Cook and Prof John Beardall (Biology)

Eutrophication is caused by excess nitrogen and phosphorus entering our waterways and is a major threat to aquatic ecosystems, causing excess algal growth which ultimately leads to a loss of amenity and ecological integrity. Denitrification is a crucial nitrogen cycling pathway because it



removes bioavailable nitrogen from aquatic ecosystems and is thus an ecologically important process because it can remove excess nitrogen from anthropogenic sources. Denitrification is an obligately anaerobic process and to date, most studies of denitrification have focused on the sediment. Recent measurements have shown that algal growths colonizing hard substrates also have high denitrification rates. This may be particularly important in small streams which are dominated by hard substrates colonized by micro and macro algae. This project will use a combination of laboratory and field

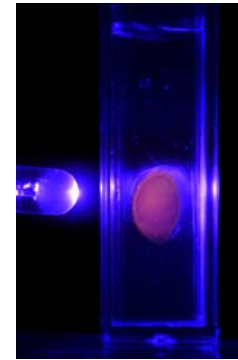
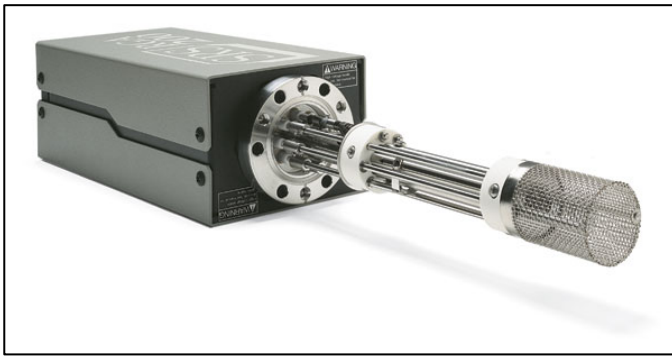
experiments to investigate the factors controlling denitrification on hard substrates colonized by algae.

5/ Membrane-Inlet Mass Spectrometry for Measuring Environmental Samples (with Dr Perran Cook and Assoc Prof Richard Morrison)

Many wetlands around Melbourne have been designed and constructed primarily for water treatment purposes. This treatment includes settling of suspended particles and removal of nitrogen through nitrification and denitrification. By acting to facilitate these processes, these wetlands can also be a sink for a wide variety of pollutants originating from the urban landscape. These include oils, detergents, pesticides/herbicides, a wide variety of chemicals – including volatile organics – from industrial and household effluent - and heavy metals. Conventionally, these pollutants must be extracted from the sediments where they accumulate, prior to analysis.

Membrane-Introduction Mass Spectrometry (MIMS) is an increasingly popular technique for investigating volatile pollutants in complex sample matrices without needing elaborate extraction and clean-up procedures. It involves using a simple peristaltic pump to pass a filtered aqueous sample past a gas-permeable membrane within the vacuum region of a mass spectrometer (MS). Any volatile components will then pass through the membrane into the ionization region of the MS, for subsequent detection.

The dual aims of this project are to optimise the performance of an existing MIMS system to quantify contaminants at environmentally relevant concentrations; and to use this MIMS instrument to investigate volatile pollutants in wetlands around Melbourne.



6/ Fluorescence-based Dissolved Oxygen Probes (with Assoc. Prof. Richard Morrison)

The dissolved oxygen (DO) concentration is a fundamentally important characteristic of aquatic ecosystems. It determines whether biota can survive and controls a large range of biogeochemical processes (e.g. heavy metal release from sediments, fate of nitrogen and phosphorus). Up until recently, DO measurements involved either tedious and time-consuming ‘Winkler’ titrations or the use of an electrochemical sensor. The Clark electrode is highly prone to drift and also consumes O_2 in the vicinity of the probe, thus rendering this method difficult to use in static water systems such as lakes, weirs or pools. It is these environments where low DO is most likely to cause environmental problems.

A completely new technique for measuring DO developed recently involves the quenching of ruthenium complex fluorescence by O_2 . The extent of quenching can be related to the oxygen concentration. O_2 is not consumed in the process, making these probes ideal for deployment in static systems, including laboratory or field-based mesocosms (experimental chambers). The major drawback of this new technology is the cost. A typical probe, with data logging capability will typically cost in excess of \$5000. Recent work at Monash has developed both the optoelectronics and the dye-based membranes to implement such a probe and this project will develop a low cost, field-deployable fluorescence-based DO sensor that will be tested in a variety of applications including streams, a lake/weir and in laboratory-based mesocosms.

7/ Investigations of Acid Sulfate Soils in Gippsland, Victoria *with Dr Barrie Bolton and Dr Ian Cartwright (Geosciences)*

Acid sulfate soils (ASS) pose a significant environmental, social and economic risk to many low-lying areas of coastal Victoria, including parts of southern Gippsland. ASS contain iron sulfides that may, when exposed to the air, produce H_2SO_4 which in turn leads to release of toxic quantities of iron, aluminium and heavy metals. ASS are often found associated with mangrove swamps, salt marshes, floodplains, wetlands, estuaries and brackish or tidal lakes. Once the processes of acid generation are underway, usually following ground disturbance brought about by such things as housing, agricultural or industrial developments, the toxic solutions produced can lead to fish kills, loss of habitat and biodiversity, conflicts between farmers, aqua-culturalists and developers, and expensive rehabilitation works. The proposed project will involve fieldwork and follow-up laboratory studies aimed at mapping the extent of ASS in parts of Gippsland, characterising their geochemistry and providing an assessment of environmental risk.

8/ An Investigation of Recently Deposited Sediment in the Fly River Delta, PNG *with Dr Barrie Bolton and Dr Ian Cartwright (Geosciences)*

The Fly River delta is one of the largest delta systems in the Australasian region. It has a classic funnel shape geometry typical of a tide-dominated system, and receives an estimated 85 MT of sediment each year; much of it very fine grained. This sediment is mainly sourced from the rapidly eroding mountains of the central PNG cordillera via two large river systems, the Fly River to the west and its much larger tributary in the east, the Strickland River. Since 1984, large amounts of mine overburden and tailings have also been released into the river system from large mining operations close to the headwaters. Since the beginning of mining operations there has been concern that mine wastes have impacted on the delta's geomorphology and geochemistry which has in turn lead to detrimental impacts on the plants, animals and people of the delta region. The proposed study will aim to characterise the texture (grainsize and shape), and composition of recently deposited benthic sediment collected from the distributary channels of the Fly River delta and to compare these results with similar studies undertaken before the start of mining.