Oral Abstracts

01 Invasion ecology – from stream theory to conservation practice

Colin Townsend[1]

1. University of Otago, Dunedin, 9054, New Zealand

During a lifetime of ecological research one theme has resurfaced repeatedly: the role of top predators in aquatic ecosystems and the impacts of predators when they invade new regions. My work started in an area of England whose streams should have held brown trout but didn't, seeking to unravel the cause and consequences of the absence of trout. Then I moved to New Zealand, whose streams shouldn't have had brown trout but did. This invasion is responsible for the local extinction of certain native fish, although particular kinds of refuge habitat allow the natives to persist in some streams. We have studied why trout and the natives cannot coexist, focusing on predation, competition and changes to host-parasite relationships. But most effort has been directed at the consequences of replacement of natives by trout, developing an understanding of effects on individual populations, community food-web interactions, and ecosystem functioning in terms of changes to productivity and nutrient cycling. The understanding that comes from fundamental and theoretical studies is crucial to the development of biosecurity policy aimed at preventing deleterious introductions as well as the management of vulnerable native species in the face of established invasions. Human global pressures, including invasions and the effects of acid deposition, continue more or less unabated. Back in England, however, brown trout have returned to some of the streams that lacked them because acid deposition has declined, and stream pH has increased, as a result of the shift in industrial production to other parts of the globe.

02 River metabolism and biofilm response to flooding and allochthonous carbon inputs in a lowland river

Robert Cook[1 2], **Ben Gawne**[1 2], **Rochelle Petrie**[1 2], **Nathan Ning**[1 2], **Gavin Rees**[1 2 3], **Darren Baldwin**[1 2 3], **Daryl Nielsen**[1 2 3]

1. Murray Darling Freshwater Research Centre, Wodonga, VIC, Australia
2. La Trobe University, A\W, Wodonga, VIC, Australia
3. CSIRO, Land and Water, Wodonga, VIC, Australia

The role of floodplain inundation to riverine carbon dynamics and riverine foodwebs is still of much conjecture in Australian lowland rivers. To date, research suggests that metabolism in regulated lowland rivers in south-eastern Australia, such as the Murray River, is predominantly supported by autochthonous production. We investigated changes in water quality, open water metabolism, biofilm development and biofilm stable isotope (∂13C) signatures upstream and downstream of the Barmah-Millewa Forest (BMF) before and after a major floodplain flooding event.

Prior to flooding, all sites had similar concentrations of dissolved organic carbon (DOC), metabolism and biofilm ∂13C signatures. During flooding, DOC increased up to 3 fold downstream of the BMF, gross primary production (GPP) increased at all sites, however, community respiration (CR) increased only at the sites downstream of the BMF by as much as 25 fold, with a corresponding decrease in net production (NP).

Biofilm ∂13C signatures became depleted by between 4 - 7 downstream of the BMF following flooding. We suggest that this reflects the incorporation of terrestrial carbon within the biofilm matrix and subsequent fractionation against 13C. Whereas, biofilm signature upstream of the BMF continued to reflected an autotrophic ∂13C with potential carbon limitation and subsequent ∂13C depletion.

This study indicated that flooding of the BMF provided an increase to the annual energy budget and processing of the allochthonous DOC into the river biofilms during flooding providing a potential pathway for allochthonous carbon to be incorporated into the metazoan food web.

Oral Abstracts

03 Fungal community dynamics and leaf litter decomposition in Australian alpine streams

Stephanie G Suter[1 2], Gavin Rees[1 3], Ewen Silvester[2]

1. *Murray-Darling Freshwater Research Centre, Wodonga, VIC, Australia*
2. *La Trobe University, WODONGA, VIC, Australia*
3. *Land and Water, CSIRO, Wodonga, VIC, Australia*

Despite the recognised significance of aquatic hyphomycetes in leaf litter decomposition in streams, few studies have been carried out in the Australian environment and only one prior study in Australian alpine streams (Suter et al. 2011). The Australian alpine environment is distinct from other parts of the world, with a characteristic flora in particular Eucalyptus pauciflora (snow gum), the only native tree species to occur in the alpine area. *E. pauciflora* have slow breakdown rates, in comparison to other eucalypt species and deciduous Northern hemisphere species. Given the extreme weather fluctuations and the nature of the litter present within the streams, this study investigated the fungal community at both temporal and seasonal timescales in alpine streams of south-eastern Australia. Sporulation, biomass and DNA-based studies combined showed that the fungal community changed over time and seasonally, with the greatest differences occurring between the two extremes of summer and winter. Synchrotron infrared microspectrocopy also revealed internal changes to leaf chemistry as decomposition occurred.

04 Root-zones of wetland plants - hot spots for nitrogen removal?

Mike Grace[1], Dale Christensen[1], Stephanie Robson[1], Jennifer Tank[1], Sarah Roley[2], Perran Cook[1]

1. *Monash University, Clayton, Vic, Australia*
2. *Notre Dame University, South Bend, Indiana, USA*

Preliminary research has found that the root-zones of wetland plants can provide conditions conducive to the removal of excess nitrogen in sediments, which may otherwise result in eutrophication problems in wetlands and other aquatic ecosystems. It is believed that labile carbon exudates and dynamic oxic-anoxic switches over a 24 hour period surrounding the root-zones can stimulate both nitrification (ammonia to nitrate) and denitrification (nitrate to nitrogen gas). Questions remain about the effectiveness of this nitrogen removal and whether different plant species are more or less effective than others in N removal as nitrogen gas.

This talk will provide an introduction to the latest developments in the 'push-pull' methodology used in these experiments and present results from several common wetland plants including Typha, Phragmites and Cladium from the Ornamental Lake at the Royal Botanic Gardens, Melbourne.

Oral Abstracts

05 Spatial variation of biogeochemical tracers across an arid-zone catchment

Jordan Iles[1], Neil Pettit[2], Grzegorz Skrzypek[1], Pauline Grierson[1]

1. *Ecosystems Research Group and Australian Biogeochemistry Centre, School of Plant Biology, The University of Western Australia, Crawley, WA, Australia*
2. *Centre of Excellence in Natural Resource Management, The University of Western Australia, Albany, WA, Australia*

In May 2013, we surveyed 25 pools of varying size, habitat type and hydrology along a 450 km section of the Fortescue River of the Pilbara region of northwest Australia. We sought to (i) investigate basin-wide patterns in the distribution of nutrients and stable isotopes, and (ii) to assess if higher trophic levels (fish) reflect pool biogeochemistry. We measured $\partial^{2}H$ and $\partial^{18}O$ of water, $\partial^{13}C$ of dissolved inorganic carbon ($\partial^{13}C$-DIC) and a range of water quality parameters and nutrient concentrations in all pools. Major sources of dissolved organic matter (DOM) into pools were assessed by fluorescence spectrometry. We also measured ^{13}C and ^{15}N of primary producers and fish spanning three feeding niches. Preliminary analyses suggest that pools are most similar to each other according to catchment position (Upper versus Lower catchments). We found that more evaporated pool water (more positive $\partial^{18}O$) correlated to higher dissolved organic nitrogen (DON) concentrations (Pearson's r = 0.72, P ‹ 0.001), and $\partial^{13}C$-DIC (Pearson's r = 0.70, P ‹ 0.001). However, the $\partial^{13}C$-DIC of surface waters ranged from -5.0 to -12.6 (mean -10.40 ± 1.56) indicating that most DIC has been contributed by groundwater. DOM fluorescence components also demonstrate significant variation in sources and concentrations of DOM supporting aquatic food webs. On-going work is assessing how well fish isotopic composition reflects their immediate habitats and whether these measures can be used as proxies for pool connectivity within sub-catchments.

06 Assessing the impact of multiple stressors on wetland ecosystem function

Teresa J Mackintosh[1], Ross M Thompson[2], Jenny Davis[1]

1. *School of Biological Sciences, Monash University, Clayton, VIC, Australia*
2. *Institute for Applied Ecology, University of Canberra, Canberra, ACT, Australia*

Local communities are influenced by the fluxes of species across the landscape. Understanding of local patterns of species composition and trophic structure can be enhanced by adopting a metacommunity approach, which combines community dynamics and spatial ecology. Metacommunity studies to date have focused mainly on how dispersal and connectivity affect the diversity of communities, rather than on food web structure. In this study we tested hypotheses about the effects of dispersal limitation, habitat connectivity and ecosystem size on the diversity and food web structure of freshwater metacommunities in Central Australia. Freshwater systems in the arid zone present an opportunity to investigate metacommunity processes on large-scale natural systems with strong barriers to dispersal. We sampled 10 freshwater sites across the West McDonnell and George Gill ranges in the Northern Territory in January 2012 for aquatic invertebrates, water quality and habitat characteristics. Food webs were assembled using literature information and stable isotope analysis. There was no effect of habitat size on food web complexity or on species richness. The communities have similar food web structure and habitat connectivity (to other source communities) was not found to influence food web structure, in spite of the differences in species composition among the communities. This work aim to contribute to a greater understanding of how spatial processes interact to maintain diversity and to generate structure in communities.

Oral Abstracts

07 Evaluation of a Dissolved Oxygen sensor network recently installed to improve monitoring of low oxygen levels in environmental and natural flows within the Riverina and Sunraysia areas of NSW

Gerhard Schulz[1], Daniel Hannon[1]

1. *NSW Dep. of Trade and Investment, Deniliquin, NSW, Australia*

Low oxygen blackwater events are a common and sometimes natural occurrence in the Murray River's lowland systems during flood events. Some blackwater events are severe and can cause large scale mortalities in fish and other aquatic organisms. These events can be extensive in size and affect more than one State. The NSW Office of Water, as leading authority for water management in NSW has an interest in monitoring such events and where possible advises on flow adjustments to minimise the adverse effects caused by low oxygen concentrations in the rivers. To be able to manage future blackwater events more effectively, the NSW Office of Water has installed real time DO sensor technologies integrated into the existing Hydrometric network in blackwater affected areas. This paper discusses the trial of 10 DO sensors during an extensive 2011-2012 blackwater event

08 Do freshwater metacommunities in the Arid Zone function as meta-food webs?

Clarissa Barbosa[1], Jenny Davis[1], Jayne Brim Box[2], Glenis McBurnie[2], Ross Thompson[3]

1. *Monash University, Clayton, Vic, Australia*
2. *Department of Natural Resources, Environment, The Arts and Sport, Northern Territory Government, Alice Springs, NT, Australia*
3. *Institute for Applied Ecology, University of Canberra, Canberra, ACT, Australia*

Local communities are influenced by the fluxes of species across the landscape. Understanding of local patterns of species composition and trophic structure can be enhanced by adopting a metacommunity approach, which combines community dynamics and spatial ecology. Metacommunity studies to date have focused mainly on how dispersal and connectivity affect the diversity of communities, rather than on food web structure. In this study we tested hypotheses about the effects of dispersal limitation, habitat connectivity and ecosystem size on the diversity and food web structure of freshwater metacommunities in Central Australia. Freshwater systems in the arid zone present an opportunity to investigate metacommunity processes on large-scale natural systems with strong barriers to dispersal. We sampled 10 freshwater sites across the West McDonnell and George Gill ranges in the Northern Territory in January 2012 for aquatic invertebrates, water quality and habitat characteristics. Food webs were assembled using literature information and stable isotope analysis. There was no effect of habitat size on food web complexity or on species richness. The communities have similar food web structure and habitat connectivity (to other source communities) was not found to influence food web structure, in spite of the differences in species composition among the communities. This work aim to contribute to a greater understanding of how spatial processes interact to maintain diversity and to generate structure in communities.

Oral Abstracts

09 Contrasting refuge use as a response to drying by aquatic invertebrates in semi-arid and temperate creeks

Sylvia Hay[1], Kim Jenkins[2], Patrick Driver[2], Richard Kingsford[1]

1. *University of New South Wales, Sydney, NSW, Australia*
2. *NSW Office of Water, Orange, NSW, Australia*

Intermittent drying is an influential feature of many arid and temperate rivers and creeks in Australia. While persistent pools represent stable patches recognised to maintain sources of invertebrates in drying creeks, alternative refugia might also be important. The significance of refugia such as in-sediment dormancy that allow invertebrates to maintain viability during dry times have seldom been explored. We tested the importance of in-sediment dormancy and aerial dispersal as alternative refugial mechanisms in both semi-arid and temperate creeks. We predicted distinct invertebrate assemblages between creek types, with colonisation patterns that reflected susceptibility to drying. Both dry sediment and aerial recolonisation were found to be important mechanisms for maintaining diversity, with in-sediment dormancy particularly important in semi-arid creeks. Aerial colonisation was used by a distinct and complimentary set of taxa to those utilising dry sediment. Dry creek beds represented significant short-term refugia for many taxa, with semi-arid creeks showing greater resilience to extended drying. Under climate change available aquatic habitat is expected to decrease, with extended dry periods making alternative refugial mechanisms increasingly important.

10 Meta-population dynamics in zooplankton communities: untangling the role of parasites, predators, and food availability

Amanda Valois[1], Robert Poulin[1]

2. *University of Otago, Dunedin, Otago, New Zealand*

Understanding the variation in populations across space and time is one of the central interests of ecologists today. Zooplankton populations are influenced by a number of abiotic (e.g., temperature, water chemistry) and biotic (predation, resources, parasitism) factors, and the relative strengths and interactions among them have been shown to vary considerably. Zooplankton inhabiting ponds represent an excellent model system to study the relative roles of these factors because of their well-defined boundaries and ease of sampling. However, most landscape-scale studies that have included parasitism in variance partitioning models have been conducted on lakes. Here we present a field study examining temporal and spatial variation in density among populations of the copepods *Boeckella triarticulata* and *B. dilatata* sampled from ponds in the South Island, New Zealand. This is the only landscape-level study on copepods that has examined the role of parasites as potential population regulators. Initial sampling (2012) revealed that 17% of the *Boeckella* populations were infected by parasites and that the presence of the parasite was not affected by hydroperiod or fish presence. Further sampling in 2013 was conducted in order to partition the variance in Boeckella population dynamics explained by changes in predation and resource availability in comparison to impacts attributed to parasitism. Subsequent analyses revealed that parasitism appears to play a significant role during the spring, when predation levels are low and resources are high. However, increased predation and development times in the summer appear to limit the persistence, and therefore the effects, of the parasite.

Oral Abstracts

11 Microrefuges for invertebrates in a wetland in response to drying

Scott R Strachan[1], Edwin T Chester[1], Belinda J Robson[1]

1. Murdoch University, Murdoch, WA, Australia

Seasonally intermittent freshwater environments show enormous temporal changes in habitat area, ranging from extensive surface water and relatively constant environment in winter to a dry, hostile even desiccated environment in summer. Invertebrates respond to adverse conditions through physiological adaptations and behavioural responses and may use these traits to retreat into microrefuges in the substrate when wetlands dry. This study examined the responses of invertebrates to drying within a wetland to identify microrefuges and their invertebrate occupants. We sampled from three potential microrefuges: surface depressions, shallow cracks and deeper fissures in the substratum of South Lake on the Swan Coastal Plain, Western Australia. Ten microrefuges of each type were randomly selected and sampled at each of three times during summer-autumn: as the wetland dried, during the dry period; as the wetland refilled to observe patterns of faunal occupancy. A was a large change in species richness was observed over the drying and reflooding cycle corresponding to changes in habitat area and physicochemical conditions.

Macroinvertebrate composition differed between microrefuges, the largest effect was turnover of species between times. Sediment organic content did not differ between times, but temperature and water content differed strongly between times across the three microrefuges. Many insects completed their aquatic stage and emerged as aerial adults before the wetland reflooded, whereas most of the crustaceans survived the drier months as resistant forms, and hatched out after the reflooding. Small scale habitat variability is important providing microrefuges for the survival of macroinvertebrates in this increasingly dry climate

12 Identifying Climate Change refuges for freshwater biodiversity across Australia

Cassandra James[1 2], Jeremy VanDerWal[1 3], Samantha Capon[4], Nathan Waltham[2], Lauren Hodgson[1 3]

1. *The Centre for Tropical Biodiversity & Climate Change, James Cook University, Townsville*
2. *TropWATER (Centre for Tropical Water & Aquatic Ecosystem Research), James Cook University, Townsville*
3. *eResearch Centre, James Cook University, Townsville, QLD, Australia*
4. *Australian Rivers Institute, Griffith University, Brisbane*

Freshwater ecosystems have very high biodiversity relative to their areal extent. They are particularly vulnerable to climate change because of their limited extent, their limited connectivity and, in much of Australia, their susceptibility to drying resulting from the high variability of temperature and rainfall. Identifying and managing freshwater refuges that will help protect Australian biodiversity from the impacts of climate change must be an important element of all future conservation planning and policy. Climatic stability is increasingly recognised as a key component of climate refuges, yet the identification of areas that combine relative future climatic stability with high biodiversity values has so far been elusive. Here we address this challenge by building ecological niche models (species distribution models) for multiple freshwater species (fish, crayfish, turtles and stream frogs) to identify broad-scale climate refuges as areas that minimise the impact of future climate change and are predicted to remain stable with respect to their freshwater species diversity. Substantial shifts in the distribution of environments suitable for freshwater taxa are predicted with highlands and upstream regions identified as important refuges for most taxa. For some taxa, areas of high instability overlap with areas currently notable for their high freshwater biodiversity values. This study presents the results of the first attempt to provide a continental-scale assessment of freshwater climate refuges across Australia.

Oral Abstracts

13 Predicting the refugial value of Australia's Ramsar wetlands under climate change

Samantha J Capon[1], Cassie James[2], Jeremy VanDerWal[2], Lauren Hodgson[2], Nathan Waltham[2]

1. *Australian Rivers Institute, Griffith University, Brisbane*
2. *James Cook University, Townsville*

Ramsar sites represent Australia's most highly valued wetlands and a major policy approach to ensuring their conservation and effective management. Climate change is not currently addressed by the Ramsar convention but poses a significant threat to the ecological character of wetlands across the continent and their role as refuges for biodiversity in particular. Here, we examine the likely refugial value of Australian Ramsar sites under future climate change by assessing their projected climatic stability. We also use species distribution models to investigate the potential suitability of these Ramsar sites for biodiversity in the future. The results indicate that Ramsar sites across Australia are likely to experience temperature increases between 2.5 and 4.4 °C by 2085 with highly unstable temperatures projected relative to current conditions. Significant changes to precipitation patterns and runoff are also projected. Findings suggest that declines in the species richness of key freshwater taxa can be anticipated in most Ramsar sites. Overall, the results indicate that Ramsar sites in south-west Australia are likely to be the least climatically stable under future climate change while those in the Northern Territory appear likely to have high future refugial value with respect to climatic stability. Ramsar sites on Australia's east coast are predicted to be affected the least with respect to the stability of species richness amongst key taxa.

14 Hazard to wetlands: a land-use/pressure characterisation at the landscape scale

Bill Senior[1]

1. *Department of Science, Information Technology, Innovation and the Arts, Brisbane, QLD, Australia*

Under the Queensland Wetlands Program (QWP) the Queensland State-wide Wetland Assessment and Monitoring Project (QSWAMP) provides a conceptual and operational framework for assessing and monitoring the state of, and hazard to, the processes and values of lacustrine (lake) and palustrine (swamp) wetlands. The initial phase of this project provides a landscape scale assessment of hazard arising from human induced pressures to wetlands in the Great Barrier Reef (GBR) catchment. In particular the assessment aims to characterise pressures arising from different land-uses and enable the attribution of mapped wetlands with a modelled level of hazard.

22 potential pressures on wetlands were identified within five categories:

- Inputs (including nutrients, sediments, pesticides etc.)
- Harvesting/exploitation
- Water regime change
- Biological introduction/perpetuation
- Habitat disturbance or alteration

Each individual pressure was qualitatively associated to 15 customised broad land-use groupings and 16 facilities/infrastructure land use types by a process of expert elicitation. This enabled the production of a 'pressure profile' for each land-use. Customised weightings (based on these profiles) were then used to provide a mapped level of landscape scale hazard based on state held land use mapping and facilities/infrastructure data sets. The most important pressures and the land-uses most strongly associated with driving those pressures on wetlands were identified. Landscape scale hazard arising from land uses was mapped for all of the more than 14000 individual wetlands in the GBR catchment.

This important step in the operationalization of QSWAMP enhances the conceptual understanding of pressures acting on wetland ecosystems and provides a landscape scale quantification of hazard from human induced land-use practices.

Oral Abstracts

15 Assessing the Impact of Longwall Coal Mining on the Hydrology of Upland Swamps of the Woronora Plateau, New South Wales

Martin Krogh[1], Adam McSorley

1. NSW Office of Environment & Heritage, Sydney, NSW, Australia

There has been considerable debate over the interaction between longwall mining subsidence and loss of flow in stream systems. Upland swamps on the Woronora Plateau provide significant baseflow to the streams of the Sydney Drinking Water catchment. In recent times however, a number of upland swamps have been significantly impacted by longwall mining, leading to the loss of perched aquifers within these swamps. This has then led to the near complete loss of flow in the stream channel immediately downstream of such swamps. Such impacts potentially have important consequences for a variety of aquatic organisms including a range of threatened species. In anticipation of mining affecting a number of these swamps, a before-after-control-impact-(BACI) research program was implemented to look at the impacts of longwall mining on upland swamp aquifer levels and their subsequent flow delivery to streams. Preliminary results from this research program demonstrate a relative loss of water within the first swamp to be undermined, a flashier response in terms of stream flow after impact and a much faster drying up of the swamp's peaty sediments. These preliminary results are contrasted with the behaviour of nearby reference swamps which have not been undermined. The implications of such research suggest that longwall mining can have serious impacts on the surface and groundwater hydrology of the Woronora Plateau. Such impacts are likely to have important flow-on effects to aquatic species and downstream users.

16 Tasmanian wetlands – a reference condition approach for wetland assessment using macroinvertebrates

Toni Furlonge[1 2], Jenny Davis[3], Fiona Dyer[1]

1. IAE, University of Canberra, Canberra, ACT, Australia
2. NRM North, Launceston, TAS, Australia
3. Monash University, Melbourne, TAS, Australia

Reference condition approach (RCA) assessments using macroinvertebrates for river systems are implemented around the world however the understanding to implement similar approaches for wetlands is inadequate. We do not know whether the underlying philosophy and assumptions of habitat type and prediction for rivers applies to wetlands. For example, river biota are thought to be strongly physically controlled and therefore habitat characteristics can be used to predict biota. More stable environments such as wetlands normally have stronger biological controls. How does this apply to wetlands? This project has addressed the knowledge gap in Tasmania by sampling 80 wetlands encompassing a wide range of wetland types. Macroinvertebrate assemblages were identified, surface water quality was analysed, local characteristics were recorded on site and catchment characteristics were derived from existing GIS datasets. Macroinvertebrates were linked to 5 wetland types derived from landform, with further analysis being implemented to include local and catchment characteristics. Preliminary results indicate that the wetland type has a substantially greater effect on the macroinvertebrate assemblage than does the type of wetland habitat, the temporal variation or the seasonal variation.

Oral Abstracts

17 A comparison of remote camera and on-ground detection methods for determining water bird species presence

Kelsie Redman[1], Andrew Hall[2], Skye Wassens[3], Heather McGuiness[4]

1. *School of Animal and Veterinary Science, Charles Sturt University, Wagga Wagga, NSW, Australia*
2. *Institute of Land, Water & Society, Charles Sturt University, Thurgoona, NSW, Australia*
3. *School of Environmental Science, Charles Sturt University, Thurgoona, NSW, Australia*
4. *Black Mountain Laboratories, CSIRO, Black Mountain, ACT, Australia*

Monitoring waterbirds during environmental watering actions can provide important information on the success of watering actions as well as indicating vegetation and food source suitability. The three key methods that can be used to monitor waterbirds are aerial surveys, ground surveys and camera monitoring. A comparison of the potential for ground surveys and camera monitors to detect a range of waterbird species was carried out at three wetlands within the Western Lakes complex in the Lower Murrumbidgee floodplain. Two replicate ground surveys (am and pm) were performed at each site in October and December 2012 (four surveys per site in total). Three camera monitors were established within each wetland taking two daily images for the period between September and November 2012 (approximately 160 images per site). Using both methods, a total of 41 waterbird species were detected and despite a smaller number of surveys, ground-surveys detected more than twice as many species as cameras, and had a higher probability of detecting species. When the time taken to establish and process camera images is taken into account ground surveys are more efficient when the aim is to establish species richness, abundance, or the presence of rare species then fixed cameras. However camera monitors may still be useful for monitoring rookery sites, and monitoring changes in species over a period.

18 Extreme events and the increasing risk of contamination of urban waterways and wetlands

Jenny A Davis[1], Ian M Kidd

1. *Monash University, Clayton, VIC, Australia*

Launceston, in northern Tasmania, is Australia's third oldest city and supports a regional population of 90,000. Residents have long been concerned about poor water quality and excessive sedimentation in the Tamar River, on the cities doorstep. Silt raking is currently being used as a short term solution and has unexpectedly exposed massive sewage contamination. Specifically, the silt rake has often become clogged with tampon strings. The cause can be attributed to aging urban infrastructure. The sewage and stormwater runoff from older parts of the city are combined. This means that the secondary treatment plants cannot cope with the sudden increase in stormwater that occurs during high rainfall events. At these times all wastewater (stormwater and raw sewerage) is released directly into the Tamar River. The problem of sewage overflows into natural waterways and wetlands occurs throughout Australia. Pumping stations are often located close to streams or wetlands which are intended to act as emergency receiving waters when pumps fail or systems become overloaded. The Launceston issue is a timely warning. We have to ensure that urban wastewater infrastructure is designed to cope with extreme events. We need to acknowledge the adverse water quality outcomes likely to arise from organic pollution under a warming climate. If not, the important biodiversity, recreational and aesthetic values of urban wetlands and waterways will disappear and the risk of water-borne and mosquito-borne diseases will increase.

Oral Abstracts

19 Integration of wetlands into the Hydrogeological Landscapes Framework for the southern tablelands of southeast NSW

Alison Cowood[1], Leah Moore[1], Allan Nicholson[2], Donna Hazell[3]

1. *University of Canberra, Belconnen, ACT, Australia*
2. *NSW Department of Primary Industries, Wellington, NSW, Australia*
3. *Southern Rivers CMA, Braidwood, NSW, Australia*

The Hydrogeological Landscape (HGL) Framework provides an interdisciplinary structure for the understanding of how water and materials are distributed and hazards manifest within the landscape. The HGL Framework has been adopted by the Southern Rivers Catchment Management Authority as a natural resource management (NRM) tool for salinity hazard identification and mitigation. To expand the applicability to NRM, this project was designed to adapt the HGL Framework for wetland management and climate change hazard, providing an innovative conceptual framework for wetland characterisation, typing and behaviour.

The project aimed to divide the southeast NSW landscape into areas of similar hydrological characteristics (HGL units) and investigate spatial variability of wetland presence and wetland types within the landscape. These two components were conceptually integrated before field testing and validation was undertaken to define management areas and develop specific management strategies.

A total of 34 HGL Units have been produced for the southern tablelands study area, each with a unique conceptual model of the functioning of surface and groundwater systems, based on the climate, topography, geology, regolith, soil and vegetation characteristics of the landscape. Wetland types that will change hydrologically due to climate change are: inland billabongs, floodplain or rainfall/runoff swamps and freshwater lakes, upland hanging swamps, bogs, fens and freshwater lakes, alpine bogs, fens and glacial lakes and riverine wetlands.

This presentation will focus on four HGL Units, the wetland types within them, how climate change will impact the surface and groundwater systems and influence the presence of wetland types within the landscape.

20 Can the freshwater bivalve *Hyridella depressa* be used as a bioindicator to evaluate the health status of the mine polluted Molonglo River, New South Wales, Australia?

Chamani P.M. Marasinghe Wadige1 [1], Anne M. Taylor[1], William A. Maher[1], Mark Lintermans[1], Frank Krikiwa[1]

1. *Institute for Applied Ecology, University of Canberra, Bruce, ACT, Australia*

In polluted aquatic systems, sediments are the most important sink of contaminants and consequently as a source of pollutants to biota. Sediment bound contaminants may persist for many decades, for example, high concentrations of metals are still present in the Molonglo River sediments following the cessation of the Captains Flat mine operation in 1962. In this context, sediment is considered an important compartment to be investigated. The usefulness of *H. depressa* as a bioindicator to assess sediment toxicity was initially established by studying its *exposure-dose-response* to metal spiked sediment in laboratory microcosms. *H. depressa* was exposed to three different concentrations of single metal spiked sediment (cadmium, lead and zinc) for 28 days. Dose was measured by total accumulated metals in whole body and individual tissues and s ub-cellular distribution of each metal was examined in hepatopancreas tissue. After 28 days exposure enzymatic and cellular biomarkers were measured as dose related responses. Despite high concentrations of metals in the sediments, exposure organisms accumulated relatively low concentrations of each metal. Labial palps accumulated significantly higher lead concentrations and gill accumulated significantly higher cadmium and zinc concentrations. A high percentage of all accumulated metals was detoxified and stored in metal rich granules. The biologically active metal fraction increased with metal exposure. Oxidative stress of *H. depressa* was evident from the biomarkers measured. Our response biomarker data indicated that metal exposure and dose significantly affected *H. depressa* indicating it would be a good bioindicator for evaluation of the health status of the Molonglo River.

Oral Abstracts

21 Five benefits of incorporating DNA-barcode data into research and monitoring programs.

Michael Shackleton[1], Gavin Rees[1]

1. Murray Darling Freshwater Research Centre, Wodonga, Vic, Australia

The accurate identification of aquatic organisms is central to conducting robust bioassessments. With the development of molecular techniques, DNA is now being recognised as an ideal way to identify organisms and promises to revolutionise the way we conduct monitoring and research in aquatic environments.

We undertook complementary classical identification procedures and DNA barcoding on aquatic macroinvertebrates to investigate the potential benefits of incorporating DNA barcoding into our long term biological monitoring programs. The application of DNA barcodes to inform species identification was found to be limited by the availability of species with corresponding DNA sequences on web-based databases. However, we found DNA barcode data enhanced or complimented morphologically-based data in five areas: providing greater resolution on identifications, revealing incorrect morphologically-based identifications, providing evidence for cryptic taxa, providing associations between adult and immature life stages, and confirming morphologically-based species delineations.

Our findings illustrate the potential benefits of incorporating molecular approaches to aquatic research and monitoring programs. However, to capitalize on barcoding techniques, a comprehensive barcode library of Australian aquatic organisms is essential.

22 Developing a Species At Risk (SPEAR) index, a trait-based biomonitoring approach, to detect the impact of low flows on south-east Australian rivers

Daniela P Cortez[1], Ben Kefford[1], Ivor Growns[2], Simon Mitrovic[1 3], Richard Lim[1]

1. University of Technology, Sydney, Broadway, NSW, Australia
2. NSW Office of Water, Armidale, NSW, Australia
3. NSW Office of Water, Sydney, NSW, Australia

Demand for water resources are particularly high during prolonged periods of drought. With predicted climatic changes, such impacts are expected to intensify within river ecosystems, particularly during low flow conditions. Identification of biological responses to these conditions may provide a valuable management tool for identifying and assessing catchments at risk.

The Species at Risk (SPEAR) index, is an effective tool for identifying stressor-specific effects based on physiological and biological traits of organisms. Previous successful SPEAR indices include SPEARsalinity and SPEARpesticides The SPEAR index may be an approach to assess risk and provide insights to underpin the implementation of preventative management strategies to reduce the impacts of prolonged drought on the riverine ecosystem.

This research will develop trait-based indicators to identify the impacts of low flow on the macroinvertebrates of south-east Australian rivers using the SPEAR method (SPEARlow flow). This will include acquisition of data from existing databases, supplemented with laboratory-based testing of traits of macroinvertebrates in response to low flow stressors (e.g. increased temperature, decreased oxygen, rheophily). Data obtained to date will be presented at the Congress.

The above research will contribute to a current PhD project, which aims to develop an understanding of water abstraction effects on river ecosystem processes and communities in an Australian context.

Oral Abstracts

23 The status of free flowing rivers in Australia

Janet Stein[1], Jamie Pittock[1]

1. *Fenner School of Environment and Society, Australian National University, Canberra, ACT, Australia*

Free flowing rivers retain the natural hydrological, ecological and geomorphological processes associated with river flow. Free flowing rivers are likely to be more resilient to climate change impacts and by allowing biota to move to more suitable habitat may facilitate climate change adaptation. Definitions of free flowing vary but all highlight the absence of dams and other major water infrastructure that restrict the movement of aquatic biota and the transport of sediment and nutrients and the replenishment of floodplain wetlands.

We assessed the free flowing status of 3 million km of stream nationally at multiple hierarchically nested catchment scales. Preliminary results show that there are few large drainage basins that are entirely free of major infrastructure. Most of these are located in northern or arid areas of Australia. Perennial streams total less than 2% of the total length of stream in free flowing basins. Tributary streams flowing freely from source to outlet are similarly rare in many drainage basins including those targeted for future developments. Our analysis highlights the urgent need for a comprehensive national program aimed at identifying and protecting the remaining free flowing rivers.

24

Abstract withdrawn

Oral Abstracts

25 Predicting ecological responses to dry season water extraction in rivers of the wet/dry tropics – setting the research and monitoring agenda

Alison King[1], Simon Townsend[2], Michael Douglas[1], Mark Kennard[3]

1. *Research Institute for Environment and Livelihoods, Charles Darwin University, Darwin, NT, Australia*
2. *Aquatic Health Unit, Dept of Land and Resource Management, Darwin, NT, Australia*
3. *Australian Rivers Institute, Griffith University, Nathan, QLD, Australia*

The rivers of northern Australia are relatively pristine; supporting diverse and productive aquatic species and ecosystems of great social, cultural and economic value. Recent economic expansion places these rivers under profound and immediate threat; with increased water extraction and dam construction planned throughout the region. Water extraction will occur mostly during the dry season when flows and resources are at their lowest as habitats contract and potentially disconnect. The aquatic biota maybe adapted to the predictable low flow period but reduced dry season flows may result in chronic long term impacts, or the exceedance of critical flow thresholds that could have acute effects on a river's ecology. Understanding these potential impacts is needed to inform Water Allocation Plans intended to maintain the ecological integrity of these rivers. We will present our current understanding of potential impacts based on reviewing the local and international literature, and present new conceptual models we have developed specifically for both perennial and ephemeral rivers of the wet-dry tropics. We will use these conceptual models to formulate research questions and potential monitoring indicators.

26 Prioritising the conservation management of Great Artesian Basin desert springs

Nick Murphy[1], Michelle Guzik[2]

1. *La Trobe University, Bundoora, Vic, Australia*
2. *The University of Adelaide, Adelaide, South Australia, Australia*

The groundwater springs fed by the Great Artesian Basin in central Australia are home to a suite of endemic plants and animals. The species within these springs have evolutionary roots stretching back to before central Australia was a desert; when animals such as flamingos and crocodiles existed in permanent freshwater rivers, swamps and lakes. Unfortunately, inappropriate groundwater use has dried up around 2/3 of flowing springs, whilst those continuing to flow have suffered due to severe mechanical modification, stock and feral animal access and invasive species. Accordingly, this unique ecosystem has been afforded EPBC listing as an endangered ecosystem. Despite this listing, pressure for water continues, and only a small handful of springs are protected in national parks. With the majority of species within the springs being short-range endemics, some are at risk of complete extinction from the degradation of a single spring. Using phylogenetic analyses with community and species distribution data in combination with physical parameters, we can prioritise springs critical to the both the persistence of short-range endemics and the preservation of a species-rich desert spring fauna. This information will be used for the ongoing management of springs, and to prevent future water extraction from having detrimental impacts on spring animals.

Oral Abstracts

27 Ecological connectivity and environmental flows: thresholds for reconnection of wetlands and channels

Kim M Jenkins[1], Claire Sives[1], Rachel Blakey[1], Skye Wassens[2], Debashish Mazumder[3], Martin Forest[1], Luke McPhan[1], Jordan Iles[1]

1. *Australian Wetlands Rivers and Landscapes Centre, School of BEES, University of New South Wales, Sydney, NSW*
2. *Institute for Land, Water and Society, Charles Sturt University, Albury, NSW*
3. *ANSTO, Kirrawee, NSW*

Ecological connectivity is a central concept in ecology that describes the movement of biota or food webs between discrete landscape features. In freshwater ecosystems, water provides the conduit for lateral and longitudinal movement of plants, animals and carbon sources. This connectivity is pivotal to the function of floodplain rivers; governing genetic dispersal, reproductive cycles and booms in productivity. Establishing connectivity is often a goal of restoration projects, including large scale Commonwealth and State environmental watering actions. Despite the significance of ecological connectivity, there is scant data confirming that hydrological connectivity leads to ecological connectivity, or the specific hydrological conditions that promote connectivity. In this paper we explore two types of ecological connectivity across a spectrum of flows. Firstly, we present evidence for a flow threshold in the transfer and uptake of allochthonous carbon from floodplains to biota in channel habitats. Secondly, we assess the movement of microinvertebrates between a river channel and associated wetlands following Commonwealth environmental watering actions. While the transfer of carbon sources and movement of fish are ecologically significant, we explore whether the flushing of microinvertebrates from wetlands into channels may provide a short-lived, but significant boost to productivity or is only a trivial food supply. Findings from these studies can be used to adaptively manage environmental water allocations, predicting outcomes for a range of flows.

28 Can Extreme Hydrological Events Rejuvenate Reservoir GHG Emissions?

Brad Sherman[1], Phillip Ford[1]

1. *CSIRO Land and Water, Canberra, ACT, Australia*

Cotter Dam (Canberra, Australia), built in 1912 and enlarged to its current size (4 GL) in 1951, is a water supply reservoir that has recently been enlarged again (to 80 GL) to increase water security. Vegetation consists mainly of regrowth Pinus radiata and scrubby bushland as the catchment recovers from a devastating fire in 2003. Floating chamber measurements of CO2 and CH4 fluxes using a Picarro 1301 CRDS have been undertaken to provide baseline data against which future GHG emissions can be compared as the dam fills and new soil and vegetation are inundated. Drought-breaking rains led to heavy flooding with more than 80 GL passing through the reservoir during a two-month period. Areal mean CH4 emissions from the reservoir prior to the flooding were low (0.26 ± 0.14 mmol m-2 d-1), relatively uniform across the 8 measurement sites, and therefore typical of 'mature' reservoirs. Following the flood, the mean reservoir CH4 emission increased to 6.2 ± 1.4 mmol m-2 d-1 with emissions at the upstream end of the reservoir (the deposition zone) approximately 100 times greater (31 ± 7.6 mmol m-2 d-1) than emissions near the dam wall (0.28 ± 0.019 mmol m-2 d-1), a pattern we consistently observed in two other reservoirs in much wetter and more densely vegetated southeast Queensland. Over the following year, there has been a return to more normal runoff conditions, mean emissions have fallen to 2.0 ± 0.75 mmol m-2 d-1 and the spatial gradient in emissions has weakened.

Oral Abstracts

29 Fair Dinkum Estuarine Zooplankton: hydrology, ecology and the vital planktonic-benthic link

Gina Newton[1]

1. Hughes, ACT, Australia

Investigations of the annual hydrological cycle of a salt-wedge estuary on the southern Australian coast (south-west Victoria) tested and supported the hypothesis that hydrological cycles (i.e. annual and tidal) are a major determinant of estuarine zooplankton ecology – including the adaptive responses and behaviours of various zooplankters. The annual hydrological cycle was found to comprise of three main phases of salt-wedge dynamics: reduction/absence, emplacement and presence. Importantly, the seasonal succession of the calanoid copepod assemblage, dominated by the estuarine endemic *Gipplslandia estuarina*, closely followed these phases. During the physically extreme and unstable phases of salt-wedge dynamics, physical environmental factors exerted the greatest influence on the ecology of the estuarine Calanoida. Conversely, biological interactions appeared to be of increased importance during the more stable phase of salt-wedge presence.

A variety of behaviourally mediated strategies were identified among the calanoids as mechanisms of population retention and position maintenance in the face of tidal and river flows – including during the extreme disturbance of annual scouring floods. These included the presence of dormant life history stages (e.g. dormant eggs in sediments, a first-time report for the estuarine Calanoida), and refuge in littoral vegetation (e.g. *Gladioferens pectinatus*). Thus traditional 'plankton' dwellers were linked to both the littoral-phytal and benthic habitats as a means of coping with environmental stress. It is recommended that future studies of estuarine zooplankton ecology consider:

- all habitat components – planktonic (pelagic), benthic and littoral, and
- the use of estuarine endemic species as indicators of hydrological conditions.

30 Trophic shifts in south-east Australian coastal rivers: A Bayesian Belief Network Approach

Karlie McDonald[1], **Darren Ryder**[1], **Matthew Tighe**[1], **Adrienne Burns**[1]

1. University of New England, Armidale, NSW, Australia

Trophic shifts have been observed to cause significant changes in the composition, structure and functioning in aquatic ecosystems. Complex spatial and temporal interactions with biotic and abiotic processes make quantifying trophic thresholds difficult, with traditional statistical models unable to account for numerous simultaneously occurring confounding biophysical and biogeochemical factors across multiple scales. The effective quantification of positive and negative feedbacks leading to trophic shifts is not well represented by traditional models, whereas Bayesian models can take into account the integration of subsystems within the whole system using both quantitative and qualitative data. Bayesian models are naturally suited to modelling and predicting outputs in complex ecosystems through the incorporation of a priori information, and the quantification of uncertainties and high spatial and temporal resolution. Bayesian belief networks (BBNs) were developed to derive nutrient water quality guidelines and identify trophic thresholds in unregulated coastal rivers in south-eastern Australia. Spatial and temporal heterogeneity of water column nutrients, and the identification of limiting nutrients and their thresholds, were quantified using diffusing substrata (NDS) in freshwater and estuarine reaches of five unregulated river catchments. The nutrient limitation data collected from seasonal nutrient diffusing strata experiments were used to link similar catchments and define the spatial and temporal scope for the models. The Bayesian models developed predict shifts in trophic state in freshwater and estuarine reaches of coastal rivers providing managers with spatially and temporally explicit low-risk thresholds for nutrient concentrations and ratios to assist in the management of trophic shifts.

Oral Abstracts

31 Variability in ephemeral systems affects assessments of macro-invertebrate communities

Claire Sellens[1]

1. CQ University, Rockhampton, QLD, Australia

The foot print from mining and grazing is extensive across Central Queensland. However, assessment of whether these land-uses are impacting on macroinvertebrates, as indicators of river health, is not straight forward. Minimally impacted reference sites are scarce in the region, and most streams and many rivers are ephemeral and intra-seasonal and inter-annual differences in community composition are strong.

The aim of this study was to define the changes in taxa composition in reference sites to understand how this affects the variability in commonly used indicators for river health. Macroinvertebrate data collected across the Fitzroy Basin over a 19 year period was examined to establish the range in PET, SIGNAL, and taxa richness scores at reference sites with different rainfall or flow conditions. The commonly assessed habitat, landscape, and meteorological data were also assessed to determine which variables most strongly aligned with changes or differences in taxa composition.

Analysis of the data set confirms that minimally impacted reference sites are scarce in the region, and that tolerant taxa are characteristic of all sites. Taxa richness is highly variable across sites; however PET scores are typically low with few Plecoptera and mostly tolerant Ephemeroptera and Trichoptera families. SIGNAL scores are less variable but typically indicate human impact even if absent.

Assessments of river health in the Central Queensland region need to be made with consideration to the natural variability of macroinvertebrate communities and the very strong effect of inter-annual differences based on characteristics of the wet season.

32 Resistance traits revealed: macroinvertebrates hang tough when the plug is pulled

Edwin Chester[1], **Belinda Robson**[1], **Scott Strachan**[1], **Jane Chambers**[1]

1. Murdoch University, Murdoch, WA, Australia

The life histories of freshwater invertebrates are being challenged by drought and the consequences of human-induced climate change. Decreased hydroperiods, potentially higher summer temperatures and a less predictable annual regime means a greater reliance on resistance traits. An ability to survive short or extended periods without free water might ultimately determine the viability of populations; this may be possible for some species, while others will have no capacity at all to survive without submersion. We can predict the latter result for many taxa. Other species, both gill and air breathing, have physical or physiological adaptations that may allow survival, but their actual capabilities are generally unknown. Drying experiments used invertebrates collected from urban lakes and drains. First, assemblages were exposed to drawdown then drying for up to 20 days, and then examined to determine survival: after an initial die off, most remaining species had relatively low mortality, with different modes of survival dependent on individual traits. There was also evidence of continuing viability and development, even when free interstitial water was lost. Common taxa were then kept in microcosms with prolonged drying while control animals were kept with water at the substrate surface. Coenagrionidae damselflies (*Xanthagrion erythroneurum,Ischnura aurora, Ischnura heterosticta*), *Physa acuta* snails and *Triplectides australis* caddisflies all had different and effective resistance traits, but survival was variable among collection locations. Relying on these traits has implications for individual development and consequently fitness: we will likely need to account for this in predicting the outcomes of climate change.

Oral Abstracts

33 Who do you think you are? The New Zealand origin of Australian *Potamopyrgus antipodarum*, an invasive freshwater snail

Adrian Dusting[1], Dianne Gleeson[1], Paul Sunnucks[2], Ross Thompson[1]

1. *Institute for Applied Ecology, University of Canberra, Bruce, ACT, Australia*
2. *Monash University, Clayton, VIC, Australia*

Reconstructing pathways of invasion is a necessary step in determining the environmental and evolutionary factors responsible for invasion. Historical and observational data have traditionally been used to infer routes of invasion, but the "silent" nature of invasions render these approaches incomplete at best. In contrast, population genetics allows the detailed reconstruction of invasion routes over extended temporal and spatial scales. We employed mitochondrial DNA sequences to test the hypothesised New Zealand origin of Australian Potamopyrgus antipodarum populations. Potamopyrgus is an invasive aquatic snail of global significance, having invaded waters in Europe, Australia, Asia and North America. Australian populations are generally considered to be the result of accidental introduction from New Zealand, with anglers, wading birds and commercial fishing stocks all regarded as potential dispersal vectors. To examine sources and pathways of Potamopyrgus invasion we sampled 16 native sites and 13 invaded sites, sequencing a region of the mitochondrial COI gene. The resulting phylogeographic structure allowed the identification of distinct COI clades and the inference of potential origins of Australian Potamopyrgus populations. We discuss the patterns of genetic structure and implications for theories relating to the routes and vectors of Potamopyrgus invasion. Finally, we consider how detailed knowledge of invasion pathways may be used to contribute to the control and prevention of biological invasions.

34 Rest is for the tiny: The effects of temperature and photoperiod on the termination of dormancy in microfauna of the Ovens Floodplain.

Isobel Colson[1]

1. *Charles Sturt University, Albury, NSW, Australia*

Freshwater aquatic microfauna possess a remarkable ability to survive harsh environmental conditions, through dormancy. Dormant eggs are produced by adult females and transferred to vegetation and the soil, where they remain, sometimes for years, until conditions are suitable for their emergence. Live animals of some groups are also able to enter dormancy. These dormant life stages play a vital role in succession and recovery of aquatic microfaunal populations, particularly in ephemeral waterbodies. Despite this importance, little is known about the particular cues triggering the breaking of dormancy in Australian aquatic microfauna, though international literature suggests that temperature and photoperiod are important cues. In this study the hatching response of dormant microfauna to a range of temperature and light conditions was investigated for billabongs on the Ovens River Floodplain. Sediment from 14 dry billabongs was collected in April 2013, combined and inundated in the laboratory in combinations of four temperatures (10, 15, 20 and 250C) and four photoperiods (8, 10, 12 and 14 hours daylight) representing 'typical' winter conditions to those of late spring. The water used for inundation was collected and refreshed every three days, for three weeks. Hatchling emergence was dominated by rotifers, especially those from the Bdelloida and Cephalodella, with a lesser number of copepod nauplii and cladoceran hatchlings. The results also showed that the highest diversity and abundance of aquatic microfauna emerged at the highest temperature and longest photoperiod, suggesting that these conditions are associated with a more favourable time of year for hatching.

Oral Abstracts

35 Promoting connectivity fuels food-webs downstream of floodplain forests

Rochelle Petrie[1], Daryl Nielsen[1], Robert Cook[1], Nathan Ning[1], Ben Gawne

1. Murray Darling Freshwater Research Centre, Wodonga, VIC, Australia

Despite the perceived importance of floodplain inundation to the ecology of lowland rivers, there is limited understanding of the contribution that floodplains make to the main river channel during floods. We sampled zooplankton communities, chlorophyll-a and Dissolved Organic Carbon (DOC) within the main river channel of the River Murray immediately upstream of the Barmah-Millewa Forest and at two sites immediately downstream of the forest during two flood events in July and October of 2010. Results demonstrate that while the smaller flood event in July did not contribute substantially to an increase in the amount of carbon (kg day-1) derived from the floodplain entering the river channel, the much larger flood in October resulted in a increase in carbon in the form of zooplankton from 200 to 3,000 kg day-1; chlorophyll-a from 100 kg to 600 kg day-1 and DOC from 15,000 to 300,000 kg day-1. These results clearly demonstrate that larger floods resulting in floodplain waters returning to the river will provide important subsidies of terrestrially derived carbon. This carbon may then become available to be incorporated into riverine food webs and provide a potential a boost to riverine secondary production.

36 Assessment of post-flood recovery of frog populations in the mid and lower Lachlan Catchment

Carmen Amos[1], Skye Wassens[1], Gary Luck[1], Jennifer Spencer[2]

1. Institute for Land, Water & Society, Charles Sturt University, Albury, NSW, Australia
2. NSW Office of Environment and Heritage, Sydney, NSW, Australia

Reductions in floodplain inundation can have significant negative impacts on frogs through loss of breeding and refuge habitats. The Lachlan River has undergone significant hydrological change due to the construction of dams and weirs resulting in a substantial reduction of flow that reaches the lower floodplain. This contributed to a prolonged dry period over 2000-2010 during which time flows ceased below Condobolin. Significant rainfall in 2010, 2011 and 2012 resulted in large flood events across the Lachlan Catchment filling a high percentage of aquatic habitats. As information on the distribution of frog species in the Lachlan is limited we aimed to identify what species have persisted in the area through the drought and to identify key aquatic habitats they are now occupying. We surveyed 49 sites on four occasions from September 2012 to April 2013 between the Great Cumbung swamp and north of Condobolin in the mid and lower Lachlan Catchment. Ten frog species were identified, including the endangered Southern Bell Frog, *Litoria raniformis* (EPBC Act 1999). Four dominant species were present across all wetland types and differences in the frog communities were driven by rarer species such as *Neobatrachus sudelli*, *Litoria caerulea* and *L. raniformis*. Wetlands with hydroperiods of 7-13 months supported the highest diversity of frogs. Non- perennial creeks also supported diverse frog communities and should be considered as important frog habitat in conservation planning.

Oral Abstracts

37 Validating an ecosystem response model: assessing model performance under wet and dry conditions

Rebecca E Lester[1], Jan L Barton[1], Peter G Fairweather[2]

1. *Deakin University, Warrnambool, VIC, Australia*
2. *School of Biological Sciences, Flinders University, Adelaide, SA, Australia*

Model validation is one aspect of ecosystem modelling that is not done often. Usually all available data are required to develop a robust model in the first place, and it is rare that models can be revisited years later when additional data have been collected. We revisited an ecosystem response model which was developed for the Coorong, the estuary of the Murray-Darling Basin, Australia, using an approach called 'ecosystem states', to assess the model simulations against five years of data that had been collected in the interim. The ecosystem states model has been used extensively to assess competing management actions in the region (e.g. methods of delivering environmental flows) and to simulate the likely future impact of climate change. Since the development of the model in 2008, the additional data has been collected for intervening years, which included both very wet and very dry years. These data enabled an assessment of the model under a range of conditions, including the first data documenting ecological recovery after prolonged drought. This analysis provides an objective assessment of the conditions under which the ecosystem states model performs well and can be reliably used as a tool to assist management, and where additional development is required.

38 Influence of flow regime on the structure of freshwater communities

Sally Hladyz[1], Michael Grace[2], Richard K Kopf[3], Robyn Watts[3], Nicole McCasker[3], James R Thomson[1], Nathan SP Ning[4], Ross M Thompson[5]

1. *Monash University, Clayton, Vic, Australia*
2. *Water Studies Centre, Monash University , Clayton, VIC, Australia*
3. *Institute for Land, Water and Society, Charles Sturt University, Albury, NSW, Australia*
4. *The Murray-Darling Freshwater Research Centre, La Trobe University, Wodonga, VIC, Australia*
5. *Institute for Applied Ecology, University of Canberra, Canberra, ACT, Australia*

The regulation of the world's major river systems is threatening global biodiversity and generating the urgent need to manage river flows. One type of management is the delivery of restoration flows to regulated river systems. This is thought to help ecosystem recovery by mimicking a more natural flow regime and potentially restoring natural ecological processes and patterns. However, our understanding of the relationship between flow and ecological response is limited. Designing ecosystem-scale experiments and monitoring the delivery of restoration flows can help advance our knowledge of flow and ecological response. In this study, we carried out an ecosystem-scale experiment and manipulated flows in four managed rivers. One river received minimal flows (base flow), two rivers received natural flow pulses (natural flow) and one river received both natural flow pulses and the delivery of two restoration flows (restoration flow). We investigated whether changes in river flow regime can alter freshwater biodiversity in the Edward-Wakool river system, located in south eastern Australia. We sampled aquatic invertebrate communities on small woody debris over a seven-month period. We measured invertebrate abundance, biomass, taxonomic richness and community structure. We found invertebrate biomass to increase in the river which received restoration flows. For other invertebrate measures (taxonomic richness, abundance, composition) the restoration flow river was similar to the natural flow rivers and therefore seemed to mimic natural flow regimes. In summary, shifts in river flow regime can drive changes in invertebrate communities which may have consequences for higher trophic groups such as fish.

Oral Abstracts

39 Development of an algal response model to evaluate water quality and stream condition and configure consumptive flow in the MacKenzie River, south-east Australia

Ata (Islam) Atazadeh[1], Keely Mills[1 2], Andrew Barton[1], Peter Newall[1], Peter Gell[1]

1. *University of Ballarat, Ballarat, VIC, Australia*
2. *Loughborough University, Loughborough, Leics, UK*

The MacKenzie River in western Victoria is being used as a case study to develop an algal response model. This River has been substantially modified since the construction of Wartook Reservoir in 1887 for water supply purposes. Ten sites along the MacKenzie River were sampled every season over one year. Physical and chemical characteristics of water including pH, temperature, conductivity (EC), dissolved oxygen (DO), total suspended solids (TSS), total nitrogen (TN) and dissolved phosphorus (PO4-P) were measured. Biological properties of the algal periphyton communities including dry mass, ash-free dry mass, chlorophyll-a concentration and species composition of diatoms and soft algae were also measured at the same ten sites. The biomass and algal community structure were found to change along the river. The results indicate that algal periphyton communities, especially diatoms, are sensitive to changes in water quality and flow rates. It is clear that assemblages vary with season suggesting that response to flow will vary depending on the season of water release. These data will be used to develop an algal response model to help inform the delivery of flows down the waterway. Better design of consumptive flows down the waterway will be of particular focus.

40 Examination of River Red Gum (*Eucalyptus camaldulensis*) condition in relation to river flow in Victoria, Australia

Aidan Kereopa[1], Angus Webb[1], Siobhan deLittle[1]

1. *University of Melbourne, Parkville, VIC, Australia*

Examining ecological responses to changes in river flow is important for appropriate management of river systems. This is particularly significant for regulated rivers as water extraction for human use can create a scenario where the biota is already in a state of water stress. This study examines the condition of River Red Gum (*Eucalyptus camaldulensis*) in Victoria at the end of a major drought period (2000-2010). We investigated the connection between antecedent hydrological conditions and health of this iconic eucalypt species. Remotely sensed data (LiDAR and Landsat TM 4-5) were used to quantify red gum condition. Plant area index (PAI) was extracted from LiDAR data, and riparian vegetation was stratified by tree height and overlayed with a normalised differenced vegetation index (NDVI). Previously acquired flow data was then correlated with tree condition using Bayesian hierarchical modelling. The analyses revealed a gradient of hydrologic stress across Victoria. A decline in tree condition from east to west in the state was related to reduced flooding. The study forms part of a wider assessment of the ecological benefit from public investment in purchasing and releasing environmental flows. The methods used allow for a review of evidence for the applicability of remote sensing data to landscape scale hydro-ecological investigations. Analysis also highlights the applicability of Bayesian hierarchical modelling to complex environmental problems. For river red gum, it highlights the importance of high flows and floods in maintaining tree condition. Whether such flows can be delivered by environmental flows programs is another matter.

Oral Abstracts

41 Biogeochemical responses to hydrological cycles in streams of the Pilbara region, northwest Australia

Andre R Siebers[1], Neil Pettit[2], Grzegorz Skrzypek[1], Jason Fellman[1], Shawan Dogramaci[3], Pauline Grierson[1]

1. *Ecosystems Research Group, School of Plant Biology, University of Western Australia, Crawley, WA, Australia*
2. *Centre for Excellence in Natural Resource Management, University of Western Australia, Albany, WA, Australia*
3. *Rio Tinto Iron Ore, Perth, WA, Australia*

Intermittent dryland streams are characterised by cycles of intense but short floods followed by long periods of drought and evaporative contraction, which in turn results in cycles of activity in microbial processes and biogeochemical cycling. We used stable isotopes (18O and 2H) to determine the origin of surface water and evaporative changes in pools from four creek systems of the semi-arid Pilbara between May 2011 and October 2012. Change in dissolved organic matter (DOM) composition was used to examine relationships between pool biogeochemistry and hydrologic regime. Pools with groundwater inputs or shallow alluvial water throughflow showed low evaporative losses, while pools isolated from groundwater were more highly evaporated. Pool DOM composition was usually dominated by humic-like compounds derived from terrestrial organic matter. However, highly evaporated pools had large contributions of protein-like compounds, most likely derived from microbial turnover of organic matter. Concentrations of both humic and protein-like compounds, as well as the humic:protein-like ratio, were positively correlated to 18O and 2H values at 2-3 months since the last flood. However, in the absence of substantial rainfall events this relationship became increasingly decoupled over time, as the influence of groundwater inflow shifted from direct effects on concentration and DOM inputs to alleviation of contraction pressures. We suggest that other factors, including differences in UV exposure and establishment of aquatic vegetation, are important factors contributing to differences in DOM among pools with increasing time since flood.

42 Evaluating potential indicators of altered flow regimes in the Murray Darling Basin using a disturbance gradient approach

Stephen Balcombe[1], Erin Peterson[2], Fran Sheldon[1]

1. *Griffith University, Nathan, QLD, Australia*
2. *Division of Mathematics, Informatics and Statistics, CSIRO, Dutton Park, QLD, Australia*

A suite of indicators are often proposed during the development phase of an environmental monitoring program because they may have the potential to be influenced by an environmental disturbance of interest (e.g., riparian clearing). Gradient analysis on such indicators can be used to identify a subset of those indicators that respond predictably to environmental disturbance gradients. When assessing the ecological effects of flow alteration, one of the challenges when using a gradient analysis approach is that climatic, topographic, and land use characteristics can have an over-riding effect on flow, as well as, physicochemical and biological processes in rivers. As such, broad-scale drivers such as climate and topography must be accounted for so that more localised influences, such as changes to the hydrological regime, may be identified. Given these challenges, our goal was to evaluate the usefulness of a gradient analysis approach for selecting ecological indicators of altered flow regimes in the Murray-Darling Basin (MDB), Australia. More specifically, we assessed whether potential indicators respond predictably to flow disturbance gradients after accounting for climatic, topographic, and land-use effects, and identified which characteristics of flow disturbance were most strongly associated with the indicators . The results of these analyses showed that some indicators of fish health and reproductive success were impacted by flow disturbance after accounting for other natural and land-use influences. Hence, the gradient analysis approach used here shows promise as a tool for assessing the ecological effects of altered flow regimes at basin-wide scales.

Oral Abstracts

43 Allelopathic effect of the invasive *Elodea canadensis* on two species of cyanobacteria

Fariba Moslih Pakdel[1], Jenny Davis[2]

1. *Monsh University, Hallam, VIC, Australia*
2. *School of Biological Sciences, Monsh University, Melbourne, VIC, Australia*

Allelopathy refers to non-resource-based interactions between primary producers that may affect the outcome of competition. The 'Novel Weapon Hypothesis' predicts that non-indigenous plants have the potential to become invasive if they produce allelopathic substances that the native species are not adapted to. The alien waterweed, *Elodea canadensis*, has become a noxious weed around Australia. We examined the allelopathic effect of *E. canadensis* on two species of cyanobacteria, *Anabaena variabilis* and *Synechococcus sp*. The growth of the target species exposed to*E. canadensis* exudates and live material was compared to that of controls (i.e. neither exudates nor live material present). We found significant negative effects on the growth of the two target organisms with the strongest effect exerted on *Synechococcus sp*. Our findings correspond with the predicted hypothesis and suggest that allelopathy plays an important role in the success of *E. canadensis*.

44 Is prolonged waterlogging killing Victoria's faunal emblems?

Joe Greet[1 2]

1. *The University of Melbourne, Parkville, Australia*
2. *Melbourne Water, Melbourne*

Eucalyptus camphora swamp forest within the Yellingbo Nature Conservation Reserve provides habitat for both of Victoria's faunal emblems: the critically endangered Helmeted Honeyeater and the endangered Leadbeater's Possum. Habitat values of the reserve are currently under threat from the dieback of E. camphora swamp forest and a lack of natural regeneration. Altered water regime resulting from drainage works carried out in the 1950s for agricultural purposes is considered a causal factor in both these threatening processes. The drainage works led to channel incision, erosion and sediment deposition downstream within the swamp impeding drainage and resulting in prolonged waterlogging. I will present research into the water regime requirements of E. camphora. This research includes monitoring of reproductive phenology and nursery-based flooding experiments to determine the water regime requirements of E. camphora at two different life-history stages: seed release and seedling establishment and growth. Results from seed release monitoring suggest that the reproductive phenology of E. camphora is adapted to natural hydrologic regimes. Results from flooding experiments suggest that its seedling establishment is also dependent on appropriate water regimes with increasing depth and duration of flooding reducing seedling survival and growth and overtopped seedlings sensecing rapidly. The implications of the research will be used to inform capital works to be implemented at the site aimed at naturalising water regimes in order to arrest dieback and promote regeneration of E. camphora swamp forest at Yellingbo.

Oral Abstracts

45 Groundwater depth thresholds for tree condition

Jarrod Kath[1], Kate Reardon-Smith[2], Andy Le Brocque[2], Elad Dafny[3], Fiona Dyer[1], Lisa Fritz, Megan Batterham

1. *Institute for Applied Ecology, University of Canberra, Canberra, ACT, Australia*
2. *Australian Centre for Sustainable Catchments, University of Southern Queensland, Toowoomba, QLD*
3. *National Centre for Engineering in Agriculture, University of Southern Queensland, Toowoomba, QLD*

A range of ecological processes supported by groundwater are at risk where socio-economic and climate drivers increase net groundwater demand. Previous research has indicated close links between groundwater and riparian/floodplain tree condition. However, little is known about the nature of the relationship or whether critical groundwater-tree condition thresholds exist. Threshold responses may indicate the existence of groundwater depths associated with rapid ecological change. This study provides evidence of threshold responses between groundwater depth and tree condition in the Condamine catchment in eastern Australia, where groundwater decline due to over-extraction is well documented. It collates tree condition data (118 sites) from recent studies of two dominant Australian floodplain species, Eucalyptus camaldulensis Denh. (river red gum) and E. populnea F. Muell. (poplar box). Boosted regression trees and quantile regression were used to investigate the nature of the relationship and threshold values. A distinct non-linear response of tree condition to groundwater depth was identified, with thresholds identified at 12.5–17.2 m for E. camaldulensis and 15.6–22.0 m for E. populnea. Threshold responses may be explained in terms of physiological limitations to rooting depth in these and similar floodplain/riparian species, with groundwater decline effectively decoupling tree roots from accessible moisture resources leaving trees more vulnerable to hydraulic stress and/or failure particularly under drought conditions. The existence of thresholds suggest that groundwater decline may trigger rapid ecological changes in riparian and floodplain tree species, which may have important implications not only for their future persistence but also the various ecological functions they support.

46 Nocturnal food webs: partitioning of prey resources between terrestrial and aquatic ecosystems by a high level predator of floodplain habitats

Rachel V. Blakey[1], Kim Jenkins[1], Richard Kingsford[1], Brad Law[2]

1. *Australian Wetlands, Rivers and Landscapes Centre, Kensington, NSW, Australia*
2. *NSW Department of Primary Industries, Parramatta, Australia*

When dry floodplain systems flood, terrestrial predators (e.g. birds, lizards and spiders) can focus their diet on aquatic taxa reflecting a subsidy from the aquatic to the terrestrial ecosystem. Despite the abundance of bats on floodplains, little is known of how this high-level predator balances terrestrial and aquatic prey, particularly during periods of high energy demand (pregnancy and lactation). We used stable isotope analysis (13C & 15N) to compare short and medium term diet of four functional groups of bats (aquatic trawler, mesic edge-space, ubiquitous gleaner and arid edge-space) with available terrestrial and aquatic prey during flooding of Barmah-Millewa Forest. We predicted that diet of bats in the medium term would reflect expected functional roles, while short-term diets would reflect a shift to aquatic prey during flooding, with a stronger shift for lactating females.

We found that aquatic trawlers and mesic edge-space bats foraged predominantly within aquatic habitats while ubiquitous gleaner and arid edge-space bats fed on terrestrial prey in both short and medium term diets. This may be due to size and echolocation call frequency constraints on the type of prey bats can forage on. Lactating females did not show a consistent preference for aquatic habitats but foraged at a higher trophic level than males for all groups, except the aquatic trawlers. This may reflect a more generalist strategy in lactating females, or in the case of aquatic specialists, potentially a constraint on foraging for higher trophic level prey, such as fish.

Oral Abstracts

47 The disturbance trifecta –drought, fire and flood effects on macroinvertebrate communities in a catchment with pine and native forest land-use

Anthea R Florance[1] , Fiona Dyer[1] , Evan Harrison[1]

1. Institute for Applied Ecology, University of Canberra, Canberra, ACT, Australia

Disturbances such drought, fire and flood are thought to play a significant role in determining the distribution and structure of macroinvertebrate communities. Recovery of macroinvertebrate communities following disturbance has shown to be considerably slower and potentially incomplete in modified landscapes. This is because changes in land-use alter the physical and chemical processes of the landscape, which affects stream characteristics such as habitat and water quality, crucial for the survival of macroinvertebrates. Between the years of 1997 to 2012, severe drought, major fire and a large flood occurred within the Lower Cotter Catchment (LCC) in the ACT. During this period the lower areas of the catchment were managed as a commercial pine forestry plantation estate. The upper areas of the catchment were managed as native forest. Macroinvertebrate data collected from the LCC between 1994 and 2013 was examined to determine the response of macroinvertebrate communities to drought, fire and flood and to determine if land-use affects the recovery of macroinvertebrate communities following fire and flood disturbance. Drought and consequent low stream flows appeared to have an overriding effect on macroinvertebrate community composition. As stream flow decreased during drought the abundance of flow favouring taxa decreased and low flow tolerant taxa increased. Catchment wide fire had less of an effect on macroinvertebrate community composition than flood and land-use did not appear to affect the recovery of macroinvertebrate community composition following fire and flood. This study demonstrates that severe drought has a far greater effect on macroinvertebrate communities than fire and flood disturbance.

48 Aquatic organic carbon dynamics in massively altered landscapes: Past, present and future

Darren P Giling[1], Ralph MacNally[1], Ross M Thompson[2]

1. Monash University, Clayton, VIC, Australia
2. Institute for Applied Ecology, University of Canberra, Canberra, ACT, Australia

Landscapes globally have been greatly altered by agricultural land use. Restoring native vegetation has necessarily occurred at small spatial scales, with limited ability to address landscape scale effects. However, extensive replanting is an economically feasible option for climate change mitigation in emerging carbon-driven economies. Much replanting occurs in riparian zones, offering concomitant ecological health benefits for aquatic systems because riparian vegetation provides important subsidies of terrestrial organic carbon to streams. We measured organic carbon fluxes in riparian replantings on 13 agricultural streams over two years to assess if replanting affected in-stream organic carbon dynamics. We then up scaled to estimate fluxes from similar sized streams in an entire catchment (second and third order streams; approximately 30% of the network). We sought to assess the regional implications of incorporating additional trees in future landscapes. At reach scales we found that replanting vegetation increased the provision of leaf litter and doubled the standing stock of coarse particulate organic carbon in-stream within three decades. Combined with greater shading, this increased organic carbon processing and reduced net ecosystem productivity by 50%. At catchment scales changes in organic carbon fluxes were high per unit of stream, but small compared to the potential for terrestrial carbon storage. We predict that extensive replanting of riparian vegetation will cause agricultural streams to become more retentive of organic carbon. This reflects a restoration of terrestrial and aquatic processes towards that of past, forested catchments. Replanting riparian vegetation in agricultural landscapes can effectively return multiple benefits within decadal timescales.

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49 Variations in seasonal flow timing, duration and depth affect riparian vegetation production and community composition in a semi arid floodplain

Rebecca Durant[1], Jessica Wilson[1], Ben Gawne[1]

1. The Murray-Darling Freshwater Research Centre, ALBURY, NSW, Australia

Riparian vegetation is known to affect floodplain/river ecosystem process and have an important role as primary producers fixing carbon which is then moved thorough the food webs. Variations in seasonal flow timing, duration and depth affect riparian vegetation production and community composition and potentially the partitioning of above to below ground primary production which will have significant effects on energy stores/flow through floodplain ecosystems. Understanding this response to inundation is critical to understanding energy flow.

It has been predicted that macrophyte production at the landscape scale will be dependent on the floodplain habitat type as a result of different flow condition in each habitat type, with macrophyte production greater in wetlands than in red gum woodlands followed by black box woodlands. Using a mesocosm approach we have shown that riparian vegetation production is incredibly complex and no single variable (season, flood duration, depth or habitat type-Red Gum, Black Box or Open water wetland) can be used to predict biomass production after inundation. Results have shown significant differences in biomass, the number of seedling germinating (abundance) and species richness between habitats at different depths over time occurring. The duration of flooding and season greatly affects the biomass, partitioning of above to below ground biomass, abundance and richness. In summer germination and establishment required greater than four weeks growing time, while after 12 weeks changes were less pronounced. However in winter there was significantly lower biomass, abundance and species richness than that recorded in summer, regardless of duration, depth or habitat type.

50 Fencing and flooding, change and stability: short-term effects in riparian coolibah woodlands

Jane Roberts[1]

1. Sole trader, O'Connor, ACT, Australia

Livestock can adversely affect stream health through grazing (riparian vegetation) and trampling (soil condition) leading to the expectation that fencing the near riparian zone and providing off-river watering points will improve stream health. Vegetation recovery is a long-term process, and varies (Lunt et al 2007) with the degree of floristic degradation and site productivity. In 2008-2009, during the Millenium Drought, Western CMA established a long-term monitoring program to track the effects of fencing the riparian zone. This had 32 sites on 5 rivers (Barwon, Darling, Culgoa, Narran, Bogan), with locations determined by the distribution of landholders participating in the fencing incentives scheme. The design was unbalanced (9 Control, 3 Reference, 20 Treatment sites) and targeted just one type of riparian vegetation (coolibah woodlands). All sites were re-sampled after 3-4 years, in October 2012, following major floods. Data analysis used ANOSIM and SIMPER routines in PRIMER, and a mixed-model ANOVA with Fencing, Time and River as factors.

Principal findings are that: Fencing has had little effect, despite improved growing conditions, with no significant differences in species composition, number of recruits and only one of five variables describing vegetation structure. In contrast, species composition, number of recruits, tree cover and litter did change with Time (interpreted as major flooding). Differences in species composition between Rivers suggest an unacknowledged regional-scale variability in riparian coolibah vegetation. Overall, the flooding response appears to be transient, with the vegetation retaining much of its baseline characteristics.

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51 Linking distribution, morphology and reproductive maturity of adult caddisflies with flight activity in the riparian zone

Joshua J Grubb[1], Jill Lancaster[2], Richard Marchant[1]

1. *Museum Victoria, Melbourne, VIC, Australia*
2. *Resource Management and Geography, Melbourne University, Melbourne, VIC, Australia*

Although adult aquatic insects represent an important link between aquatic and terrestrial environments, especially in the riparian zone, their biology is not well-understood. The aim of this study was to characterise the distribution of adult caddisflies in the riparian zone and test whether flight distance from the stream differed between species, sexes, female reproductive status, and with wing morphology. To describe caddisfly distribution in the riparian zone, we set up light traps at various distances (0-45 m) from the Cumberland River, SW Victoria. For six species encompassing a range of body sizes, wing morphology was described by wing aspect ratio; female reproductive maturity was characterized by stage of ovarian development and presence/absence of eggs. Contrary to predictions, 50-80% of males and 30-60% of females caught were found throughout the riparian zone, and wing aspect ratio was not correlated with median flight distance. Immature females of some species indicated a relatively long-lived adult stage and tended to be found near the river. Most females were mature and the proportion of mature and spent females was similar over all distances. These results suggest that the riparian zone is an important habitat for adult caddisflies and a broad zone may be necessary to support diverse assemblages. Distribution patterns in the riparian zone may be more strongly linked to adult behaviours, such as mate searching or food acquisition, than to sex, reproductive status or wing morphology.

52 Processes of nutrient removal in riparian zones in sandy soils

Peter O'Toole[1]

1. *Murdoch University, Murdoch, WA, Australia*

Ellen Brook contributes only ~7% of the flow, but 39% and 28% of the total phosphorus and nitrogen load into the Swan River, Perth, Western Australia. To reduce nutrient export, riparian vegetation is promoted as a best management practice. International literature has shown the significant benefits of riparian vegetation to reduce incoming nutrients and improve water quality. The efficacy of riparian vegetation depends on the presence of slope and/or an impermeable subsurface layer (to generate flow through the riparian vegetation promoting plant/sediment and water interaction) and soil type (the capacity to take up and store nutrients). However, in Ellen Brook the majority of the catchment is flat and dominated by sandy soils. To assess whether riparian vegetation is effective at reducing nutrient concentrations, groundwater (three rows of nested piezometers; 0.5m,1.5m and 2.5m depth), stream, soil and vegetation parameters in the paddock and riparian zone were compared between a sloped and flat site. They indicated little subsurface flow but rather vertical rise and fall of shallow groundwater in the flat Ellen Brook catchment. Interestingly, this riparian zone also received inputs from the highly eutrophic stream during early winter flows. The capacity of the riparian zone to affect nutrient concentrations with primarily vertical flow was assessed using soil columns. At Ellen Brook, phosphorus removal was limited. However, it did facilitate nitrogen removal through denitrification. At the sloped site, riparian vegetation was found to have a higher capacity to remove nutrients, as flow passed through the active root zone.

Oral Abstracts

53 The future of Australian freshwater life

Bruce Chessman[1]

1. *University of New South Wales, Kensington, NSW, Australia*

Dire consequences for global freshwater biodiversity have been predicted in view of expected climate change over the coming century. The Australian freshwater biota, exposed to periods of severe aridity in the past, may have evolved wider resistance and resilience to hydrological fluctuations than that in many parts of the world. However, it also includes many cold-adapted species that are highly susceptible to increasing temperatures. Forecasting of species' responses to projected climate change has been heavily dominated by correlative bioclimatic modelling of geographic distributions, but Australian freshwater species may undergo a variety of climate-related impacts and adaptations other than range shifts. Population responses during the recent Millennium Drought and the subsequent wetter and cooler phase have differed greatly among freshwater taxa, exemplifying the likely complexity of reactions to future climates. This variability can be explained to some degree by existing knowledge of species traits and life history strategies, indicating the potential for mechanistic predictions of how species will respond to future climatic trends and extremes. I suggest that correlative forecasting needs to be complemented by a greater understanding of the biology and ecology of sensitive species, including interspecific interactions, leading to more process-based forecasting. Mechanistic modelling should also help to reduce uncertainty about the benefits and risks of actions that are frequently proposed for conserving freshwater biodiversity in the face of climate change, such as protecting refuges, increasing connectivity, use of environmental water allocations, stream shading and managed relocation.

54 Doing applied research is the easy bit: How do we get that research used in aquatic ecosystem management?

J A Webb[1]

1. *Department of Resource Management and Geography, The University of Melbourne, Parkville, VIC, Australia*

As researchers, we live in an era where funding is increasingly difficult to obtain. Political rhetoric, and the resulting changes to funding schemes, pushes us towards research with immediate applications for management. This attitude exists within the wider water management sector as well. A recent survey of water professionals consistently returned the response that research and development systems needed to better align research undertaken with needs identified by managers. However, the majority of research proposals are still completely developed by researchers, leaving them in the uncomfortable position of trying to convince managers of the utility of the work. This process inevitably leads to large amounts of research supposedly able to benefit management, but which is never used for that purpose. In this presentation, I will detail the process that achieved management relevance for our research into the ecological benefits of environmental flows. In this case, and in a growing number of examples from other scientists and disciplines, the 'push' for research is coming directly from the managers themselves. This reverses the situation outlined above, but can also take scientists well out of their comfort zone in terms of the research conducted. Through sustained partnerships between managers and researchers, we seem to have (almost) achieved the applied science Nirvana of undertaking research with immediate impacts upon management practices. I conclude by asking the question of whether this was only achieved accidentally, or whether the experience provides any general principles to help us to move from theory to practice in water science.

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55 A step too high – understanding natural barriers to fish passage along the upper Murrumbidgee River

David Sangston[1], Fiona Dyer[1], Evan Harrison[1]

1. Institute for Applied Ecology, Bruce, ACT, Australia

The spatial distribution of fish in unregulated rivers is controlled by natural barriers. While channel morphological features (such as marked changes in stream gradient or substrate character) define natural barriers, their impacts are both flow and species dependent. The flow dependence of barrier impacts means that river regulation has the potential to seriously affect the distribution of natural barriers along a river. Most studies relating to natural barriers in streams are from North America where fish have different characteristics from Australian fish. Few Australian studies have investigated the effects of natural barriers upon riverine fish. Murray cod *Maccullochella peelii peelii* are 'keystone' native Australian fish that are known to migrate hundreds of kilometres to spawn in lowland rivers. It is not known if similar behaviour occurs in upland rivers, but it is likely to be affected by the presence of natural barriers. The aim of this study was to characterise natural barriers to Murray cod migration along the Murrumbidgee River in the ACT, identify how those barriers respond to flow changes and make predictions about their impacts upon Murray cod movement. Detailed 3D maps of 30 potential barriers were produced from survey data collected during low flow conditions. Velocity data was also collected for each potential barrier. Physical characteristics of the barriers were highly variable and it is likely that sequences of barriers may prove insurmountable for Murray cod. Additional extraction of water from the river may have implications for Murray cod passage along the Murrumbidgee River in the ACT.

56 Distribution of the Oriental Weatherloach (*Misgurnus anguillicaudatus*) in the South Australian region of the Murray-Darling Basin: From specimens collected by Natural Resources SA Murray-Darling Basin, 2010-2013

Irene K Wegener[1], Lara Suitor[1]

1. Natural Resources SA Murray-Darling Basin, Department of Environment, Water and Natural Resources, Berri, SA

The Oriental Weatherloach (*Misgurnus anguillicaudatus*), a fish species native to East Asia, was first recorded as a wild breeding population in the Yarra River (Victoria) in 1984. Since then, it has dispersed into other systems including the Murray–Darling Basin. The Oriental Weatherloach is considered to be a successful invader due to its high reproductive potential, flexible diet, longevity and tolerance to a broad range of environmental conditions. Additionally, it shows remarkable environmental adaptability and therefore has the potential to inhabit a range of habitat and environments present across South Australia.

In February 2011, the Oriental Weatherloach was recorded for the first time in South Australia on the Chowilla Floodplain. Following its initial capture, the species has now been recorded at 12 wetland locations across the South Australian region of the Murray–Darling Basin between 2011 and 2013. Oriental Weatherloach caught during sampling between 2010 and 2013 exhibited distinct length modes, with the range and mean fish size increasing between 2011 (mean = 108mm) and 2012 (mean = 137mm). Fish were caught at sites with varying substrates and physical habitat. Environmental variables such as surface water electrical conductivity, pH, turbidity, dissolved oxygen and temperature did not appear to influence presence or absence of the Oriental Weatherloach at particular sites. The species distribution range has increased downstream since its initial capture, however it is still being caught in low numbers. Ongoing surveying will assist with determining the range expansion of the species through the South Australian region of the Murray–Darling Basin.

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57 Electrofishing efficiency in the Murray River and implications for monitoring temporal change

Jarod Lyon[1], Tom Bird[2], Joanne Kearns[1]

1. *DSE Freshwater Ecology, Arthur Rylah Institue for Environmental Research, Heidelberg, VIC, Australia*
2. *Melbourne University, Melbourne, VIC*

Quantitative methods used for monitoring and projecting population trends of species require the estimation of population size. Mark-recapture methods can be used to estimate parameters necessary for determining population size. As part of the Murray River resnagging monitoring program, which is examining the change in population size in response to a resnagging intervention, we undertook an electrofishing detection experiment. In this experiment, we tagged approximately 100 fish per annum with radio-transmitters in a two kilometre study site on the Murray River at Yarrawonga, over a period of seven years. This site was then surveyed non-invasively using radio-telemetry to determine which of these fish were within the site, and then electrofished to determine the proportion of available fish that were captured. The electrofishing surveys were replicated up to three times over a ten day period. Electrofishing detection varied between 8.6 % and 45.7 % from the twelve detection events undertaken thus far. The detection average in 2007 was 14 %; 19 % in 2008; 21 % in 2009 16 % in 2010, 7 % in 2011, 16 % in 2012 and 12 % in 2013. Our results show that variation in detection rates will likely have a significant impact on estimates of population size and vital rates. Furthermore, our approach may offer a cost-effective means for reducing the error in parameter estimates derived from standard mark-recapture experiments.

58 Temperature effects on growth, survival and development of Murray cod (*Maccullochella peelii*) larvae from four geographical locations in the Murray-Darling Basin

Daniel Svozil[1], R. Keller Kopf[2], Robyn Watts[3]

1. *Charles Sturt University, Thurgoona, NSW, Australia*
2. *Institute of Land, Water and Society, Charles Sturt University, Thurgoona, NSW, Australia*
3. *Institute of Land, Water and Society, Charles Sturt University, Thurgoona, NSW, Australia*

Small changes in water temperature during the early life history of fishes can affect their growth, recruitment, abundance and distribution. However, there is little information available about the influence of temperature on functional traits of freshwater fish larvae or how these vary across spatial gradients.

The aim of this study was to examine temperature-specific growth, survival and development of Murray cod (*Maccullochella peelii*) larvae from four regions across the Murray-Darling Basin (Northern, Macquarie, Lachlan and Southern). Larvae from each of these regions were reared from 0-28 days post hatch (dph), at five temperatures ranging from 14 to 30°C. Total length was measured and development stage observed at fixed intervals and survival was recorded daily.

Larvae from the Lachlan region experienced significantly higher mortality at temperatures of 26°C and above, compared to larvae from all other regions. Significant regional differences in somatic growth were observed among larvae at different ages and temperatures ($P<0.05$), however these were not consistent until 24 dph at 26°C. A decline in growth among larvae from all regions at temperatures of 26°C and above indicates that predicted temperatures increases associated with climate change above this threshold will negatively impact larval growth and recruitment success.

These results support hypotheses suggesting that populations of widely distributed freshwater fish species have unique adaptations to local environmental conditions. Conservation and population recovery strategies for native fish may need to be modified to consider regional differences among populations and their unique responses to anthropogenic pressures such as river regulation.

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59 Identifying the micro-habitat and flow requirements conducive to effective recruitment of the endangered Macquarie Perch

Prudence McGuffie[1 2], Mark Lintermans[1], Dean M Gilligan[2], Chris Walsh[2], Dylan van der Muelen[2], Ross Thompson[1]

1. *Institute of Applied Ecology, Canberra University, Canberra, ACT, Australia*
2. *Fisheries and Ecosystem Research, Department of Primary Industries, Batemans Bay, NSW, Australia*

Macquarie Perch (Macquaria australasica) is a native fish listed as Endangered under the Australian Environment Protection and Biodiversity Conservation Act 1999. Populations of Macquarie perch have contracted in distribution and abundance and there are now only four large self-sustaining remnant populations remaining (Abercrombie River, upper Murrumbidgee River, Cotter River and Dartmouth Dam). Therefore active conservation measures are required to facilitate population recovery through gaining knowledge on the species micro-habitat requirements, recruitment biology and the influence of flow on population processes. Such information is critical for threatened species recovery planning and their management. To achieve these objectives we propose an acoustic telemetry study in conjunction with a larval and juvenile sampling program.

60 Rehabilitating the Environmental Values of Lake Corangamite

Stuart D McCallum[1] , Mark Schultz[2]

1. *Greening Australia, COLAC, VIC, Australia*
2. *Sustainable Water Strategy, Corangamite Catchment Management Authority, Colac, VIC, Australia*

Lake Corangamite, Australia's largest permanent saline lake, is a terminal lake – one of nine comprising the Western District Lakes Ramsar site - that fluctuates in depth and salinity in response to the prevailing climate. Since the 1950s when the lake reached its highest recorded level of 118m AHD, there has been a steady decline to below 113m AHD. The corresponding decline in the lake biota includes the loss of submerged macrophytes, fish, and a decline in the diversity and abundance of invertebrates. The euryhaline Australian Brine shrimp, Parartemia zeitziana, formerly recorded infrequently during drought periods, is now consistently abundant.

Waterbirds have varied greatly in diversity and abundance with the lowest counts being recorded in the periods of highest salinity. The construction of the Woady Yallock diversion scheme in the 1950s to prevent flooding of agricultural land is a major factor in the decline. Climate change predictions indicate a drier future for the lake.

To address the lake's deteriorating condition, the Western Sustainable Water Strategy calls for the diversion scheme to be "re-managed" to return water to the lake and to assess the operation of the scheme in 2022 in response to predicted and observed climate patterns. This presentation examines preliminary modeling, which indicates that a median climate change scenario is equivalent to the continued operation of the scheme. The results of Integrated Quantity and Quality Hydraulic Models are used to consider the predicted environmental consequences of a range of alternative management scenarios.

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61 Communicating science to enable "conversations that matter"

Siwan Lovett[1]

1. Australian River Restoration Centre, Canberra, ACT, Australia

"In today's environment, hoarding knowledge ultimately erodes your power. If you know something very important, the way to get power is by actually sharing it." Joseph Badaracco

As the quote from Joseph Badaracco states, by sharing our knowledge in many different ways, and by working together, we can empower ourselves, and the communities we seek to work with, to do more. By adopting a broad definition of 'knowledge', we can include many more forms of understanding about how our rivers function and what we need to do to conserve and restore these systems so that they can support environmental, social and economic needs. By investing in networks and relationships, we can support groups doing great work, and share the lessons they learn with others so that mistakes are not repeated and successes are built upon. By taking time to value ourselves and the work we do, we can reaffirm and share our sense of purpose to inspire and motivate others to protect and care for our waterways. This presentation will focus on the need to share knowledge and empower people to act and provide some of the philosophy and practical techniques that underpin this approach. It will also showcase some of the most recent projects undertaken by the Australian River Restoration Centre that bring science and practice together, namely, *True Tales of the Trout Cod*, the reinvention of the *RipRap Magazine* and the *Finterest.com.au* website.

62 Measuring the success of flow restoration across multiple scales: thinking outside the bucket

Fran Sheldon, Sally Hladyz, Stephen Balcombe, Erin Peterson, Jenny Davis

Natural flow regimes are important for maintaining the ecological integrity of flowing water systems. Likewise, altered flow regimes, often accompanied by other environmental stressors, are a significant factor in the ecological degradation and loss of biodiversity in freshwater systems globally. With many rivers and basins globally targeted for some degree of flow restoration there is a need for measuring the success, or otherwise, of environmental flow releases to inform long-term flow management. What is missing from much of the environmental flows literature, however, is a detailed discussion of potential indicators that may be suitable for assessing the ecosystem responses to environmental flows across a range of spatial and temporal scales. In this paper we present a conceptual model of the ecosystem response to environmental watering and discuss a suite of ecosystem-response indicators likely to be sensitive to flow-regime restoration. This includes short-term changes in ecological responses resulting from environmental flows delivered as individual pulse releases or ad hoc flow releases, as well as, longer-term responses to more widespread systematic restoration of the flow regime at the catchment scale, particularly in large floodplain river systems.

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63 Pool stratification in the upper Murrumbidgee River: the influence of flow and geomorphic character

Fiona Dyer[1], Alica Tschierchke[1], Danny Wright[1], Patrick Ross-McGee[1], Mark Lintermans[1]

1. Institute for Applied Ecology, Canberra, ACT, Australia

Thermal and oxygen stratification are common features of lakes and pools in lowland rivers with persistent stratification commonly resulting in water quality problems and reductions in available habitat. Stratification is rarely observed in upland river systems because the structure of the rivers creates turbulent flow that mixes the water column, however significant reductions in streamflow can produce stratified conditions. This study investigated the effects of flow and pool character on stratification in pools in the upper Murrumbidgee River. Six pools, ranging in depth from 3 to 8 m in the upper Murrumbidgee River were studied during the summers of 2011/2012 and 2012/2013. The 2011/2012 summer was characterised by low temperatures and high flow conditions and the 2012/2013 summer was characterised by high temperatures and moderate to low flow conditions. Dissolved oxygen and temperature were recorded at sub-daily intervals at a range of depths using sensors attached to chains to determine the vertical patterns in environmental variables over time. Results indicated that shallower pools in open valleys respond more quickly to variations in air temperatures than do deep pools in narrow valleys. This response is amplified during low flow periods. Dissolved oxygen stratification was observed in some pools in both summers, however conditions did not persist through a full diel cycle in the 2011/2012 summer. Persistent stratification was observed in the 2012/2013 summer with oxygen concentrations as low as 0.5 mg/L at depth. Weather conditions, flow and the geomorphic character of the pools appear to be the controlling influences.

64 The Water Levels of the Thirlmere Lakes, and possible impacts from mining

Steven E Pells[1], Philip J N Pells[2]

1. UNSW, Cromer, NSW, Australia
2. Pells Consulting, MacMasters Beach, NSW, Australia

Within the World Heritage Thirlmere Lakes National Park are five unpolluted fresh water lakes approximately 15 million years old.

The lakes are recognised as being unique becausethe size and unusual shape of the lakes' catchment area has allowed the uninterrupted development of deep peaty deposits for at least 100000 years, and the stability of the landscape has enabled many aquatic organisms to evolve in isolation. Consequently, this area is an outdoor laboratory of great scientific importance.

Since the early 2000's declining water levels were observed by locals, to the point that in December 2009, Lake Nerrigorang was only dry cracked peat. By late 2011, Lakes Gandandarra and Werri Berri were also dry. While drought conditions had prevailed through much of the decade, attention also turned to nearby longwall mining activities as a potential cause for the declining water levels.

Despite their significance, no measurements of flows, water levels, or even ground- levels, had been historically undertaken at the Thirlmere Lakes.

An ongoing independent study has sought to piece together the evidence of historical water levels in the five lakes, and to assess the case for impacts from mining, or otherwise. Various lines of evidence were considered, including: historic bushwalker and forestry records; anecdotal evidence; terrestrial photographs; ecological indicators; ground-survey and drilling data; ongoing water level monitoring and mining records and water usage. Industry-standard hydrological and hydrogeological modelling tools were used to replicate the historical water-balance and to assess possible impacts of the nearby longwall mining.

Oral Abstracts

65 Translucency and transparency environmental flow rules may actually work!

Ivor Growns[1]

1. NSW Office of Water, Armidale, NSW, Australia

In regulated rivers environmental flows (the provision of water to maintain ecosystems) are the main management technique used to ameliorate the ecological effects of flow alteration. In 2010 a new environmental flow regime based upon translucency and transparency rules was put in place in the Hawkesbury-Nepean River system by Sydney Water Corporation. For the transparency component all inflows to the dams are released up to the 80th flow percentile. For the translucency component 20% of the flows above the transparency threshold are also released. In autumn 2013 I sampled macroinvertebrates from edge, pool-rock and "riffle" habitats in 21 regulated and unregulated sites that had been previously sampled between 1995 and 1997. In the 1990's there was a clear impact of river regulation on the macroinvertebrates in those habitats. Most analyses of the new data indicated that there were no significant differences in either the pool-rock or "riffle" macroinvertebrates between the unregulated and regulated sites in the 2013 samples. These results indicate that the environmental flows have resulted in ecological improvement. However, more sampling occasions and results from the edge samples are required to confirm.

66 Flood regimes driving community transitions in semi-arid floodplain woodlands

Heather M McGinness[1], **Veronica A J Doerr**[1], **Anthony D Arthur**[1], **Micah Davies**[1]

1. CSIRO, Canberra, ACT, Australia

Water resource development in south-eastern Australia has resulted in serious reductions in the frequency with which floodplain woodlands are inundated, resulting in significant habitat degradation. Forecast changes in management practices and climate are likely to result in further changes to flood regimes for floodplain woodland remnants; however the potential effects of such changes are poorly understood. This study demonstrates that differences in flood frequency are associated with predictable shifts in site character and ultimately transitions to different vegetation and fauna communities, even within the same broad vegetation type (Eucalyptus largiflorens black box woodlands). These shifts have a synergistic effect resulting from interactions between vegetation changes, fauna habitat preferences and fauna behaviour. Such transitions encompass changes in structure and composition of a community or site; with potentially far-reaching implications for ecosystem function and biodiversity persistence at multiple scales and for the way a site is valued and managed. Knowledge of the nature of these shifts allows land and water managers to make informed decisions about site management according to what they regard as desirable characteristics. Desirable characteristics may be relevant to broad scale management, such as entire landscapes, or to fine scale targeted management, such as management of threatened or invasive species.

Oral Abstracts

67 Fish recruitment during a large-scale flood in the Macquarie Marshes – role of environmental flows

Derrick Mr Cruz[1], Angela Prof. Arthington[2], Thomas Dr Rayner[3], Richard Prof. Kingsford[4], Iain Prof. Suthers[5]

1. *Australian Rivers Institute, Griffith University, Brisbane, Qld, Australia*
2. *Australian Rivers Institute, Griffith University, Brisbane, QLD, Australia*
3. *Charles Darwin University, Darwin, Northern Territory, Australia*
4. *The Australian Wetlands, Rivers and Landscapes Centre, UNSW, Sydney, NSW, Australia*
5. *Fisheries & Marine Environmental Research facility, UNSW, Sydney, NSW, Australia*

In Australia's hydrologically unpredictable inland rivers, casual factors driving recruitment of native fish remain poorly understood. Since European settlement, native fish populations have declined while introduced, non-native fish have flourished, favoured by river regulation. Attempts to restore native fish populations have centered on targeting environmental flows to promote native species while suppressing non-native species; however, the benefits of such restoration efforts are unclear. This study investigated the native and non-native fish community within the heavily regulated, semi-arid floodplain system of the Macquarie Marshes, NSW. I measured the response of fish communities to a large one-in-10yr flood event, sustained by targeted environmental flows. Ephemeral floodplain sites were regularly sampled for larval, juvenile and small-bodied fish over a six-month period and the micro-habitat use and community structure of both native and non-native species recorded. A total of 20,737 individual fish, representing eight species in seven families, were captured. Native fish recruits were largely absent and non-native species dominated fish communities across every stage of the flood, outnumbering native fish 16:1. Micro-habitat overlaps between natives and non-natives also occurred at all stages indicating high resource competition pressures. We also captured the first known record of the native Hyrtl's tandan, *Neosilurus hyrtlii*, in the Macquarie river catchment, highlighting the potential restoration benefits large-scale floods can provide via hydraulic connectivity.

68 Putting Theory into Practice: delivering environmental water effectively

Anne Jensen[1]

1. *Anne E Jensen Environmental Consultant, Maylands, SA, Australia*

While the overall concept of returning water to river ecosystems in the Murray-Darling Basin has been accepted, in practice there are many questions about how to deliver environmental water effectively at specific sites for demonstrable environmental benefits. In 2013, following Commonwealth buy-backs, the limiting factor is no longer the water itself, but the number of flow-ready sites where environmental planning, landholder agreements and administrative arrangements are in place so water can be delivered at appropriate times for environmental benefit. Another key factor is natural variability of flows, and the short lead time to predict seasonal conditions and select appropriate water regimes for each site.

Recent environmental waterings near Loxton in the SA River Murray Valley required targets with hypothesised benefits for each site, and monitoring of ecological responses. The specific environmental objectives and targets for a range of flow scenarios will be described, as well as the practical constraints on delivery, adaptive conclusions from monitoring of ecological responses, and constraints due to administrative requirements. The delivery of environmental water is a major experiment in adaptive management at a landscape scale. It is critical that learnings are shared and updated among practitioners and researchers to achieve most effective results in a highly sensitive political environment. The process needs to include feedback loops for adaptation in administrative processes, as well as in management, in order to achieve best possible use of available environmental water.

Oral Abstracts

69 Dams in Northern Australia – An Example of the Limnology of the Burdekin Falls Dam and its Effect on Downstream Environments

Damien Burrows[1]

1. *TropWATER, James Cook University, Townsville, QLD, Australia*

The Burdekin River, on Queensland's tropical east coast, has variable water clarity, running turbid during elevated wet season flows and relatively clear the remainder of the year. A 1.8 million ML dam was constructed on the river at the Burdekin Falls in 1987. Despite the environmental assessment predicting it would be clear, the dam has remained persistently turbid ever since. The persistent turbidity has been found to be due to limited settling of the suspended colloidal sediment trapped in the reservoir during the wet season, which would otherwise pass through the system within days. Management options such as reducing catchment erosion may reduce turbidity to some extent, but in the main, the turbidity of the dam results from its size, trapping a large amount of turbid water, and the highly seasonal flow regime whose post-wet season flows are unable to dilute the stored turbid water.

The turbid dam water is distributed downstream through 159km of river and across the irrigated floodplain through numerous previously clear streams and wetlands, greatly altering ecosystem processes in the downstream environments. However, due to surrounding intensive agricultural land uses, the remaining clearwater wetlands have significant eutrophication issues and associated fish kills, whereas wetlands affected by persistent turbidity have a more favourable oxygen status for aquatic biota - the turbidity providing some benefit.

Impoundment limnology is a key driver of downstream effects in water resource developments, though rarely considered in impact assessments. Further large dam developments currently proposed for tropical catchments may have similar impacts.

70 Movement behaviours of a riverine population of the threatened Macquarie perch during the spawning season

Wayne Koster[1], **David Dawson**[1], **John Morrongiello**[2], **David Crook**[3]

1. *Department of Environment & Primary Industries, Heidelberg, VIC, Australia*
2. *CSIRO, Hobart, Tasmania, Australia*
3. *Charles Darwin University, Darwin, Australia*

Movement is an important and often complex component of the life histories of freshwater fish. Understanding movement behaviours is therefore critical to the development of strategies to conserve fish populations. The Macquarie Perch *Macquaria australasica* is a threatened freshwater fish species that has undergone a major decline in range and abundance. Whilst there is good ecological information for populations that have become established in artificial impoundments, substantial gaps exists in our knowledge of remaining riverine populations. A synchronised upstream spawning migration during spring-early summer has been documented for impoundment populations, with fish spawning in the lower reaches of inflowing streams. Whether riverine populations exhibit similar synchronised migratory behaviour during the spawning season is unclear. In this study, radio-telemetry is used to test the hypothesis that riverine Macquarie Perch exhibit synchronised migrations to specific river reaches during the spawning season. The results of the research show that the movement behaviour of riverine Macquarie Perch was complex and non-synchronous. Fish occupied restricted home ranges, undertook occasional local upstream and downstream moves coinciding with flow variations, but there was no evidence of movement of multiple fish to specific locations. These results suggest that management of riverine populations cannot necessarily be based on the behaviour of lacustrine populations, and highlights the need to consider population-specific variation in behaviours in management of threatened species.

Oral Abstracts

71 Long-term patterns in spawning and early life history of Murray cod

Paul Humphries[1]

1. *Charles Sturt University, Albury, NSW, Australia*

Despite their diversity in freshwaters globally, fishes have suffered major declines over many decades, mostly because of habitat and flow alteration, introduced species, over-harvesting and pollution. This is as true in Australia as anywhere else in the world. One conspicuous example of such declines, is the Murray cod. Populations of Murray cod are now much lower than when Europeans first settled along our inland rivers. Yet its 'equilibrium' life history strategy and predictable spawning period means that, given the right conditions for recruitment, this species can hang on under extremely harsh environmental conditions. I present the results of a 15-year study of the spawning and early life history of Murray cod in the Broken River, northern Victoria. This period spanned the whole of the millennium drought, the decommissioning of Lake Mokoan – a major off-channel storage in the system - and floods in 2010-2012. Murray cod continued to spawn throughout this whole period, very predictably between early November and mid-December, with drifting of larvae peaking in early December. Spawning occurred irrespective of flow conditions, but instead was related to a temperature threshold. Larvae were typically 8-15 days-old when drifting, but differed substantially in developmental stage and the amount of yolk they retained. Growth of larvae varied inter-annually, and was intimately related to temperature patterns in the week prior to capture in the drift. I will speculate on why I think Murray cod has persisted in the Broken River and how it provides hope for the future of this iconic species.

72 Tracking long-distance migrations in large rivers: Piloting pop-up satellite archival transmitters on giant catfish in the Mekong

Harmony Patricio[1], **Shaara Ainsley**[2], **Francois Guegan**[3], **Sinsamout Ounboundisane**[4], **Doug Demko**[5]

1. *Australian Rivers Institute Griffith University, Brisbane, QLD, Australia*
2. *FISHBIO, Davis, CA, USA*
3. *WWF, Vientiane, Lao PDR*
4. *FISHBIO, Vientiane, Lao PDR*
5. *FISBHIO, Chico, CA, USA*

The Mekong River flows over 4000km through six different nations in SE Asia. Over 130 fish species are reported to migrate distances up to 1000km. Mekong giant catfish are critically endangered on the IUCN Red List, yet little is known about their migration characteristics. Such information is essential if actions to conserve the fish are to be taken. Over 112 hydroelectric dams are currently in underway in the lower basin, yet limited understanding of migrations makes it impossible to accurately assess the impacts of dams on fish. We have tested a novel technique to track the migrations of Mekong giant catfish using pop-up satellite archival transmitters (PSATs). PSATs are typically applied in marine environments, and to our knowledge this is one of the first studies to use PSATs in a freshwater system or on a Pangasius species. Two hatchery-raised fish were tagged using a new attachment method and held in a small reservoir for a period of four months, at which time the tags were programmed to self-release. During the tagging period we received intermittent signals to the satellite, which was unexpected for a species that is primarily benthopelagic. The location accuracy of the tags was tested through manual upload of the data after self-release, and the fish were examined to determine their physical tolerance for the tagging procedure. The results of the study indicate that this method can provide suitable geolocation information for fish that migrate long distances in large rivers.

Oral Abstracts

73 Change in Macquarie perch and rainbow trout diet during the early filling stage of a recently enlarged reservoir

Sally Hatton[1], Fiona Dyer[1], Mark Lintermans[1]

1. University of Canberra, Canberra, ACT, Australia

The Enlarged Cotter Dam (ECD) poses several threats to the only viable population of endangered Macquarie perch (Macquaria australasica) in the ACT. This study is investigating changes in food resources for Macquarie perch and rainbow trout in the early filling stage of the ECD. During the early filling stage trophic upsurge is likely to occur, following flooding and the resulting breakdown of terrestrial vegetation, leaf litter and organic matter in top soils of the reservoirs inundation zone. This is expected to result in a change in fish food resources through an increase in the production of invertebrates, the predominant dietary items of Macquarie perch. Macquarie perch and rainbow trout diet and fish food resources were sampled in the ECD before reservoir filling and in the early stages of filling, with trout diet and food resources also collected from two other existing reservoirs in the Cotter System. Preliminary results show that there are differences between the diets of fish across the three reservoirs. Food availability results also show there are significant differences in food resources across different habitats and between the three reservoirs, with complex habitats being more productive. It is important to understand the impact enlargement of reservoirs has on fish diet changes and fish food resources, as changes in food availability may affect fish condition, and potentially reproductive output. Knowledge gained from this project will be used to enhance future management decisions surrounding reservoir filling and the implications for native freshwater fish species.

74 Exploding concern about copper: the impact of the Ok Tedi mine on algal chlorophyll in the Fly River system, Papua New Guinea

Ian C Campbell[1], John Beardall[2]

1. Rhithroecology, Blackburn South, VIC, Australia
2. School of Biological Sciences, Monash University, Clayton, Victoria, Australia

Phytoplankton was measured fluorometrically at four sites along the Fly River, PNG, one site in the Strickland River and in nine floodplain off-river waterbodies, to evaluate the impact of the Ok Tedi mine. Although previous investigations had proposed that the copper-rich mine wastes would depress algal standing crop, our data, the first direct measurements of phytoplankton standing crop, indicate that the mine wastes increase algal standing crop. The likely cause of the increase is the runoff of nitrogenous compounds from explosives. No mine impact was detected in chlorophyll in the floodplain Off-River Water Bodies. Chlorophyll was often concentrated in a prominent sub-surface maximum, and compositional differences made it clear that the potamoplankton is a discrete assemblage and not primarily washout from the lentic water bodies. Most investigations of mine discharge impacts on waterways have primarily focussed on toxic metals, few have considered the potential impacts of other chemicals such as explosives.

Oral Abstracts

75 Ecogenomics and eFlows: delivers the goods, but can muddy the waters

Gavin Rees[1], Michael Shackleton[1], Garth Watson[1], Chris Davey[1]

1. Murray-Darling Freshwater Research Centre, Wodonga, VIC, Australia

Measuring community changes in response to perturbations is a fundamental aspect of ecological study. Molecular biology has provided ecologists with a suite of techniques that enhance our capacity to detect a wide range of organisms, particularly microscopic organisms or those difficult to study or identify. Given the relative infancy of ecogenomics, there are a limited number of studies that demonstrate some of the wider benefits of a genomic approach to study community changes. We applied an ecogenomic approach where we measured whole eukaryote community structure (animals, plants, fungi) in two Murray River studies. In the first instance we could show strong differences in the community present on biofilms and water column samples, at two contrasting sites. In the second study we tracked the community structure of riverine biofilms during and after exposure to a flooding event. While there were times when clear differences could be seen between sites, no clear picture emerged in response to the flood waters. Further work is required to determine whether there was indeed no consistent change in response to the flood, or whether methodological issues obscured any real response.

76 Monitoring herbicide toxicity in rivers using benthic diatom communities

Rebecca J Wood[1], Simon Mitrovic[1], Satish Choy[2], Ben J Kefford[1]

1. Centre for Environmental Sustainability, University of Technology, Sydney, NSW
2. Department of Science, Information Technology, Innovation and the Arts (DSITIA), Queensland Government, Brisbane, QLD, Australia

Herbicides pose a threat to aquatic ecosystems, especially to phototrophic organisms such as benthic algae. Benthic diatoms may be a valuable indicator of toxic impacts of herbicides in aquatic systems. Information on the sensitivity of a wide range of freshwater benthic diatom taxa to herbicides is required in order to develop a new biomonitoring tool that can determine herbicide toxicity in rivers. Unfortunately herbicide sensitivity data is only available for very few species as current methods of conducting algae toxicity tests on individual taxa are lengthy and costly. This study utilised the rapid toxicity approach to produce reliable sensitivity data for numerous diatom genera in a 48 hour exposure toxicity test. Natural benthic diatom communities were collected from rocks in-situ and placed directly into rapid toxicity tests. The relative sensitivities of the diatom genera to eight common herbicides (Atrazine, Simazine, Hexazinone, Tebuthiuron, Diuron, MCPA, Glyphosate, 2,4-D) were determined. This study identifies diatom taxa most at risk of herbicide toxicity within a field collected multi-species benthic diatom community. The most sensitive genera to were; *Encyonema, Cymbella, Gomphonema, Ulnaria*, whilst more tolerant genera were; *Eunotia, Achnanthidium, and Navicula*. These results are compared to field based observations of benthic diatom community changes relative to measured herbicide concentrations. The results of this project to date are assessed in terms of the development of a new biomonitoring index that uses benthic diatoms to provide a cost effective and ecologically relevant method for the detection and assessment of herbicide impacts in rivers of North Queensland.

Oral Abstracts

77 The case for remote sensing of inland water quality in Australia

Tim J Malthus[1], Erin L Hestir[1], Arnold G Dekker[1], Roderick Oliver[1]

1. CSIRO Land and Water, Canberra, ACT, Australia

Australia's inland water quality ranks poorly among the world's developed countries. In managing this issue, we face similar challenges to other countries, where consistent and accurate information on inland water quality over wide areas of the continent are required such that current conditions can be assessed and responses to other impacts such as land use, flooding and climate change investigated. However, conventional monitoring campaigns and data are costly to sustain, scarce and declining, have poor geographic and temporal coverage, and may be of variable accuracy.

We will explore the role that optical remote sensing could play in assisting us to objectively assess inland water quality over multiple spatial and temporal scales to complement existing, limited monitoring programs. The presentation will discuss the extent to which research has matured to simultaneously extract a number of relevant water quality variables from in situ and satellite optical data using sophisticated algorithms (e.g. chlorophyll, cyanobacterial pigments, sediments and dissolved organic matter).

We will also highlight that we know very little of the optical characteristics of Australia's inland waters, knowledge that would help us better parameterize retrieval algorithms to a point where regional and continental assessment of a significant part of Australia's inland water quality could be achieved. The ongoing challenges toward realizing the goal of accurate inland water quality products over wider spatial areas will also be discussed. These include sensor spatial resolution, cloudiness, atmospheric correction, limited in situ data with which to both provide adequate validation and to adequately parameterize algorithms.

78 Improving survival of a freshwater turtles in the urban landscape: the human interaction factor

Caitlin Bartholomaeus[1], Jane M Chambers[1], Catherine Baudains[1], Mirela Tulbure[2]

1. Murdoch University, Perth, Australia
2. University of New South Wales, Sydney, Australia

Human perceptions, attitudes and knowledge shape the urban environment. Cities globally have replaced the natural habitat with one to suit human needs. Native species that have managed to survive this change have adapted to the new environment (e.g. Racoons in North America) or are reliant on remnant habitat patches (e.g. freshwater turtles in a wetland). Species survival is dependent on the range and quality of resources available but can also be affected by direct interaction with humans.

This study investigates *Chelodina colliei*, the only native freshwater turtle species in Perth, Western Australia. Like many other wetland species, this turtle's habitat is isolated in a sea of urban sprawl. Through the investigation of the size and distribution of *C.colliei's* populations, and the use and resources available in and around anthropogenic and natural wetlands, we were able to identify key factors that affect their survival. Surveys of residents indicating how, when, why and where humans interact with this species, enabled us to identify the positive and negative impacts of human activities and behaviours on turtles.

By understanding human-turtle interactions, resource availability and urban hazards, sustainability of turtle populations can be promoted through environmental restoration, modification of the built environment and by improving human appreciation of local native species. This fresh approach to exploring the urban ecology of *C.colliei* allows us to ascertain how local-scale human interaction can influence the survival of turtle populations and to build a holistic picture to inform freshwater turtle conservation and management within the urban ecosystem.

Oral Abstracts

79 Effects of fine sediment addition and removal on stream invertebrates and fish: a reach-scale experiment

Christoph D. Matthaei[1], Gerry P. Closs[1], Javad Ramezani[1]

1. University of Otago, Dunedin, OTAGO, New Zealand

We investigated effects of sedimentation on stream fish communities and their invertebrate prey. A second aim was to determine whether removing fine sediment from streambed substrata can reverse negative effects of sedimentation. We manipulated two farmland streams for two months, by adding or removing fine sediment in 50-m reaches twice (on the first day and one month later). Each stream contained one addition, one removal and one control reach separated by buffers. Streams were sampled five times, 2 days before, 2 days and 27 days after manipulation 1 (with the third occasion also being 2 days before manipulation 2), and 4 and 34 days after manipulation 2. Electrofishing was conducted once, at the end of the experiment. Sampling included physicochemical and invertebrate community variables, fish densities and several fitness and diet variables for juvenile brown trout. Benthic invertebrate taxon richness and density of the common caddis *Aoteapsyche* responded negatively to sediment addition and positively to sediment removal. Brown trout density (estimated repeatedly using nocturnal spotlighting) showed the same patterns, and densities of native fish (determined by electrofishing) exhibited similar trends. Further, trout condition was poorer in sediment addition reaches than in removal or control reaches. Our results imply that increased deposited fine sediment levels can degrade stream habitats and negatively affect invertebrate and fish communities, including density and condition of trout, which are commercially and/or recreationally important in many countries. These findings should help develop mitigation plans for current farming practices and improved future best management practices.

80 Broad-scale assessment of instream woody habitat condition for Victoria's rivers

Adrian Kitchingman[1], Zeb Tonkin[1], Jarod Lyon[1]

1. Dept Environment and Primary Industries, Arthur Rylah Institute, Heidelberg, VIC, Australia

The removal of Instream woody habitat (IWH) has been identified as a major contributing factor in the decline of many freshwater fish populations. To identify and prioritise areas for river restoration where IWH needs protection and augmentation, baseline information on the level of IWH in rivers and its condition is required.

Field assessments of natural IWH densities were undertaken in 'pristine' river reaches throughout Victoria. This information was used in a predictive modelling approach to determine natural IWH densities in rivers across Victoria. Current densities of IWH river reaches across Victoria were calculated using a combination of high resolution aerial photographs, field assessments and measures of riparian overhang. A simple comparison of the predicted natural IWH densities and the current IWH densities enabled researchers to assess the condition of IWH densities in streams throughout Victoria.

The predicted natural IWH densities in Victorian rivers were on average 0.03 m3m-2 and varied according to slope, stream width and climatic variables. Current densities of IWH in river reaches across Victoria are on average 0.01 m3m-2 which equates to an average reduction of ~41% below estimated natural IWH levels. Over 20,000 Victorian river reaches, equalling ~17,000 km, have severely or highly depleted IWH densities. IWH densities more than 80% below natural levels were estimated for 30% of river reaches.

Maps and IWH loads of this broad-scale assessment will help managers identify areas in most need of rehabilitation activities. Modelled IWH loads also will aid research into to IWH dynamics and its ecological role.

Oral Abstracts

81 Perspectives from the last twenty years of hyporheic research: advances, ambiguities and aspirations

Sarah Mika[1], Darren Ryder[1], Andrew Boulton[1], Maurice Valett[2]

1. *Ecosystem Management, School of Environmental and Rural Science, University of New England, Armidale, NSW, Australia*
2. *Systems Ecology, Division of Biological Sciences, University of Montana, Montana, USA*

In many rivers, the hyporheic zone regulates fundamental ecosystem processes at reach to catchment scales, influencing surface water quality and primary production. Over the last twenty years, hyporheic research has advanced from primarily description to include prediction and manipulation, particularly in the emerging field of hyporheic restoration. Nonetheless, gaps remain in our understanding of hyporheic ecology. Ambiguities include tests of the hyporheic refuge hypothesis, predictive models of microbial activity and composition in relation to hydrological exchange, hyporheic food-web structure, and regional differences in ecosystem services performed by the hyporheic zone. Research priorities identified twenty years ago in scale-associated heterogeneity, hierarchical organisation of hyporheic systems, and hydrologically driven emergent properties of hyporheic exchange remain, especially the need to understand the cumulative effects of sequential hyporheic zones at sub-catchment and catchment-scales. We suggest future hyporheic aspirations and some ways to address them, recognizing recent technological advances that enable us to tackle these large-scale research priorities.

82 Origins of Australian freshwater fishes

Peter Unmack[1]

1. *Institute for Applied Ecology, University of Canberra, Canberra, ACT, Australia*

The world's fish fauna is dominated by two groups, Ostariophysi (9622 species) and Acanthopterygii (16207 species), which combined account for about 81 per cent of all fishes. Most freshwater fish faunas are dominated by ostariophysans, consisting of minnows (Cypriniformes), characins (Characiformes) and catfishes (Siluriformes). In contrast, the worlds marine habitats are dominated by acanthopterygian fishes. The freshwater fish fauna of the Australian continent (which includes New Guinea) is exceptional in being dominated by acanthopterygian fishes rather than ostariophysans. Indeed, Australia has the only freshwater representatives for many acanthopterygian families. This makes the continental fish fauna unlike any other apart from the island of Madagascar. While Australia's extraordinary mammal fauna receives a lot of attention, our fish fauna is no less distinctive. While most Australian freshwater fishes ultimately have marine origins, most families have been present in Australian freshwaters for at least 40-80 million years. In this presentation I will review the phylogenetic information that examines the number of marine – freshwater transitions for various Australian freshwater groups and provide approximate estimates for the timing of these invasions.

Oral Abstracts

83 Morphological variation in the western rainbowfish (*Melanotaenia australis*) among habitats of the Pilbara region of northwest Australia

Samantha Lostrom[1 2], Jennifer Kelley[2], Jon Evans[2], Samuel Luccitti[3], Pauline Grierson[1]

1. *Ecosystems Research Group and West Australian Biogeochemistry Centre, School of Plant Biology, The University of Western Australia, Perth, WA, Australia*
2. *School of Animal Biology, University of Western Australia, Perth, WA, Australia*
3. *Rio Tinto, Perth, WA, Australia*

The western rainbowfish, Melanotaenia australis, is abundant and widespread across streams of the Pilbara region of northwest Australia. Hydrological flow regimes are highly dynamic and can vary from no flow to rapidly flowing depending on the landscape and season. However, little is known of the plasticity and resilience of *M. australis* to spatial variation in habitat conditions. We measured morphological variation in *M. australis* across 11 sites along a 450 km section of the Fortescue River in the Pilbara. We sought to (i) quantify body shape variation across the catchment using landmark-based geometric morphometric analyses, and (ii) assess if morphological variation corresponded to habitat conditions (water velocity, pool size and chemistry, catchment position, predation and diet). We found that *M. australis* exhibits a range of morphologies, with differing body depths explaining the most variation in shape (45.97%). Preliminary analysis indicates that the morphology of *M. australis* differs according to sex and catchment region of the Fortescue River. Flow rates and habitat complexity, which are commonly reported to affect body shape in other fish species, did not explain morphological variation of *M. australis* across our study sites. However, flow rates within the catchment were low (all less than 1 m/sec); on-going work is assessing how *M. australis* may alter body shape at higher flows.

84 Fish freight: the role of fishes in the transport of energy and nutrients in rivers

David Crook[1], Duncan Buckle[1], Alison King[1], Sally Oughton[1], Michael Douglas[1]

1. *Charles Darwin University, Darwin, NT, Australia*

Migrating anadromous fishes (e.g. Pacific salmon Oncorhynchus spp.) in the Northern Hemisphere play a defining role in temperate ecosystems by delivering marine derived energy and nutrients to oligotrophic environments (Naiman et al. 2002). Assimilation of this energy into food webs occurs via predation and consumption by other organisms and post-spawning decomposition of carcasses. The "material subsidy" (sensu Flecker et al. 2010) provided by these fish is crucial to the maintenance of populations of a wide range of terrestrial flora and fauna (Naiman et al. 2002). In tropical rivers, the importance of energy transported by migrating fish is poorly understood at present, although recent stable isotope studies suggest that fish movement is a potentially critical ecological process . We used otolith ageing and chemical analyses to examine the movements of Diamond-scale mullet Liza ordensis and five species of Forktail catfish Neoarius sp. between fresh water and the estuary/sea in a tropical river (Daly River) in the Northern Territory. Analysis of strontium isotope ratios (87Sr/86Sr) and otolith: body size relationships were used to quantify the marine-derived biomass transported to the freshwater ecosystem. Otolith chemistry analysis revealed evidence of marine residence in the early life history of Diamond-scale mullet examined followed by a return migration of juveniles into freshwater (i.e. catadromy). Forktail catfish exhibited highly variable patterns among species and among individuals within species. Similar to temperate ecosystems, our analyses suggest that migratory fishes play an important role in transporting marine derived energy into tropical rivers.

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Oral Abstracts

85 A Review of on-ground recovery actions for threatened freshwater fish in Australia

Mark Lintermans[1]

1. *University of Canberra, Canberra, ACT, Australia*

There are many different on-ground recovery actions available to managers, but no synthesis of what, how or why these recovery actions have been deployed. A questionnaire was distributed to a variety of fisheries managers, researchers and private individuals involved with threatened fishes. Details of on-ground recovery actions since 1990 were sought, along with the reasons that initiated the action, and whether or not they had an associated monitoring program. Recovery actions were grouped into 12 categories with the most commonly utilised recovery categories being harvest control, translocation, habitat enhancement and stock enhancement. The number of recovery actions grew significantly in the decade beginning 2000 as the impacts of prolonged drought in southeastern Australia intensified. 58% of recovery actions occurred in the Murray-Darling Basin, although this region only holds 27% of the 74 listed threatened freshwater fish in Australia. Few or no recovery actions were reported for many species, and few actions occurred in northern or western parts of the country. More than 80% of recovery actions reportedly had some form of monitoring. The diversity of management interventions is reviewed, and patterns and issues identified to guide future recovery efforts.

86 Where Have all the Fishes Gone: Distribution and Population Trends of Southern Pygmy Perch Through Climatic Extremes

Luke Pearce[1 2], **Paul Humphries**[2], **Robyn Watts**[2]

1. *NSW Department of Primary Industries, Albury, NSW, Australia*
2. *Charles Sturt University, Albury, NSW, Australia*

Southern pygmy perch, Nannoperca australis, is a small freshwater fish, whose range has declined in recent decades, particularly within New South Wales. The species is now listed as Endangered in both South Australia and New South Wales. Coppabella Creek, a small tributary of the Upper Murray River, is one of only three remaining locations where southern pygmy perch are know to exist within NSW. Over the past 10 years, like many regions of southern Australia, Coppabella Creek has experienced both ends of the extreme climatic spectrum, the driest period on record, followed by a succession of floods, including the highest on record. We followed the Coppabella Creek population through these climatic extremes and documented the impacts on their distribution and abundance. While there was significant drying of pools and losses of fish during the drought, the fish persisted in refuge sites. However, following flooding, there were significant declines in the both the abundance and distribution of the species. Abundance declined from 2375 individuals across 6 sites during the drought, to only 4 individuals at 2 sites post floods. During the drought, the distribution covered 28 of the 34 km of Coppabella Creek. Post flood, that distribution reduced to 7 km. We outline the management actions that were taken during these extreme events and discuss the implication of these actions on the future management of small threatened fish species populations.

Oral Abstracts

87 Sedimentary pigment analysis reveals pre-European shift in trophic state in a freshwater lake - evidence from Lake Colac, western Victoria, Australia

Phuong Doan[1], Peter Gell[1], Keely Mills[1 2]

1. *Centre for Environmental Management, School of Science, Information Technology and Engineering, The University of Ballarat, Ballarat, VIC, 3353, Australia.*
2. *Department of Geography, Loughborough University, Leics LE11 3TU, UK*

Recent research has focused on freshwater ecosystems to observe their "coping mechanisms" and to ascertain whether the aquatic systems demonstrate an ability to recover post-drought, as well as other long-term responses. While much of this research is focused on contemporary systems and associated monitoring, a lack of long-term studies on drought in western Victoria limits our ability to assess the vulnerability of this region to climate change and variability. For future management it is becoming more important to understand how these systems have responded to periods of drought in the past: (1) whether they have undergone similar transformations and and (2) whether they have exhibited signs of recovery, thus implying the level of system resilience to future hydro-climatic change.

Paleolimnological approaches provide insight into how shallow lake systems in western Victoria have changed in response to past climate variation, and possibly previous droughts, at a millennial scale. Using a multi-proxy palaeoecological approach, the history of key western Victorian lake system was reconstructed. Evidence retrieved from the sediment record suggests that a long-term severe drought occurred prior to European settlement. This drought led to a trophic state switch in the functioning of the lake system, from a macrophyte to a phytoplankton dominated system, which has remained stable through the period leading up to the recent drought.

88 Response of ephemeral lake vegetation to changes in water quality and water regime

Adrian Clements[1]

1. *Charles Sturt University, Albury, NSW, Australia*

Ephemeral lakes are a distinct part of the Australian environment. Discrete vegetation communities emerge in ephemeral lakes as a consequence of intermittent periods of wet and dry climates and variable water quality. This project aims to identify the ecological responses of aquatic vegetation communities to changes in water quality and water regime (both individually and in combination) in ephemeral lakes.

The main study site is Lake Brewster, with comparisons to Lake Cowal and Lake Cargelligo, all of which are situated in the mid-section of the Lachlan River catchment, NSW. Each lake has differing levels of human use and impact. Lake Brewster is a modified ephemeral lake which has been divided into a main storage, and inflow and outflow wetlands. The former two are studied in this project.

Significant differences in the composition of the standing vegetation and seed bank have been revealed from preliminary analyses. It is hypothesised that these differences are a result of differing water quality and water regimes. Presented here is a preliminary conceptual model of the influence of water regime and water quality on aquatic vegetation communities of modified ephemeral lakes. Also presented are experimental designs for further studies into the effects of nutrients, turbidity and water regime on seed bank emergence and plant growth.

Oral Abstracts

89 Urban constructed wetlands: a cure for pollution or a potential problem?

Edward Tsyrlin[1], Chris J Walsh[2]

1. *Melbourne Water, Docklands, VIC, Australia*
2. *Department of Resource Management and Geography, The University of Melbourne, Melbourne, VIC, Australia*

Urban stormwater has been identified as a prime degrader of river health. And wetlands are commonly used to protect streams from the effects of urban runoff and to improve the state of the waterways in downstream reaches. We assessed changes in macroinvertebrate community along three urban streams, upstream and downstream of stormwater wetlands accounting for spatial autocorrelation.

Constructed wetlands are intended to improve water quality and ecological condition in the downstream reaches but we found no evidence of improvement in ecological condition downstream of the three wetlands we studied.

These constructed wetlands were not adequately designed for the quantity and quality of the runoff they receive. Wetlands with better design, coupled with dispersed stormwater features are likely to provide a better outcome for the stormwater treatment.

The role and benefit of constructed wetlands as a commonly used river health management option is not always clear. At least in some cases, they do not improve the ecological state of streams and may even contribute to its degradation.

90 The rapid expansion of Typha and Phragmites in Reedy Lake, Geelong

Marcus Cooling[1], Megan Lewis[2], Michelle Clark[2]

1. *Ecological Associates, Adelaide, SA, Australia*
2. *School of Earth and Environmental Sciences, The University of Adelaide, Adelaide, SA, Australia*

Reedy Lake is a 550 ha floodplain wetland of the Barwon River estuary in Geelong, Victoria. Since 1983 the extent of reed beds, comprising Phragmites australis and Typha domingensis, has increased by 51% to now occupy 353 ha of the wetland. The conditions for this change were first created over 130 years ago with the exclusion of saline estuary water from the lower Barwon River. Subsequent changes, including increased lake storage levels and more frequent summer flooding made conditions more favourable for reeds, but the removal of cattle in the 1970s triggered the recent, rapid expansion. This paper documents the dynamics of reeds in the lake drawing on satellite NDVI analysis, historical vegetation mapping, groundwater monitoring and land use history. The relative importance of grazing, salinity, carp and water levels on reed management are discussed.

Oral Abstracts

91 Forget pH – Puissance d'Sédiment! - the power of sediment to restructure your wetland

Jane Chambers[1], **James Tweedley**[1], **Robyn Paice**[1]

1. *Murdoch University, Murdoch, WA, Australia*

This study highlights the integral nature of sediments in key processes that define nutrient status and the dominance of particular ecological regimes in the Ramsar-listed Vasse Wonnerup Wetlands in south-west Western Australia. Coarse sand (>50%) supported an aquatic macrophyte dominated regime in the upper Vasse, while the upper Wonnerup sediments were comprised of fine sand and silt, and supported macroalgae. Fine particle size correlated with high values and distribution of total organic carbon, total nitrogen, total phosphorus, available phosphorus (Fe-bound) favouring the growth of macroalgae and phytoplankton. Measuring sedimentation rates was highly problematic due to highly variable water depths, but estimates for gross sedimentation were high (up to 600g m-2 d-1). The ratio of plate (net sedimentation) and pipe traps (total sedimentation rates) in winter were about a 0.3-0.5 in the Wonnerup but 0.1-0.2 in the Vasse, suggesting a predominance of resuspension in the Wonnerup but due to newly added sediments from the catchment in the Vasse. Seasonal measurement of turbidity indicated very clear water (<5NTU). This suggests that sedimentation was event-based (during storm periods) rather than a continual process. However, sediments caught in sediment traps had up to 16x higher nitrogen and phosphorus than benthic sediments. This was particularly alarming in the upper Vasse, where macrophytes *Ruppia megacarpa* and *Lepilaena australis* currently dominate a low nutrient environment. However an obvious ecological impact has not yet been detected. Seasonal drying of the upper Vasse may be a key factor in maintaining low sediment nutrients.

92 Beyond bioassessment – Coupling predictive modeling of climate, stream temperature, flow regimes, and biota to assess biodiversity response to climate change in USA freshwater ecosystems

Charles Hawkins[1]

1. *Western Center for Monitoring and Assessment of Freshwater Ecosystems, Logan, Utah, USA*

We have increasingly used predictive models in the USA to improve characterization of site-specific reference conditions and interpretation of biological responses to environmental alteration. In general, we have found that (1) Random Forest models are more accurate and precise than other modeling techniques we have evaluated, (2) variation in taxa composition is well predicted from a few temperature and flow variables, and (3) model precision is likely constrained by regional variation in meta-community dynamics. In this talk I describe how we have applied some of these advances to examine how stream invertebrate biodiversity might respond to climate change. We predicted current and future stream temperature and flow regimes by linking climate model predictions to Random Forest models that predict stream temperature and hydrologic regime from climate and watershed attributes. We then linked stream temperature and flow predictions to a RIVPACS-type model to predict how site-specific probabilities of capture of 539 benthic invertebrate taxa would change at 1197 stream reaches in response to climate-induced alteration in stream temperature and flow regime. Both individual taxa and assemblages were predicted to vary markedly in their vulnerability to climate change. Differences in predicted taxa vulnerabilities were generally consistent with known environmental tolerances. Predicted changes in local biodiversity were associated with differences in both initial conditions and magnitude of alteration. However, the biota-flow associations were difficult to interpret because most flow metrics were correlated with temperature. Manipulative experiments will likely be needed to disentangle the effects of temperature and flow regime on stream biodiversity.

Oral Abstracts

93 Recent developments in RIVPACS: supporting the return of ecological integrity to European waters

J I Jones[1], R T Clarke[2], J Davy-Bowker[3]

1. *River Communities Group, University of London, London, United Kingdom*
2. *School of Applied Sciences, Bournemouth University, Bournemouth , United Kingdom*
3. *The Freshwater Biological Association, Wareham, United Kingdom*

The River InVertebrate Prediction and Classification System (RIVPACS) marked a major advance in biomonitoring techniques, introducing the reference condition approach. Here the physical and geographical characteristics of the river are used to determine what taxa would be expected to be present if the site were not polluted. This reference condition approach was subsequently adopted in the Water Framework Directive (2000), far reaching European Union legislation governing the management of Europe's water resources. Although RIVPACS pre-dated the Water Framework Directive, this directive has had a substantial influence on recent development. Checks, and subsequent modifications, had to be made to ensure that the RIVPACS bioassessment tool complied with the legal framework. Also, the directive marked a move from assessing the influence of a single pressure (usually organic pollution) to a more holistic approach based on ecological (not chemical) quality. Taxonomic groups other than macroinvertebrates are now included in assessments, e.g. macrophytes, with a strong emphasis on the level of confidence and precision provided. New indices are being developed using objective statistical techniques to assess a range of pressures on ecological quality (e.g. acidification, low-flow, hydromorphology, heavy metals). As the directive requires member states to develop Catchment Management Plans that are capable of delivering "Good" ecological status, techniques are being developed that can predict the consequences and cost-effectiveness of catchment management measures. There is now an unprecedented drive to develop the wide range of biomonitoring tools needed to predict and support the return of ecological integrity to European waters after decades of pollution.

94 Objectively defining reference conditions for stream bioassessment programmes using generalised dissimilarity models

Peter M Rose[1], Mark Kennard[1], Fran Sheldon[1], David Moffatt[2], Gavin Butler[3]

1. *Australian Rivers Institute, Griffith University, Nathan, QLD, Australia*
2. *Department of Science, Information Technology, Innovation and the Arts, Brisbane, QLD, Australia*
3. *NSW Department of Primary Industries, Grafton, NSW, Australia*

Defining reference condition for stream bioassessment has challenged ecologists for over three decades. Criticisms of the commonly used reference condition approach include: (i) equivocal definitions of 'minimally disturbed' reference condition and idiosyncratic approaches to site selection among stream biomonitoring practitioners; and (ii) contending with highly modified areas where near-pristine reference condition does not exist, leading to management decisions based on a shifting benchmark. We used generalised dissimilarity modelling (GDM) to classify stream types based on fish assemblage-environment relationships and objectively define candidate reference conditions for bioassessment. Our study focused on coastal river basins of eastern Australia encompassing the Ecosystem Health Monitoring Program (EHMP) assessment area; a highly modified region with a complex biogeographic history. GDM was implemented using fish presence-absence data at 396 sites linked to functionally relevant GIS-based natural and anthropogenic predictor variables. Stream segments were classified into ecoregions using the GDM-transformed natural variables. Function plots of the retained anthropogenic variables were used to inform the criteria for defining reference conditions. Nine predictors representing multiple spatial scales explained 33.1% of the deviance. Key drivers of species turnover were elevation, air temperature, % unconsolidated rock geology in the upstream catchment, and mean annual runoff. Ecoregions present in the assessment area were also represented in adjacent and less anthropogenically influenced basins to the north and south, and thus amenable to spatial extrapolation of future assemblage-level modelling. This talk will conclude by proposing a framework for objectively and remotely selecting taxa-specific reference condition using GDM and a stratified, probabilistic sampling design.

Oral Abstracts

95 An improved macroinvertebrate index of stream condition for the Melbourne region

Christopher J Walsh[1]

1. University of Melbourne, Parkville, VIC, Australia

The usefulness of biological indicators of stream condition depends on their sensitivity to human disturbance, and consistency of response across physiographic gradients. The Victorian State Environment Protection Policy legislates objectives for the biotic index SIGNAL, and the observed:expected (OE) index AUSRIVAS. AUSRIVAS is a poor predictor of human impact in the eastern Melbourne region, and while SIGNAL score is a sensitive index, the maximum SIGNAL score observed in the absence of human impacts varies across the physiographically diverse Melbourne region. Models predicting distributions of 60 macroinvertebrate families in relation to climatic, physiographic and human-impact variables were used to predict family occurrences in each reach of the region with human impacts set to zero. Using these predictions as the expected assemblage, I sought the OE index that a) best correlated with forest and urban land cover, b) showed the highest ratio of between-to-within-site variance in long-monitored sites of contrasting human impact, and c) was invariant across the region for predicted assemblages in the absence of human impacts. The best index weighted each observed and expected family at each site by its predicted probability of occurrence and by the shape and direction of its response to forest and urban impacts. This index, combining elements of OE and biotic indices, was as strongly correlated with human impacts as SIGNAL, but was less variable within sites, and had a consistent range of values across the region. Use of individual taxon distribution models to derive integrative indices of stream condition shows great promise.

96 How science contributes to environmental water management: a Victorian perspective

Phil Mitchell[1]

1. Department of Environment and Primary Industries, East Melbourne, VIC, Australia

Science underpins environmental water management in Victoria, with key areas of contribution including:

• the FLOWS method, Victoria's approach for assessment of environmental water requirements for rivers. First released in 2002, FLOWS is underpinned by best available science, includes involvement of local community as a key component and is a cost effective, consistent approach able to be applied across the state. Since 2002, more than 40 FLOWS assessments have been completed. Over that time, learnings and new science have enabled the FLOWS method to be updated, and FLOWS Edition 2 is soon to be released.

• the recently released Victorian Estuary Environmental Flows Assessment Method (EEFAM). The FLOWS method was developed for rivers and streams and the underlying approach has also been applied to determine wetland watering regimes. However, it was recognised that environmental flow assessment for estuaries was a gap in the program. So another project was begun to review the application of FLOWS to estuaries, and to review worldwide estuary flows methods. The result was the development of EEFAM.

• the Victorian Environmental Flow Monitoring and Assessment Program (VEFMAP), which is a monitoring program developed (and implemented) to specifically monitor the ecological responses to environmental flows. Outcomes from VEFMAP are being used to further enhance FLOWS assessments by providing the scientific evidence to underpin the relationships between flow and ecological response - a critical requirement of any flow assessment.

This presentation will outline Victoria's water management framework, highlighting the contribution of science to the process.

Oral Abstracts

97 The Victorian FLOWS method: using science to inform environmental water management

Simon Treadwell[1], Phil Mitchell[2]

1. *Sinclair Knight Merz, Melbourne, VIC, Australia*
2. *Sustainable Water Enviornments Division, Department of Enviornment and Primary Industries, Melbourne, VIC, Australia*

The Victorian FLOWS method was developed in 2002 and has since underpinned the development of environmental flow recommendations in Victoria. It provides a consistent statewide approach for assessing the flow requirements of water dependant environmental assets associated with waterways.

The major steps in the implementation of the FLOWS method have remained largely unchanged over the last ten years. However, as with any scientific method it has been refined through use and evolved to meet the changing needs of environmental water managers.

SKM has recently completed an update of the FLOWS method for the Department of Environment and Primary Industries, which include the requirement for panels to:

- provide more explicit rationale for the link between flow recommendations and ecological response and to document areas of uncertainty in recommendations;

- set environmental flow recommendations under various climate scenarios (i.e. dry, wet and average conditions), provide advice on risks during low flow periods, and to prioritise flow components;

- assess flow scenario compliance with flow recommendations; and

- provide advice on operational issues associated with drought management and flow restoration following abatement of dry conditions.

The updated FLOWS method has two beneficial outcomes: first, the underpinning method has been improved in the light of new information; and second, an emphasis on providing more detailed rationale to support recommendations will facilitate greater consistency across different practitioners in future FLOWS studies. This talk will summarise the important features of the revised FLOWS method and demonstrate how good science is being used to advance environmental water management in Victoria.

98 Estuary environmental flows assessment method (EEFAM): a "building block" approach

Lance Lloyd[1]

1. *Lloyd Environmental Pty Ltd, Syndal, VIC, Australia*

The estuary environmental flows assessment method (EEFAM) is a standard methodology which can be applied consistently across Victorian estuaries. The primary objective of EEFAM is to define a flow regime to maintain or enhance the ecological health of an estuary. While the method is used to inform Victorian water resource planning processes it could be used in many parts of southern Australia.

The output of EEFAM is a recommended flow regime for estuaries. This recommendation is developed from the known dependence of the estuary's flora, fauna, biogeochemical and geomorphological features on the flow regime. EEFAM is an evidence-based methodology. This 'building block' approach conforms to the asset-based approach of the Victorian Waterway Management Strategy and regional waterway strategies.

EEFAM is based on FLOWS, the Victorian method for determining environmental water requirements in rivers, but refined and expanded to reflect environmental and management issues specific to estuaries. EEFAM and FLOWS can be applied simultaneously to a river and its estuary as part of a whole-of-system approach to environmental flow requirements. EEFAM is also modular, and additional components can be readily incorporated.

The draft method was trialled and refined by applying it to the Werribee and Gellibrand estuaries. The final methodology describes the role of a documented objective setting process that links environmental objectives to flow objectives and recommendations through the use of ecological conceptual models; the use of a multi-disciplinary expert panel and the use of hydrological tools and hydraulic models to support the development of environmental flow recommendations.

Oral Abstracts

99 Predicting ecological responses to environmetal flows: making best use of the literature, expert knowledge, and monitoring data

Angus Webb[1], Siobhan C de Little[1], Kimberly A Miller[1], Michael J Stewardson[1], Ian Rutherfurd[1], Andrew Sharpe, Lisa Patulny[1 2], N LeRoy Poff[3]

1. *University of Melbourne, Carlton, Vic, Australia*
2. *Coffey Environments, Abbotsford, Victoria, Australia*
3. *Department of Biology, Colorado State University, Fort Collins, Colorado, USA*

Around the world governments are making huge investments in environmental flows. However, much of the rationale for these releases is based on expert opinion, which is non transparent and can be challenged. Radically different approaches are required to inform the development of general predictive models of ecological response to flow alteration. Here, we describe such an approach, which attempts to make best use of all the information available from the literature, experts, and monitoring data to inform the development of general quantitative response models. We illustrate the process using the example of terrestrial vegetation encroachment into regulated river channels. Environmental flow assessments frequently propose that flow releases can be used to remove this vegetation. However, the evidence for these predictions has not been rigorously tested. Our analysis of literature, experts, and a purpose-designed monitoring data set of nearly 10,000 points, found strong evidence that increased inundation duration reduces terrestrial vegetation within river channels. Predicted cover dropped rapidly towards 0% with relatively short inundation period (e.g. 50 days) for most sites. However, dividing the same total inundation period into several separate inundation events reduces its effectiveness. More importantly, the model allows us to make quantitative predictions of vegetation cover under different inundation scenarios. While our project is focused on demonstrating that the Victorian environmental flows program has been a sound investment of public funds, our results also have the potential to be incorporated into planning and decision-making processes, helping to drive a transformation in evidence-based practice for environmental flow management.

100 Environmental water delivery – policy and practice

Bridie Velik-Lord[1]

1. *Victorian Environmental Water Holder, Melbourne, VIC, Australia*

Entering its third year of operation, the VEWH is forging ahead with innovative and progressive decision making to maximise the value from its Water Holdings. These decisions include trade-offs between use, carryover and trade of environmental water. Add changing seasonal conditions, delivery constraints, other entitlement holders and the need to provide multiple benefits as much as possible, and the complexity of environmental water management becomes clear.

Over the last three years, in partnership with waterway managers, the VEWH has implemented a planning framework for environmental water management in Victoria. There is a strong community and partner engagement focus undertaken by waterway managers across the state, ensuring that the views of stakeholders are represented in regional waterway strategies and seasonal watering proposals. A range of scientific information including environmental flow studies and ecological responses validated through the Victorian Environmental Flow Monitoring and Assessment Program is also used to inform watering priorities on an annual and inter-annual basis.

Throughout the process, the VEWH works closely with other water holders (such as the Commonwealth Environmental Water Holder and the Murray Darling Basin Authority) to ensure planning is aligned and coordinated, and to negotiate the use of their water in Victorian waterways.

Oral Abstracts

101 Stygofauna in the 21st century: iron-ore mining, coal seam gas and water supply

Stuart Halse[1]

1. Bennelongia Environmental Consultants, Wembley, WA 6913, Australia

The occurrence of stygofauna in aquifers across the broad landscape has been studied intensively only during the last 25 years. Inventories have established that the Pilbara and Yilgarn regions of Western Australia comprise a global hotspot for stygofauna biodiversity, while recent surveys suggest that some invertebrate groups are also well represented as stygofauna in eastern Australia. In addition to having considerable physiological and biogeographic interest, stygofauna exemplify many of the challenges confronting biologists when putting ecological theory into practice. One of the most striking characteristics of stygofauna is the small range of many species. In relation to iron-ore mining in the Pilbara, de-watering of open cut mines may lead to extensive areas of groundwater drawdown that encompass the full ranges of some stygofauna species. Less is known about the potential impacts of coal seam gas mining but the large sizes of some production fields mean they may encompass the full ranges of a significant proportion of any stygofauna species occurring within them. Water supply borefields tapping into groundwater aquifers are nearly always located in areas containing stygofauna species but groundwater drawdowns associated with sustainable water supply are usually small compared with mine de-watering or coal seam gas extraction and water supply activities rarely affect stygofauna significantly at the species level. Critical issues in environmental assessment are determining species ranges, inferring the aquifers the species use and assessing the likelihood of groundwater drawdown detrimentally affecting persistence. Adequate sampling design and methods and integration with geological and information are critical to assessment.

102 Just add water? Lessons from Pillicawarrina

Samantha Dawson[1], **Richard Kingsford**[1], **Peter Berney**[2]

1. Australian Wetlands, Rivers and Landscapes Centre, University of New South Wales, Sydney, NSW, Australia
2. NSW National Parks and Wildlife Services, Sydney, Australia

River regulation and agricultural activities have degraded many wetlands in the Murray-Darling Basin. To aid restoration, State and Commonwealth water management agencies are increasing environmental flows through infrastructure efficiencies, water buyback (>$8 billion) and purchasing agricultural land to increase protected area estates (Yanga, Toorale, Macquarie Marshes). My study site is the Macquarie Marshes in northern NSW, on the recently purchased Pillicawarrina property, which had been grazed and was cropped (irrigated and dryland) from the 1980s onwards. Part of this property was purchased in 2009, with the goal of returning the floodplain to pre-existing wetland vegetation. Initial restoration involved breaching levee banks to re-establish river-floodplain linkages. This approach (indirect restoration) is common in semi-arid wetlands, whereby wetland plant communities recolonise by natural processes, assisted through flooding and environmental flows. We aimed to investigate the likely success of indirect restoration by examining the composition of the soil seed bank and the extant plant community in cropped and uncropped areas.

We sampled soil seed banks on Pillicawarrina across eight types of extant vegetation and past cropping regimes. Seeds from sieved samples were identified and tested for viability and then compared among vegetation types and disturbance gradients. Additionally, we surveyed previously cropped sites, comparing plant community composition to the adjacent wetland vegetation communities in the Macquarie Marshes Northern Reserve. Preliminary results suggest increased river-floodplain connectivity and flooding drive restoration of floodplain plant communities but this is mediated by the amount of disturbance, with the most highly disturbed areas taking longer to recover.

Oral Abstracts

103 Hydro Tasmania's first dam removal: rehabilitation of Lagoon of Islands

Carolyn Maxwell[1]

1. Hydro Tasmania, Hobart, TAS, Australia

Restoration following dam removal is occurring in many places around the world, but there have been only a handful of dams decommissioned in Australia. Lagoon of Islands, on Tasmania's Central Plateau, has had poor water quality since 1988. Hydro Tasmania decided the dam had outlived its usefulness in Tasmania's hydro-electric system. Hydrological management changed accordingly: the major inflow, Ripple Creek Canal, was decommissioned in May 2010, water level was reduced and the dam that impounded this once unique wetland was dismantled in April 2013. Lagoon of Islands is now on its way to becoming a healthy wetland.

Hydro Tasmania has decided not to intervene, but rather to let nature dictate the rehabilitation of Lagoon of Islands. It is still early days, but the changes in hydrological management have caused a significant change to the dominant processes structuring the ecosystem. Currently (August 2013), Lagoon of Islands has no algal bloom for the first time in over 5 years. Nutrient concentrations have fallen by an order of magnitude, and turbidity has dropped by two orders of magnitude.

104 Combining ecological knowledge and species distribution modelling in vulnerability assessment

Alex Bush[1]

1. Macquarie University, North Ryde, NSW, Australia

Over recent decades there have been significant changes in response to small climatic shifts and based on forecasts of future climate scenarios there is an urgent need to assess species vulnerability so that conservation priorities can be set. So far, vulnerability assessments have largely been based on projected changes in range size derived from the output of species distribution models. One drawback of risk assessment using these models is that they do not incorporate information on species ecological and life history traits. Here, we develop a vulnerability assessment of fish that occur in New South Wales to climate change that considered both species traits, and the projections of modelled distribution. The importance of each trait is then ranked by a panel of experts through an iterative review process. For each species' we can then determine their relative risk under future climates, as well as identifying the spatial priorities for conservation. The study also considers the potential benefits to each species if man-made barriers to dispersal were removed. By reducing overall reliance on the predictions of models and using available ecological knowledge, this process provides greater justification for funding appropriate adaptation strategies.

Oral Abstracts

105 From theory to practice: A Watercourse Assessment and Prioritised Rehabilitation Plan for Sutherland Shire

Meredith Brainwood[1], Anne Carey[1], Caroline Forest[1]

1. Applied Ecology P/L, Limekilns, NSW, Australia

The Watercourse Assessment and Prioritised Rehabilitation Plan was prepared in 2011/12 for Sutherland Shire Council. The aim of this study was to assess the condition of watercourses within Sutherland Shire and to develop prioritised rehabilitation actions. The objectives of the study were to:

- establish predisturbance stream conditions
- assess current stream conditions
- identify natural assets, and problems for streams
- evaluate data to determine rehabilitation actions required
- prioritise rehabilitation works

The project involved the assessment of around 250km of streams, divided into approximately 1000 reaches, or stream sections. Shorter reaches had one sample point, while longer reaches had more, so that over 1500 sets of sample point data were collected and assimilated as part of the project. Catchment surveys involved field assessment of predetermined sample points and reaches. Data was collected to inform an assessment of assets and problems, based on catchment setting, geomorphic condition, hydrology, instream habitat, riparian vegetation, water quality and fauna present.

Data analysis involved implementing a scoring system that gave a robust indication of overall stream health across four catchments. Streams were categorised based on their assets and problems Reaches in the more urbanised catchments were further weighted based on stream length. Works plans were developed for each reach, based on field assessment and underpinned by desktop analysis of the catchment. This information was used to inform the prioritisation of rehabilitation actions. Rehabilitation works were designed to move each reach closer to its predisturbance condition, with a particular emphasis on establishing and maintaining a sustainable ecosystem condition.

106 Re-thinking riverine bioassessment: lessons learnt in Victoria

Leon Metzeling[1], Paul Leahy[1], Paul Wilson[2]

1. EPA Victoria, Macleod, VIC, Australia
2. Department of Environment and Primary Industry, Melbourne, VIC, Australia

A macroinvertebrate bioassessment program covering six catchments was first introduced in Victoria in 1990. It was subsequently expanded through various state and federal initiatives from the mid '90s to be a truly statewide program. In that time, the primary objective was condition assessment and this drove its design, analysis and reporting, primarily through the Index of Stream Condition. In recent years, it has become apparent to both DEPI and EPA that this objective was no longer sufficient. Other questions or needs now have greater prominence and require answers. These include enhanced understanding of the key drivers of river health, particularly around the influence of the riparian zone and the specific impacts of broader land-use, monitoring the effectiveness of management interventions and risk characterization of water quality problems. A new program has been designed to address these issues while also recognising the need to maintain some ongoing surveillance at a small set of sites which are aligned with the collection of other data (hydrological, meteorological and water quality) for the broader assessment of condition. Genetic approaches are also rapidly developing and this will change how we do bioassesment in the near future. The processes undertaken to reach this point and the shape of the new program will be discussed in the presentation.

Oral Abstracts

107 The standard of stream living in the ACT - a long-term analysis of invertebrate communities in urban and rural streams

Evan Harrison[1], Chris Levings[1]

1. Institute for Applied Ecology, University of Canberra, Canberra, ACT, Australia

Many Australian Capital Territory (ACT) streams drain rural and urban areas. These land-uses have the potential to degrade water quality and in-stream habitat, which can have consequences for biotic diversity, amenity, and human health. The ACT Water Quality Monitoring Program (WQMP) has since 2001 provided an ongoing targeted assessment of the biological condition of urban and rural streams throughout the ACT using invertebrate communities. Long-established test and reference sites used in this study have provided strong inferential power in determining changes in biological condition of impacted streams, and in determining potential causes. Over the length of the program, streams within the ACT have been subject to disturbance from fires, floods and droughts, in combination with the effects of runoff from urban and rural land-uses. Throughout the assessment program, the biological condition of rural streams was generally better than that of streams with more urbanised catchments. Erosion and sedimentation continue to be the most likely cause of biological impairment in rural catchments, while poor water quality and hydrological change is likely driving the biological condition of urban streams. The ACT WQMP has been successful at informing the ACT Government of the biological condition of ACT streams and the influence of any management actions on stream biological condition within urban and rural land-use areas.

108 Assessing the effect of salinity on stream macroinvertebrate communities: the case of the Hunter River Catchment, New South Wales?

Ben J. Kefford[1], Jan Miller[2], Martin Krogh[2], Ralf B. Schäfer[3]

1. University of Technology Sydney (UTS), Broadway, NSW, Australia
2. Office of Environment and Heritage, Department of Premier and Cabinet, Sydney, NSW, Australia
3. Institute for Environmental Sciencesy, University Koblenz-Landau, Landau, Germany

Licensed discharges of saline effluent from coal mines and power stations occur in the Hunter River catchment. Since 1994 a salinity trading scheme has largely been successful at preventing salinity levels rising above target levels of 600 and 900 µS/cm in the upper and the mid-lower Hunter River, respectively. Determining whether these levels are protective of ecosystem health in the Hunter Catchment is complicated by natural sources of salinity, salinity often occurring in pulses, variation in ionic proportions of salinity and salinity concentrations being confounded with other environmental fluctuations. Here we examined changes in stream macroinvertebrate traits and large-scale turn-over of families with increasing salinity in the Hunter River and adjoining catchments (Karuah River, Lake Macquarie, Tuggerah Lakes and Manning River). Increasing salinity was found to be associated with a reduction in the abundance of salinity sensitive families, as indicated by laboratory tests. There was also a greater reduction in the abundance of families which were both salinity sensitive and have traits making their populations likely to recover slowly from pulse disturbances. These results suggest that salinity, especially pulses of salinity, are potentially altering macroinvertebrate communities, although evidence that other environmental factors may also (partly) play a role will be presented. We found that as EC increased, there was significant turnover in macroinvertebrate families including below salinity levels of 600 and 900 µS/cm. In conclusion, salinity changes in the Hunter and adjoining catchments are potentially (in conjunction with other variables) affecting macroinvertebrate community structure.

Oral Abstracts

109 So what? From Bioassesment to Environmental Decision Making

Simon Linke[1], Virgilio Hermoso[1], S Langhans[2]

1. Australian Rivers Institute, Griffith University, Nathan, QLD, Australia
2. IGB, Berlin, Germany

Freshwater scientists have perfected bioassessment in over the last three decades – a success that is even spilling over into the terrestrial and marine realms. What is rarely mentioned, though, is the use of assessments beyond the evaluation of ecosystems' status towards the next necessary step: to guide their protection and recovery. This field, termed 'environmental decision science' is more advanced in non-riverine realms. It has evolved from conservation planning to solve more diverse environmental management problems, such as restoration or threatened species management. We propose to merge the benefits of aquatic assessment and environmental decision sciences and explore modifications to both that would be needed to operationalise this union in the aquatic field. In this presentation we discuss:

1. Techniques for making robust and efficient environmental decisions
2. The intersection of bioassessment precision and decision making
3. Linking bioassessment to socioeconomic values.

We will conclude with the argument that freshwater scientists should expand their research scope to address management options instead of stopping at the half-way mark.

110 A comprehensive suite of tools for managing ecological values and assets in rivers

Ralph W Ogden[1]

1. eWater, UC Innovation Centre, Bruce, ACT

A comprehensive suite of modelling tools for adaptively managing environmental water, developed over two decades of cooperative research centre R&D, is discussed in relation to various facets of this task. The suite of tools can help managers undertaking qualitative analyses to frame environmental problems and solutions. 1) Work with the community to build a conceptual model of rivers and associated values—species, habitat, amenity, health etc. 2) Work with scientists, managers and other experts to create a sister conceptual model linking flow and other possible environmental drivers to the target species/health/environmental assets. 3) Carry out a systematic analysis of the literature to transform this into a defensible and effective evidence-based conceptual model, to serve as a focus for management. Perform various quantitative analyses to design environmental flow regimes. 4) Capture the numerical relationships between river flow and ecological responses (e.g. species abundance, amount of hydraulic habitat). 5) Design a flow regime for a site that satisfies as many environmental flow requirements as possible for the least volume of flow. 6) Design a decision support system (DSS), e.g. plug this flow regime into models used by managers/engineers to plan and operate river systems, or create a DSS for managing a wetland complex that links inflows to areas flooded to ecological responses. 7) Explore trade-offs between environmental, social and economic objectives. Then, once management actions have been performed, 8) monitor/predict their effects. A key feature of this suite of tools is it allows for managers to build and re-use a knowledge base.

Environmental flows, modelling tools, evidence-based, restoration, aquatic ecology.

Oral Abstracts

111 An evidence-based approach for flow management: optimization for ecology and consumptive use

Susan J Nichols[1], Sue J Powell, J Angus Webb, Geoff Adams, Siobhan C de Little, Brenda Dyack

1. University of Canberra, Canberra, ACT, Australia

Regulation of flow in river systems, and use of water for consumptive and economic purposes, has led to detrimental effects on riverine, wetland and floodplain environments worldwide. Policies to return water to the environment focus on minimizing these effects, and balancing environmental and economic objectives, but the practice of delivering environmental water is in its infancy and managers face numerous challenges in doing this. Environmental managers are required to employ 'best available science' to deliver 'evidence-based' practice, but anecdotal evidence suggests they may not always make best use of the existing scientific literature. Furthermore, current methods to help define environmental flows rarely consider consumptive uses as part of the same set of calculations, which is necessary to optimise returns for both with the available water allocation. We demonstrate two approaches for managers to consider as ways to improve practice. We present a framework to systematically examine the scientific evidence to identify causal relationships between ecosystem attributes and environmental flow releases, which can improve both the defensibility and effectiveness of environmental allocations. We then present a method to evaluate a spectrum of flow options using ecological-response models incorporated into climate-linked daily hydrology and irrigation river-management models, which represent a system's gamut of rivers, water storages, operational constraints, water management and consumptive demands. A multi-objective optimization approach concurrently models the eco-hydrology and consumptive allocation systems and provides decision makers with a range of alternative optimal management options that represent the most efficient ways to trade-off economic and environmental management objectives.

112 Development of an Integrated Ecosystem Condition Assessment to meet the challenges of adaptive management

Ben Gawne[1], Rhonda Butcher[2]

1. MDFRC, Wodonga, VIC, Australia
2. Water's Edge Consulting, Mooroolbark, VIC

Condition assessment is a key step in the adaptive management cycle. Condition assessments have been instrumental in driving policy reform, but as is often the case, policy implementation can change the demands placed on condition assessments. The Australian Government is working closely with state agencies in the development of an Integrated Ecosystem Condition Assessment (IECA) framework, to progress nationally agreed policy objectives for aquatic ecosystems to be managed as connected, functioning units.

The intent is to build on current approaches to condition assessments to provide an aquatic asset-based condition assessment methodology, that incorporates different connected aquatic ecosystem types and key ecosystem functions. The IECA Framework aims to allow condition to be evaluated and reported in relation to identified ecological values or objectives, risks/stressors, thresholds and management actions, to aid adaptive management.

The Victorian pilot application of the IECA framework was undertaken at two Murray River icon sites using existing data. The assessment used 19 condition and five stress indicators across four identified values (biodiversity, ecosystem function, resilience and amenity). The assessment was based on data collected after the Millennium drought broke, and both Barmah Forest and Hattah Lakes were rated as being in moderate condition. The project has undertaken a number of innovations that should improve the value of condition assessments within adaptive management frameworks, but a number of areas, such as the assessment of stressors, remain to be fully developed.

Oral Abstracts

113 Abstract withdrawn.

114 Fix it, pipe it, or do nothing: Decision making through the application of reconciliation ecology to management of urban streams

Meredith Brainwood[1], Anne Carey[1]

1. Applied Ecology Pty Ltd, Manly, NSW, Australia

We surveyed 1000 reaches in 250kms of streams in four major subcatchments in Sutherland Shire and developed prioritised works plans for rehabilitation of these urbanised waterways. Lessons learned from this project were carried forward to similar projects in Auburn, Parramatta and Ryde LGAs. For clients, the big questions are: How much will it cost? Where do we spend the money first? What will we get for our money? Where can we get funding from? Project development is informed in part by the need to work within client requirements and expectations, and the logistics of managing large datasets to provide ecologically valid prioritised works plans.

Predisturbance condition was initially proposed as a benchmark for restoration outcomes; however this may be difficult to determine, and often provides unrealistic and unsustainable goals in an urban setting. Condition scores are best treated as informative, rather than definitive, for developing rehabilitation priorities. Thus works prioritisation is influenced by predisturbance condition and overall condition scores, but may be affected by condition upstream and downstream, and availability of followup management. It needs to incorporate restoration principles from several paradigms, including vegetation management, erosion control and water quality management.

We believe that effective rehabilitation of urban streams can be achieved through the application of reconciliation ecology principles, and that "success" is best measured through developing a sustainable equilibrium condition that incorporates as much of the original environment as possible, yet requires limited ongoing resources to maintain this state in the presence of a range of ongoing urban-derived perturbations.

Oral Abstracts

115 Policy development and stakeholder engagement for the Victorian Waterway Management Strategy

Amber Clarke[1], Sarina Loo[1], Janet Holmes[1], Jane Doolan

1. Department of Environment and Primary Industries, East Melbourne, VIC, Australia

Victoria was the first state in Australia to develop an integrated policy framework for improving river health. The 2002 Victorian River Health Strategy outlined the vision for managing rivers in Victoria, statewide targets and a regional decision-making model with community input. Implementation over the past decade was highly successful, with the majority of statewide targets met or exceeded and the policy framework providing clear direction for regional agencies to identify priority management activities and guide government investment. As part of the adaptive management approach, a review of the strategy was undertaken in 2010. The review identified key areas requiring updated or new policy and a four-year process of policy development and stakeholder engagement was initiated. Management of wetlands and estuaries was incorporated into the existing policy framework for managing river health, along with significant legislative and policy changes since 2002. New policy was developed to ensure the involvement of Victoria's Traditional Owners in waterway management and a more flexible management approach to enable better planning and response to climatic variability and extreme events such as flood and bushfire. The project incorporated a comprehensive stakeholder engagement program, including guidance by an Expert Scientific Panel, Stakeholder Reference Committee, the Victorian Waterway Managers' Forum and an Internal Review Committee. The broader Victorian community also provided feedback on the draft policies and actions during a six-week public consultation period. The new Victorian Waterway Management Strategy provides direction for managing Victoria's waterways over the next eights years.

116 Aquatic Ecosystem Conservation: the process, methodology and challenges of listing the first Australian river system under national environment law

Gina M Newton[1]

1. Hughes, ACT, Australia

Australia's premier environment law, the Environment Protection and Biodiversity Conservation Act (EPBC Act) lists threatened species and ecological communities (ECs). Some 60 threatened ECs have now been listed at the national level, with nearly half listed since the Act was last amended in 2007. The first riverine threatened ecological community, the River Murray and associated wetlands, floodplains, and groundwater systems from the junction with the Darling River to the Sea, was listed in August 2013. Listing of threatened ECs under the EPBC Act represents an effective national approach to 'whole of system', landscape-scale, and multi-species conservation. It is also a valuable tool for increasing awareness of important ecosystems, habitats and native species under pressure, and of the related ecosystem services they provide. Listing can also provide leverage for conservation related funding and complements other protective measures, such as parks and reserves. Listing is based on a scientifically rigorous assessment, including analysis of criteria as set out in the EBPC Act Regulations, supported by indicative thresholds and interpretive guidance which are available in the Guidelines of the national Threatened Species Scientific Committee. Australia's approach to the assessment of threatened ecological communities (which can be likened to ecosystems in many cases) may be considered international best practice. The methodology and challenges associated with listing this iconic riverine/floodplain community will be discussed and an overview of the scientific assessment provided.

Oral Abstracts

117 Warming temperature and eutrophication shaping predictions of Cyanobacterial development

Anna Rigosi[1], Justin Brookes[1]

1. *University of Adelaide, Adelaide, SA, Australia*

Cyanobacteria development in fresh waters presents a hazard that needs to be adequately managed. Climate change may alter the risk, so it is crucial to understand: (a) how cyanobacteria respond to warming temperatures and (b) how those changes will interact with variation in nutrient availability (representing different future land uses or hydrology). These concepts were explored using a variety of approaches: (a) statistical analysis of data from more than 1000 natural and man-made lakes in United States collected in 2007 by the US EPA; (b) statistical modelling; building a Bayesian network with long term data from 20 lakes located at different latitudes, spanning a variety of trophic states; (c) deterministic modelling; conducting multiple simulations under combined temperature changes and nutrients availability scenarios. The Bayesian network revealed that there is a 5% greater probability of having a bloom in the highly hazardous class with an increase in temperature of 0.8ºC or an increase in TP of 0.01 mgL-1 from oligotrophic to mesotrophic conditions. This provided insights on how cyanobacterial risk may change with temperature and nutrient increases. This knowledge will support the development of strategic adaptation plans by water utilities.

118 Could irrigation development counter the effects of climate change in rivers in the Tasmanian Midlands?

Regina H Magierowski[1], Peter E Davies[1 2], Bryce Graham[3], Steven JB Carter[4], Ted C Lefroy[2]

1. *School of Zoology, University of Tasmania, Hobart, Tasmania, Australia*
2. *Centre for Environment, University of Tasmania, Hobart, Tasmania, Australia*
3. *Department of Primary Industries, Parks, Water and Environment, Hobart, TAS, Australia*
4. *School of Maths & Physics, University of Tasmania, Hobart, Tasmania, Australia*

Climate change has the potential to directly and indirectly affect river ecosystems. Direct effects influence key ecological drivers, such as variation in temperature and rainfall and hence runoff. Indirect effects include changes to vegetation cover and land and water management practices. In some locations, these indirect effects are potentially a greater threat than the direct drivers that are the focus of much climate change research. An additional concern is whether changes in land-use and water management will interact with changes in climate to cause impacts larger than those expected by climate change alone. To better understand the range of potential futures for rivers in the Tasmanian Midlands, we modelled river flows and temperature under a number of scenarios that incorporate potential direct and indirect effects of climate change, as well as plans for a new irrigation scheme. Outputs from these models were used as inputs to Bayesian Networks designed to predict changes in condition of key river ecosystem components. Our results suggest that the biggest threat facing the Tasmanian Midlands is the projected increase in river temperatures across the entire region. Our projections for impacts on hydrology varied spatially, with some river reaches expected to see a marked decline in condition, while other reaches could potentially benefit from 'shandying' of transferred water and through storage of winter flows for summer release. These results have been incorporated into a spatial multi-criteria analysis tool that facilitates their use in decision making and for an analysis designed to identify potential climate refuges.

Oral Abstracts

119 Climatic thresholds: the influence of increasing sediment temperature on aquatic biota

Daryl Nielsen[1 2], Elke Jasper[3], Nathan Ning[2], Susan Lawler[3]

1. *CSIRO, Wodonga, VIC, Australia*
2. *The Murray-Darling Freshwater Research Centre, Wodonga, VIC, Australia*
3. *Environmental Management and Ecology, La Trobe University, Wodonga, VIC, Australia*

Under the influence of climate change, dormant seeds of wetland plants and eggs of microfauna may be subjected to temperatures that may affect their viability while the wetland is in its "dry" phase. To test the hypothesis that dormant seeds and eggs are resilient to increasing temperature, we exposed wetland sediment to a range of temperatures up to 150oC and assessed the richness and abundance of communities that developed when the sediment was inundated. Both aquatic plants and microfauna emerged from the seed bank at temperatures lower than 50°C but few taxa emerged at higher temperatures. The nature of the response differed between the two groups. The numbers of microfauna emerging decreased abruptly once temperatures exceeded 50° C. In comparison, the abundance of aquatic plants began to decline once temperatures exceeded 30°C, suggesting that aquatic plant communities are more sensitive to temperature increases. These results suggest that changes to soil temperature during the dry phase of wetlands may play an important role in influencing wetland aquatic plant and microfauna communities. Soil temperatures in the proximity of 50° C are already known to occur during summer in parts of south-eastern Australia. Such temperatures are likely to become more common under current climate change predictions, which may threaten the abundance and diversity of wetland microfauna and aquatic plant communities.

120 Buffering our aquatic habitats from climate change: using riparian vegetation to reduce impacts on stream biodiversity and ecosystem function.

Ross Thompson[1]

1. *University of Canberra, Bruce, ACT, Australia*

Understanding the effects of changing climates on the processes which support aquatic biodiversity is of critical importance for managing aquatic ecosystems. Using manipulative experiments, we assessed the community-level responses of aquatic ecosystems to a realistic future temperature regime which included extreme events. There was evidence of major changes in community composition, with an unpredictable suite of species favoured. Body size of component species declined, and there was evidence that the top-down (grazing) influence of stream invertebrates was reduced, allowing increased algal biomass. Emerging aquatic insects were smaller, and timing of emergence was altered, with potential impacts for terrestrial consumers which rely on this resource. In some species, there were temporal mismatches between emergence of the sexes, with potential impacts on species' persistence. Field studies were used to determine the potential for riparian plantings to reduce stream temperatures of sufficient magnitude to mitigate against these effects. There was evidence that riparian replanting was sufficient to cool stream reaches to a degree consistent with preventing the predicted increases under climate change scenarios. There is potential therefore to use revegetation activities to mitigate against the impacts of warming climates in aquatic processes and biodiversity.

Oral Abstracts

121 a. From water science to water policy: experiences from two decades of watery CRCs

Gary Jones[1]

1. eWater, University of Canberra, ACT, Australia

No abstract supplied.

122 Tapping into community knowledge for effective policy making - the New Zealand experience

Laurel Teirney[1]

1. Consultant, McCandrew Bay, DUNED, New Zealand

The positive influence of community knowledge and involvement in policy development and decision making is highlighted in two very different examples from New Zealand: how a "bottom-up" approach resulted in an integrated management strategy for the Fiordland Marine Area, and how Maori cultural values were incorporated into mainstream freshwater resource management decisions. The Fiordland Marine Guardians were created in1995 to include Ngai Tahu, commercial and recreational fishers, tourism, environment, science and community interests. The group became the driving force through a process of sharing knowledge, identifying and resolving issues and developing an integrated strategy. Government agencies provided support and advice and implemented the strategy, passing special legislation that formalised an ongoing management role for the Guardians. The same process has subsequently been successfully applied to the Kaikoura Marine Area by the Kaikoura Coastal Marine Guardians. The Cultural Health Index for Streams and Waterways was developed by tapping into Maori knowledge and the way they value freshwater. This tool allows Maori to advocate their position more effectively and enables resource managers to incorporate cultural perspectives in decision making. The index has three components: traditional cultural importance, mahinga kai (food) value and stream ecosystem health. Information about the three components was gathered by local Maori for more than100 sites in four river catchments and stream health was assessed using cultural indicators developed by them. Comparison with a western index of stream health showed the two measures to be significantly correlated, giving water managers confidence in the cultural measure and input from Maori.

Oral Abstracts

123 a. The science behind river health policy

Jane Doolan[1]

1. *Consultant, Melbourne, VIC, Australia*

No abstract supplied.

124 Some factors determining the fauna of pit gnammas

Brian Timms[1]

1. *University of NSW, Sydney, NSW, Australia*

Pit gnammas are relatively small and 'deep' pools on granite outcrops, unlike the shallow pans. Pans are well known, having diverse crustacean dominated communities and many specialised/endemic species. By contrast pit gnammas are unknown. Though some 80+ species of invertebrates were found in 50 pools in WA from 5 samplings spanning 3 years, momentary species composition is low, averaging 2 to 16 per site. Their fauna is dominated by insects, there are few endemics and no special adaptations. Pool size is of major importance, as is whether or not they are covered or uncovered, and whether lotic or lentic. Unlike for pan gnammas, species richness and community composition hardly varies across the study area with climate factors. Surprisingly, diversity is much lower despite pits being less temporary than pans. Why are the two habitats on similar rocks so different?

Oral Abstracts

125 Inter-annual variability in platypus diet: a potential role for drought?

Melissa Klamt[1], Ross Thompson[2], Josh Griffiths[3], Tom Kelly[3], Jenny Davis[1]

1. *School of Biological Sciences, Monash University, Clayton, Victoria, Australia*
2. *Institute for Applied Ecology, University of Canberra, Canberra, ACT, Australia*
3. *cesar, Melbourne, Victoria, Australia*

The effects of drought on fish and macroinvertebrate communities in Australia have been widely described. However we have little information on the potential impacts on the iconic platypus. Here, we determined the trophic relationships of platypus populations at the Tarago River and Labertouche Creek, Victoria in two years; during drought (2009) and post drought (2013). Trophic relationships were determined by stable isotope analysis of platypus fur and potential dietary items. Stable isotope analysis, in conjunction with the conventional cheek pouch content analysis, can provide considerable information on platypus diet, including elucidating links to soft-bodied taxa such as larval dipterans which are not easily observed in cheek pouch contents.

Platypus appear to be feeding on a wide range of invertebrates and relying on terrestrial carbon inputs as the basal carbon resource supporting their food web under both drought and post drought conditions. These results highlight the generalist nature of their diet and their ability to persist in less than ideal conditions. Future challenges such as loss or limitation of habitat, especially through climatic drying, will be a major concern for the platypus and its prey.

126 Species hiding in plain sight: using population genetics to infer cryptic species and dispersal in Australian arid-zone freshwater insects

Amy Smith[1], Adrian Pinder[2], Glenis McBurnie[3], Jayne Brim-Box[3], Ross Thompson[1], Katherine Harrisson[1], Jenny Davis[1], Paul Sunnucks[1]

1. *Monash University, Vermont South, VIC, Australia*
2. *Department of Environment and conservation, The Government of Western Australia, Wanneroo, WA, Australia*
3. *Department of Natural Resources, Environment and the Arts, Northern Territory Government, Alice Springs, NT, Australia*

The arid-zone is Australia's largest biome, making up approximately 70% of the continent's area. Arid-zone freshwater ecosystems encompass a spectrum of water availability, from permanent groundwater-fed springs to ephemeral ponds created by torrential rain. Dispersal allows strong-flying freshwater insects to maintain broad geographical ranges in this environment, despite occupying isolated 'islands' of water surrounded by uninhabitable land. In contrast, populations of weak-flying species, become isolated and may diverge genetically but not necessarily morphologically, and may thus evolve into cryptic species. The Australian arid-zone is predicted to increase in area under climate change, with extreme events increasing in frequency and/or intensity. For management purposes it is imperative to understand important processes, such as dispersal, and the extent of cryptic speciation and spatiotemporal distribution of lineages. This study sought to answer two questions: are cryptic species present, and do weaker flyers have more structured populations and use the landscape at smaller spatial scales than do stronger flyers? Individuals from two species of mayflies and two species of dragonflies were collected from eight sites in the Pilbara and sixteen sites in Central Australia. DNA was extracted and each species was screened for variation with at least one mitochondrial and one nuclear sequence marker. Weaker-flying mayfly species had more structured populations, with likely cryptic species present. In contrast, the stronger-flying dragonflies exhibited very low levels of genetic divergence between the Pilbara and Central Australia despite the geographical distance. These results highlight the importance of managing arid-zone water-bodies at both continental and smaller spatial scales.

Oral Abstracts

127 Anthropogenic water storages as refuge for macroinvertebrates in South-West Victoria

David T Dodemaide[1], Ty G Matthews[1], Rebecca E Lester[1]

1. Deakin University, Warrnambool, VIC, Australia

In Australia, the average temperature and frequency of drought events are predicted to increase due to human-induced climate change. This is likely to have impacts on freshwater ecosystems by altering hydrologic regimes, water chemistry and reducing available habitat. This will affect water availability and so potentially change assemblage structures of aquatic macroinvertebrates. Under these scenarios, aquatic macroinvertebrates are likely to rely on permanent waterbodies as a source of refuge during extended periods of drought. Ecological research associated with the importance of refugia from drought have tended to focus on natural lakes and wetlands rather than anthropogenic waterbodies. Therefore, we compared macroinvertebrate assemblages from potable and waste water storages with those from nearby natural waterbodies using both kick samples and rock scrubs. We also examined relationships between macroinvertebrate assemblages with macrophyte diversity, water quality parameters and habitat characteristics recorded at each location. These results illustrate the degree to which macroinvertebrate assemblages from anthropogenic water storages are representative of those in adjacent natural ecosystems, and hence, whether the water storages have the potential to provide possible refuge for macroinvertebrates during drought periods. The findings of this study will be shared with local water managers and will therefore improve the management of similar anthropogenic water bodies to enhance the conservation of aquatic biodiversity in the region.

128 a. Science policy interface from an APS policy adviser's perspective

Tony Slatyer[1]

1. DSEWPAC, Canberra, ACT, Australia

No abstract supplied.

129 b. Environmental Water Management in Australia – National Water Commission Perspective on Managing the Science and Policy Interface

Kerry Olsson[1]

1. National Water Commission, Canberra, ACT, Australia

No abstract supplied.

130 c. Implementing water policy reform: An update from the MDBA

Jodie Swirepik[1]

1. Murray Darling Basin Authority, Canberra, ACT, Australia

No abstract supplied.

Oral Abstracts

131 d. The Science/ Policy nexus – learnings, roles and water science experiences

Kim Ritman[1]

1. ABARES, Canberra, ACT, Australia

The Department of Agriculture is an organisation of over 4500 people working in locations all around Australia. The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) is a research bureau within the department which provides professionally independent research, analysis and advice for government and private sector decision-makers on significant issues affecting Australia's agriculture, fisheries and forestry industries.

The department works in complex, natural resource domains, which calls for science to underpin our evidence-based policy development, decision-making and service delivery. Our scientists are constantly producing evidence and seeking out the best delivery mechanisms for it. Our policy makers are constantly searching for evidence to improve the quality of their decisions. This presentation will explore from a practitioner's perspective, how and what types of scientific advice interact with the policy making process and use case studies to illustrate this interaction.

In recent years ABARES has focussed on multidisciplinary research that integrates science, social and economic disciplines to inform policy and decision making. As an example, ABARES recently carried out research to inform the Murray Darling Basin Authority's planning and decision-making process in implementing the Basin Plan. The research provided a measure of the vulnerability and adaptive capacity of communities within the Basin to changes in water availability.

132 Impacts of large-scale bushfire on the freshwater crayfish of the Grampians National Park

Kerrylyn Johnston[1]

1. Murdoch University, Murdoch, WA, Australia

Bushfire is a relatively common natural occurrence in Australia which can affect hundreds of square kilometres of land per fire event. The Grampians National Park (GNP) in south-west Victoria has been affected by large-scale bushfires in recent years. It is a diversity hot-spot for freshwater crayfish, including the threatened and range restricted species Euastacus bispinosus and Gramastacus insolitus. Bushfire may be a largely unrecognised threat to crayfish survival through habitat alteration and degradation. The Mt Lubra bushfires occurred in 2006 and burnt around one half of the GNP area. The current study compared pre-fire and post-fire freshwater crayfish abundance data (five species) and various water quality and physical environmental habitat parameters to assess the post-fire status of crayfish populations. Fire altered crayfish abundances at sites throughout the GNP but affected different habitat types and the different crayfish species that inhabit each in distinct ways. For example, preliminary analysis shows that for stream crayfish, the most significant fire effects were reduction of stream depth, water quality and habitat heterogeneity. This was largely caused by sedimentation resulting from the loss of riparian vegetation that usually stabilises stream banks and prevents silt/sediment entering streams. Increased crayfish predation from visual predators such as birds also reduced abundances. In contrast, the timing of these bushfires appear to have had minimal negative impacts on crayfish species inhabiting seasonal floodplain wetlands, because they occurred when substrates were still wet and covered in green aquatic vegetation, which acted as a buffer against the worst effects of the bushfire.

Oral Abstracts

133 Water resource infrastructure and its potential as an anthropogenic refuge

Bryce T Halliday[1], Rebecca E Lester[1], Ty G Matthews[1]

1. Deakin University, Warrnambool, VIC, Australia

Permanent sources of natural water are expected to decline in the future under scenarios associated with climate change. Therefore, man-made water storages that can provide a permanent and stable water source may become refugia for fish. Presently, little is known about either fish or zooplankton assemblages in man-made water storages in south-west Victoria. This study forms part of a collaborative research project with Wannon Water, the local water authority. The aim of the study is to identify the distribution, diversity and abundance of fish and zooplankton that reside within potable and water reclamation plant (WRP) storages and compare these to assemblages from nearby natural water bodies such as small lakes and wetlands. The relationship between fish, zooplankton, physicochemistry and habitat characteristics of the three different storages types will also be explored. The fish assemblages were sampled using either boat or backpack electrofishing as well as fyke and box nets. Zooplankton populations were sampled using zooplankton tows. Preliminary findings showed that fish had variable abundance and species richness in both the natural and potable storages, but were absent from WRPs. There were no significant differences in zooplankton assemblages among the three water body types. This study highlights a previously undescribed freshwater anthropogenic refuge and may have implications for the future management of man-made water storages.

134 Experimental evidence for impacts of an invasive herbivore (Camelus dromedaries) on arid zone freshwater pools

Glenis McBurnie[1], Jenny Davis, Ross M Thompson, Catherine Nano, Jayne Brim-Box

1. Monash University/ NT Government, Alice Springs, NT, Australia

Aquatic ecosystems in arid environments are considered to be 'islands of water in a sea of dry land', providing important refugia and 'stepping-stones' of connectivity for aquatic fauna. Aquatic ecosystems in central Australia are vulnerable to degradation due to their natural isolation coupled with the impacts of invasive herbivores such as camels, which degrade small desert waterbodies through drinking, trampling, and by fouling with large quantities of dung. The objective of this study was to determine the impact of camels on arid zone aquatic ecosystems. To do this we experimentally assessed the impacts of camel dung on the water quality and macroinvertebrate colonization and community composition of arid zone freshwater pools.

Experimental mesocosms were used to imitate small arid zone waterbodies. Camel dung (2kg) was added to half the pools (the treatment), the remaining pools (without dung) acted as the controls. All pools were sampled weekly for water quality, nutrients, chlorophyll a and macroinvertebrate richness and abundance, over an eight week period during summer.

Significant negative effects of camel dung on water quality and macroinvertebrate colonisation and community composition were detected. Macroinvertebrate abundance was higher in control pools; treatment pools were favored by pollution tolerant taxa such as mosquito larvae and control pools were favored by sensitive taxa such as larval mayflies and larval dragonflies. The latter are predators and appeared to have a major influence on community composition. Our results reinforce the need for active management of invasive herbivores to protect aquatic biodiversity and to manage potential disease-vector species.

Oral Abstracts

135 Leaf breakdown and associated macroinvertebrates in the alpine streams of the Snowy Mountains, Australia

Lloyd Werry[1], Simon Williams[2], Richard Lim[1], Benjamin Kefford[1]

1. *Center for Environmental Sustainability, School of the Environment, Faculty of Science, University of Technology, Sydney, Broadway, NSW, Australia*
2. *NSW Office of Water, Department of Primary Industries, Wollongong, NSW, Australia*

Keywords: stream invertebrates, ecosystem functions, water temperature

Climate change is suggested to affect alpine stream ecosystems and their ecological processes. Macroinverterbrate involvement in leaf litter breakdown may be affected by stream temperature fluctuations. This study was undertaken to determine whether temperature influenced leaf litter breakdown, macroinvertebrate activity and colonization.

Rate of leaf breakdown and macroinvertebrate colonisation were measured during autumn, winter and spring 2013 at 5 sites in the upper Snowy River catchment, NSW spanning an altitude range of 1100-2000m. Plucked and oven-dried leaves of snow gum (Eucalyptus pauciflora) were placed in fine (50µm) and coarse-mesh (5-6mm) nylon bags. These bags were incubated in riffle/run reaches over 5 and 10 weeks.

Data collected in autumn (March – May) indicate that Trichoptera larvae (Helicophidae, Conoesucidae, Hydrobiosiidae and Ecnomidae) appeared to effectively fragment leaf litter in coarse mesh bags, at and below tree-line sites, whilst above tree-line sites microbial leaching appear dominate. Rate of leaf break down in both bag types declined with altitude and increasing water temperature, but markedly in coarse-mesh bags. Macroinvertebrate colonisation on coarse-mesh leaf bags decreased with altitude; Trichoptera were common at and below tree line sites with Helicophidae, Conoesucidae, Hydrobiosiidae and Ecnomidae being dominant.

We will also present results of winter and spring monitoring.

1. Hughes, L. 2010. Climate change and Australia: key vulnerable regions, Reg. Environ Change.11(1): s189-s195

136 Multi-year delay in recovery of amphipod populations following cease-to-flow events in forested upland stream reaches

Samantha Imberger[1], Christopher J Walsh[1]

1. *The University of Melbourne, Richmond, VIC, Australia*

The recovery of stream fauna from supra-seasonal drought is highly variable. The factors influencing drought recovery are poorly understood, with many species able to recover quickly, and others eliminated for extended periods.

We investigated the effects of drought on two amphipod taxa *Pseudomoera gabrieli* (Eusiridae) and *Austrogammarus spp.* (Paramelitidae) through an analysis of 11 years of semi-quantitative macroinvertebrate monitoring data collected from three forested streams in the Dandenong Ranges and quantitative samples of amphipods from two upstream sites in 2003 and 2013.

Abundances of *Austrogammarus* and *P. gabrieli* in the lower reaches of Lyrebird Creek fell from 102 and 103 per unit effort respectively, to zero following cease-to-flow events in the summers of 2007 and 2008. Similar declines in abundances were not observed in the other two streams, which did not cease to flow, or in the springs at the heads of the catchments. *P. gabrieli* returned to the lower reaches of Lyrebird Creek in lower abundances after 3 years, but *Austrogammarus* remains absent 5 years later, despite upstream and downstream source populations within 1 km.

The failure of *Austrogammarus* (which includes the threatened species, A. australis) to recover after 5 years, indicates a lack of suitable drought refugia and very low dispersal rates. The response of *P. gabrieli* suggests a similar lack of local refugia, but greater dispersal ability. With the threat of climate change and increasing demand for water extraction, this study highlights the challenges of protecting fauna with limited abilities to disperse or utilize local refugia.

Oral Abstracts

138 Developing turbidity closure criteria for receiving surface waters at Ranger minesite

Amy George[1], Chris Humphrey[1]

1. DSEWPaC, Darwin, NT, Australia

The Environmental Requirements (ERs) for closure at Ranger Uranium Mine stipulate that the minesite and associated natural waterbodies must be rehabilitated to a state which allows them to be incorporated into the surrounding Kakadu National Park. Water quality closure criteria are being developed in response to these requirements. The closure criteria aim to provide a management approach that allows water quality to remain within a range that will not compromise the long-term environmental objectives of the area. Turbidity is one of a number of measures for which closure criteria for receiving waters, including billabongs and stream channels adjacent to the Ranger minesite, are being developed. Research conducted at Georgetown Billabong, adjacent to the mine, has revealed a distinct relationship between turbidity and chlorophyll-a, the latter an indirect measure of primary productivity. This relationship has been assessed over several years (1981, 2009, 2012 and 2013) to identify turbidity threshold values associated with reduced primary production. The threshold values will be evaluated against existing and separate macroinvertebrate response data derived from creek channels to develop closure criteria which represent biological change, rather than simply water quality change. Thresholds so far identified are consistent with literature values reported for turbidity effects upon aquatic organisms and suggests sustained exposure in the range 30-50 NTU results in reductions in chlorophyll-a.

Poster and Speed Talk Abstracts

200 Joining the dots: connecting downscaled climate projections, hydrology, ecosystem values, and management frameworks to conserve biodiversity in freshwaters

Leon A Barmuta[1], Peter E. Davies[1], Anne Watson[1], Bryce Graham[2], Martin G. Read[2], Danielle M. Warfe[1 3]

1. *University of Tasmania, Hobart, TAS, Australia*
2. *DPIPWE, New Town, Australia*
3. *Centre of Excellence in Natural Resource Management, The University of Western Australia, Albany, WA, Australia*

We used Tasmania to demonstrate how outputs from downscaled climate models could be integrated with spatially resolved hydrological models and freshwater biodiversity data. In consultation with stakeholders, we quantified how different climate change scenarios could affect the risks to biodiversity assets, documented the scope and types of adaptation actions, and assessed the strengths and weaknesses of the policy and planning instruments in responding to climate change. We concluded that downscaled climate predictions linked with modelling of catchment and hydrological processes now refine projections for climate-driven risks to aquatic environments. Spatial and temporal hazards and risks can now be compared at a variety of scales via Bayesian Belief Networks, as well as comparisons between biodiversity assets. Uncertainties can be identified and built into adaptation processes. Notwithstanding this progress, we identified the following obstacles to implementation.

Biodiversity data sets need to be improved and updated, and better, spatially explicit information on the contributions of groundwater to surface waters is needed. The bewildering array of adaptation tools available to stakeholders needs to be organised using procedures such as scenario modelling which incorporate explicit tools for comparing costs, benefits, feasibility and social acceptability so that priorities can be set transparently. Formal mechanisms for the uptake of knowledge about identified risks into policy and legislative instruments remain undeveloped. The greatest challenge is to integrate multiple adaptation strategies (sometimes at different scales) to achieve specific adaptation objectives—especially where a mix of water management and non-water management is required.

201 Engineered Options for Improving Fish Habitat

Lisa Evans[1], Matthew Beitzel[1], Andrew P Brooks[2], Mark Jekabsons[1]

1. *Conservation Research, CANBERRA, ACT, Australia*
2. *Australian Rivers Institute, Griffith University, Brisbane*

Rehabilitation of fish habitat in degraded river reaches is now a widespread activity in Australia. Decisions about the correct approach to take can be difficult because of site constraints and the variety of methods that can be employed. Significant river reaches in the ACT are severely degraded, generally from catchment clearing and urban development. Some of these river reaches are critical to the ongoing survival of native fish species because they provide passage between habitat that is important for refuge and breeding. Two different habitat improvement approaches have recently been trialled in the ACT, being: Engineered Log Jams (ELJs) and concrete structural habitat (dubbed Cod Caves). These two habitat improvement structures were used in different locations and selected to meet locally specific requirements. This poster outlines why these different techniques were used and what were the costs and benefits of using these different approaches.

Poster and Speed Talk Abstracts

202 The Waterbug App: Taxonomic keys and novel technologies, striking a balance between unwieldy and frivolous

John Gooderham[1], Michael Sharman, Mandy Hall, Penny Johnson[1], Edward Tsyrlin[1]

1. The Waterbug Company Pty Ltd, Lenah Valley, TAS, Australia

Dichotomous keys have long been one of the primary tools for the identification of organisms. While the traditional printed format remains a useful tool , technological advancements mean that it is possible to broaden the scope of these keys so they can provide more information and appeal to a wider audience. *The Waterbug App* is a mobile phone app that is intended to introduce the taxonomy of freshwater invertebrates to a broad audience, utilising high resolution images, movies and sound to supplement text descriptions.

Citizen science is carefully and slowly becoming an accepted source of credible data. To work properly it needs to have practical and accessible tools. *The Waterbug App* provides such a tool. It utilises a taxonomic framework that has been developed to allow non-professionals to identify waterbugs without the use of a microscope. Characteristics of live animals, such as motion and colour are used to place animals within a hierarchy of taxonomic identification that is constrained to animal groupings that can be distinguished with limited magnification .

The Waterbug App has been designed to be adaptable to use alternative taxonomic frameworks. Inside the app is a generic structure designed to allow any dichotomous key with linked illustrations to be authored as portable apps for Android or iOS operating systems By importing a plan of the dichotomous key in Extensible Markup Language (XML), the underlying engine can generate multimedia apps from existing dichotomous keys.

203 Climate change? River regulation has more impact on water bugs!

Anne Watson[1], Leon A Barmuta[1]

1. University of Tasmania, Hobart, TAS, Australia

The shallow Tooms Lake dam was constructed in 1840 and supplies water for irrigation to much of the Tasmanian Midlands, via Tooms River. Although this river has been regulated for over 170 years, the invertebrate community remains depauperate and dominated by fly larvae, worms and snails, in contrast to the diverse fauna of the adjacent unregulated Macquarie River. In addition, the 2006-08 drought impacted more severely on the macroinvertebrate community of Tooms River, showing that the biota have less resilience to drought and potentially to climate change, than the biota of the highly variable-flow Macquarie River.

There is a tendency to consider that the benefits of dams outweigh the detriments, but little monitoring has been done to actually measure the impacts of small irrigation supply dams. Despite this, further irrigation projects are proposed for the central Midlands, with more dams and inter-catchment transfers of water to expand agricultural productivity and build resilience to drought and climate change for farmers.

The NCCARF 'Joining the Dots' project combined outputs from dynamically downscaled climate models with hydrological modelling and systematic biodiversity data as inputs to Bayesian Belief Networks (BBNs). The BBNs identified major impacts to Tasmanian freshwater biota from projected climate change. These impacts are predicted to be most severe in low rainfall regions which already have high demand for irrigation supply, such as the central Midlands.

Is this the future for freshwater biodiversity in southern Australia? A proliferation of dams to exacerbate the impacts of climate change?

Poster and Speed Talk Abstracts

204 Cryptic Crays: Monitoring Murray River Crayfish in the ACT

Katie Ryan[1], Mark Jekabsons[1], Matthew Beitzel[1], Lisa Evans[1]

1. *Conservation Research, Canberra, ACT, Australia*

Murray River crayfish, the largest and most widely distributed of all species from the genus Euastacus, are listed as vulnerable in the Australian Capital Territory (ACT). An initial survey of this species in 1988 revealed that despite evidence of distribution throughout the length of the Murrumbidgee River within the ACT, catch rates were patchy and low in comparison with other parts of their range. In response to these findings, the ACT Government banned fishing of Murray River crayfish in 1993 and put in place a monitoring program. Twenty five years after the initial survey and 20 years following the closure of the fishery, a review of the monitoring program has revealed that they are still at risk. Additionally, it appears that modification to the monitoring program may be necessary to achieve additional insight into Murray River crayfish populations in the ACT. This poster will outline results of the review of monitoring from 1988-2013, discuss the results of trialling Munyana nets as a new method for monitoring, and provide recommendations for future monitoring of Murray River crayfish in the ACT Region.

205 Persistence and connectivity of fish populations in the extreme arid environment of the Lake Eyre Basin, Australia

Ashley L Murphy[1], Mark Adams[2], Alan R Lemmon[3], Dale McNeil[4], Thuy Nguyen[5], Peter Unmack[6], Ross Thompson[6], Jenny Davis[1], Paul Sunnucks[1]

1. *School of Biological Sciences, Monash University, Melbourne, Vic, Australia*
2. *Evolutionary Biology Unit, South Australian Museum, Adelaide, SA, Australia*
3. *Department of Biological Sciences, Florida State University, Tallahassee, FL, United States*
4. *Department of Water, Environment and Natural Resources, Adelaide, SA, Australia*
5. *Biosciences Research Division, Department of Environment and Primary Industries, Bunrooda, VIC, Australia*
6. *Institute for Applied Ecology, University of Canberra, Canberra, ACT, Australia*

The Lake Eyre Basin in the Australian arid zone is one of the harshest environments in which freshwater fish are found. Waterholes are often the only available habitat for riverine species, but most of these become uninhabitable during drought periods, and almost all have dried at least once in the past 200 years. For fish species to persist, not all waterholes can be simultaneously uninhabitable, and fish must disperse when possible to maintain a wide geographic range, allowing recolonisation of sites when conditions improve. We will use genetic techniques to investigate the ecological and evolutionary processes operating on these species on a range of timescales. Preliminary results using mitochondrial markers from three species across the Northern Territory and South Australian rivers of the Basin have shown little within-drainage genetic diversity, but significant among-drainage variability. This suggests that populations in each drainage may be functionally isolated and subject to genetic bottlenecking and drift, explicable by the extreme boom-and-bust nature of this system. Further research will expand on this, by sequencing up to 1400 anonymous loci per individual, from populations sampled in replicate drainages across the entire Lake Eyre Basin. Five taxa were chosen to represent a range of hypothesised persistence strategies, from 'resilience' (spangled perch, bony bream), to 'resistance' (Lake Eyre and Finke hardyhead, Desert and Finke goby), with barred grunter utilising an intermediate strategy. This will allow us to explore the differences among drainages and species, and determine how fish populations persist in this extreme environment.

Poster and Speed Talk Abstracts

206 Measuring the stream ecosystem service benefits of riparian revegetation

Elliot Picone[1], Darren S Ryder[1], Rhiannon Smith[1], Romina Rader[1]

1. University of New England, Armidale, NSW, Australia

Ecosystem services are the goods and services provided by ecosystems that contribute to human wellbeing. Riverine ecosystems are among the most important ecosystems in terms of service provision but are also among the most degraded. Riverine ecosystems provide ecosystem services such as carbon sequestration, erosion mitigation, pollutant filtration and retention, biodiversity conservation and terrestrial and aquatic habitat provision. My research investigates the efficacy of vegetation restoration and fencing, two commonly implemented management interventions, to improve the ecological condition and associated ecosystem services in rivers of the Border Rivers-Gwydir in northern NSW. To do this I will quantify the stream bank and instream ecosystem services provided by streams and compare paired treatment (fenced) and control (unfenced) stream reaches. I hypothesise that fenced-off stream reaches will provide greater ecosystem services such as carbon sequestration and ecosystem metabolism, erosion mitigation, nutrient retention and regeneration, biodiversity conservation and terrestrial and aquatic habitat provision, compared with unfenced stream reaches. In addition, I hypothesise that stream bank plantings in combination with fencing will accelerate the provision of these services relative to fencing alone. By understanding the ecological mechanisms regulating the provision of services and the cost/unit ecosystem service provision generated through fencing and stream bank plantings, this study will facilitate improved management interventions that ensure restoration efforts target the ecological attributes of streams to optimise ecosystem service benefits.

207 Mapping the Moira Grass: the decline of *Pseudoraphis spinescens* grasslands at Barmah Forest

Lyndsey Vivian[1], Robert Godfree[1]

1. CSIRO, Canberra, ACT, Australia

Floodplain grasslands are highly dynamic, diverse and productive ecosystems. However, many floodplain grasslands are degraded because of changes to natural flood regimes. In southern Australia, one of the largest floodplain grasslands occurs at Barmah Forest, a ca. 30,000 ha floodplain on the Murray River. These grasslands, dominated by *Pseudoraphis spinescens* (Moira grass), have been declining in extent since river regulation in the 1930s. Current management focuses on using environmental flows to provide more natural flood regimes. However, there is no current estimate of the remaining extent of the grasslands following the Millennium Drought and the subsequent flooding from 2010-12, and little is known about the seed bank. To address these knowledge gaps, we conducted surveys to map and quantify the current distribution of *P. spinescens* grasslands in treeless plains and lakes across Barmah Forest, and investigated the seed bank dynamics. We also gathered evidence from photographs, historical observations and monitoring data to determine how *P. spinescens* grasslands have changed over time. Our results suggest there is currently less than 44 ha of *P. spinescens* grassland patches remaining in treeless areas in the forest, with an additional 105 ha containing lower cover. The seed bank also appears to be depleted. *Pseudoraphis spinescens* grasslands have declined at different times in different parts of the forest. A range of factors may be causing this decline, including altered flood regimes, drought, and grazing. Further research into understanding these drivers is crucial for improved conservation and management of this important floodplain ecosystem.

Poster and Speed Talk Abstracts

208 Determining the hydro-ecological effects of abstraction in the Mount Lofty Ranges, South Australia

Sally E Maxwell[1]

1. CSIRO, Adelaide, SA, Australia

The flow regimes of rivers in the Mount Lofty Ranges are intermittent. Coupled with this, wide spread extraction for agricultural use has altered these flow regimes, increasing the spatial and temporal extent of disconnection. Water allocation plans seek to balance use between the environment, social and economic concerns. Determining the amount of water required by the ecosystem to sustain ecological communities and processes requires a multidisciplinary approach. Previous methods of determining environmental water requirements have focussed on geomorphic reach types coupled with hypothesised responses of key taxa. Our work seeks to further the current approach by using data driven methods to determine the ecological effects of water extraction, classify the flow regimes based on hydrological parameters and model future responses to varying levels of extraction.

209 Planning for the Future: Mobile Targets Under Climate Change

Alex Bush[1]

1. Macquarie University, North Ryde, NSW, Australia

Climate change represents a major challenge to conservation in the future, and undermines protection within reserve boundaries. We tested the likely benefits of including predicted species distributions in reserve design for rivers under climate change, and the impact of varying connectivity requirements on future representation. We used the modeled distribution of 126 dragonflies to identify reserve networks that remained representative under future climates, and compared the effect of connectivity penalties that emphasised either longitudinal riverine connections or connections to all neighbouring subcatchments. Solutions that did not include future distributions in the planning stages were 16-30% less likely to protect the same species by 2055 and 2085 and less efficient in the longer term. In addition, solely targeting longitudinal connectivity was significantly less likely to protect current species in the future than if cross-catchment connections were included. Where protected areas can be expanded to assist species adapt to climate change, significant gains in efficiency are possible if longer-term goals are considered when selecting sites. Furthermore, to improve the representation of species under future climates reserve selection should consider inter-catchment connectivity, although the nature of optimal solutions will depend heavily on the range of taxa included, their dispersal capacity, and the availability of climatic refugia.

Poster and Speed Talk Abstracts

210 Hydrological connectivity and ecological functional processes in inland floodplain wetlands: nutrient and carbon cycling

Tsuyoshi Kobayashi[1], Skye Wassens[2], Timothy J Ralph[3], Darren S Ryder[4], Neil Saintilan[1], Debashish Mazumder[5], Li Wen[1], Simon J Hunter[1]

1. *Office of Environment and Heritage NSW, Department of Premier and Cabinet, PO Box A290 Sydney South, NSW 1232, Australia*
2. *School of Environmental Sciences, Charles Sturt University, PO Box 789 Albury, NSW 2640, Australia*
3. *Dept of Environment and Geography, Macquarie University, Sydney, NSW 2109, Australia*
4. *Ecosystem Management, University of New England, Armidale, NSW 2351, Australia*
5. *Australian Nuclear Science and Technology Organisation, Kirrawee DC, NSW, Australia*

Floodplain wetlands have intricate multi-channeled networks and unpredictable wet and dry phases related to variable hydrological regimes and geomorphic processes such as sedimentation and erosion. Hydrological reconnection of river channels with outer floodplain and wetland habitats initiates mobilisation and transformation of nutrients and carbon in inland floodplain wetlands. In this study, we aim to show habitat-dependent patterns of mobilisation and transformation of nutrients (total and dissolved nitrogen and phosphorus) and dissolved organic carbon (DOC) following environmental water releases, based on the available data from the Murrumbidgee Wetlands, Macquarie Marshes and Gwydir Wetlands. In general, concentrations of nutrients and DOC are lower within channels and higher on the floodplain and in wetlands where shallow inundation and mixing of topsoil with water occurs. Higher concentrations of nutrients and DOC on the floodplain represent a combination of supply from channels coupled with in situ releases from the water-soil interface. The volume, timing, depth, rate of rise and fall, and spatial distribution of water being introduced to floodplain wetlands influence the amount and distribution of nutrients and carbon in these systems. Rates of ecological functional processes such as primary productivity and respiration (or decomposition) are closely related to concentrations of nutrients and DOC. We propose a nutrient-DOC framework, combined with hydrological regimes and geomorphic processes, to better predict and understand the relationship between hydrological connectivity and ecological responses of inland floodplain wetlands.

211 Ecological resilience in a water supply stream as a result of significant habitat and geomorphic shift from several major storm events up to approximately a 1:100 year ARI event

Joshua P Cox[1], Phil Taylor[1], Norm Mueller[1]

1. *GHD, Canberra, ACT, Australia*

Burra Creek is a fourth order ephemeral stream in a major ACT Water supply catchment that was impacted by major storm events in late 2010 resulting in large scale geomorphological change within the stream. This event scoured large sediment deposits and macrophyte beds, in many places down to bedrock, which had been aggregating since the last significant storm events in 1995, approximately 15 years previously, and prior to that 1988-89.

This study assesses the ecosystems ability to rapidly recover and adapt to significant structural geomorphological and habitat changes brought on by a naturally occurring environmental disturbance.

The health of streams is generally measured through macroinvertebrate assessment of riffle and edge samples undertaken biannually in spring and autumn with taxa identified to family level. Assessment was completed with taxa identified to genus level and supplemented with water quality, riverine vegetation, habitat, and detailed geomorphological data for broader impact detection.

The analysis uses multiple metrics investigating macroinvertebrates at the genus level with further analysis of supporting data for comparison and determination of impact from an environmental disturbance.

This detailed data has been analysed and compared to pre-storm data to assess potential change and recovery to the freshwater ecology of Burra Creek using a before-after design. Response of the system and mechanisms of resilience to major storm events are identified.

Poster and Speed Talk Abstracts

212 Exposure-dose-response frame work for the assessment of sediment lead toxicity in the freshwater bivalve - *Hyridella depressa*

Chamani P.M. Marasinghe Wadige[1], Anne M. Taylor[1], William A. Maher[1], Frank Krikowa[1]

1. *Institute for Applied Ecology, University of Canberra, Bruce, ACT, Australia*

Lead is a non-essential metal which is introduced into aquatic environments through anthropogenic activities such as mining. Lead accumulates in sediments can be toxic to aquatic biota. To assess the fate and effects of lead contaminated sediments on aquatic biota in freshwater ecosystems, the exposure-dose-response relationship of *Hyridella depressa* was investigated in laboratory microcosms. *H. depressa* was exposed to three different exposure concentrations of lead spiked sediments (7 ± 1, 205 ± 14 and 419 ± 16 µg/g) over 28 days. Dose was measured by lead accumulation in whole soft body and individual tissues. Sub-cellular distributions of lead and biological responses in terms of enzymatic and cellular biomarkers were measured in hepatopancreas tissues at day 28. Lead accumulation in whole body tissues were significantly increased over the exposure period and reflected sediment lead concentrations. Despite high concentrations of lead in the sediments, organisms accumulated relatively low lead concentrations (low treatment: 2.2 ± 0.2 µg/g, high treatment: 4.2 ± 0.1µg/g). Labial palps accumulated significantly more lead compared to other tissues. Of the lead accumulated in the hepatopancreas 83-91% was detoxified and stored in metal rich granules (MRG). The proportions and concentrations of lead in the MRG fraction increased with lead exposure. The biologically active lead was mainly present in the mitochondrial fraction and increased with lead exposure. Total antioxidant capacity significantly decreased while lipid peroxidation and lysosomal destabilation increased with lead exposure. The data indicated that *H. depressa* lead exposure resulted in lead doses that caused significant sub lethal health effects.

213 Evaluating barriers to aquatic invertebrate dispersal: weirs and tributaries in the montane rivers of the Australian Alps

Andrew Brooks[1 2], Ben Wolfenden[1], Barbara Downes[2]

1. *NSW Office of Water, Wollongong, NSW, Australia*
2. *Dept Resource Management and Geography, University of Melbourne, Melbourne, VIC, Australia*

Dams and weirs are a significant source of environmental degradation in rivers. One hypothesis explaining how they reduce species diversity is that dams and weirs are barriers (i.e. breaks in connectivity) to dispersal along rivers. Such connectivity can be pivotal to populations remaining extant, and also to restoration of degraded reaches. However, it is unknown whether and how dams or weirs block or impede dispersing species, hence diminishing the likelihood of successful downstream restoration. The aim of this project is to test whether and how dams and weirs (on tributaries and main stem channels) impede dispersal of aquatic invertebrates and thus compromise river rehabilitation using environmental flows. We first examined whether drifting invertebrates were impeded by 13 natural, slow-moving pools by measuring invertebrate drift entering and exiting each pool using drift nets (25 x 25cm opening, 1.5m long with 250µm mesh). Second, we tested whether drift rates through natural pools differed from drift through the pool of Mowamba Weir when the weir was over-topping. Preliminary results show that deep, slow-moving natural pools are sinks for much of the invertebrate drift, and are potentially barriers to drift dispersal. Mowamba weir pool reduced the drift dispersal to a greater extent than natural pools for some species, suggesting that the weir is a partial barrier to dispersal and could limit downstream colonisation. Future studies will examine whether weirs on tributaries of regulated rivers (Geehi River, Snowy River) obstruct drift dispersal and hinder downstream colonisation in the tributary and mainstem of regulated rivers.

Poster and Speed Talk Abstracts

214 Small wings, big country: Using genetics to explore dispersal of aquatic insects in the Australian arid zone

Emma Razeng[1], Katherine Harrisson[1], Arlene Butwell[2], Glenis McBurnie[3], Jayne Brim Box[3], Alan R Lemmon[4], Ross Thompson[5], Paul Sunnucks[1], Jenny Davis[1]

1. *School of Biological Sciences, Monash University, Clayton, VIC, Australia*
2. *Australian Rivers Institute, Griffith University, Nathan, QLD, Australia*
3. *Biodiversity Conservation Unit, Department of Natural Resources, Environment and the Arts, Alice Springs, NT, Australia*
4. *Department of Biological Sciences, Florida State University, Tallahassee, Florida, USA*
5. *Institute for Applied Ecology, University of Canberra, Canberra, ACT, Australia*

Aquatic ecosystems in Central Australia are subject to boom-bust cycles, with the fauna, including insects, enduring long droughts and extreme flood events. During the drought phase, watercourses are reduced to a few disconnected pools, few of which are permanent. As a result, the habitats available to aquatic insects in Central Australia are highly fragmented both spatially and temporally. In this environment of highly variable connectivity, the ability to disperse successfully is likely to be a key factor for persistence. In multi-institutional collaborative research, focusing on seven insect species encompassing strong and weak dispersers, we will uncover patterns underlying dispersal traits, population genetics and landscape connectivity. By analysing up to 1400 anonymous nuclear markers per individual, we will identify fine-scale patterns of gene flow among spatially disconnected populations and infer the relationships among dispersal traits, environmental factors and functional connectivity of species in geographic space. Results from a preliminary study using single mitochondrial and nuclear DNA sequence markers indicate significant variation among populations of weakly dispersing species, while strong dispersers display minimal spatial genetic subdivision. However, the large volume of anonymous loci used in the current study will provide much more precise estimates of dispersal, gene flow and timing of these events among populations. The findings of this study illustrate the importance of permanent water and flooding events to the desert ecosystem, informing future management decisions in a region where water is a valuable commodity.

215 Desert goby *(Chlamydogobius eremius)* behaviours in arid Australian waterholes: intraspecific variability in boldness and movement behaviours

Nicholas P Moran[1], Bob Wong[1], Ross Thompson[1 2]

1. *School of Biological Sciences, Monash University, Carlton North, VIC, Australia*
2. *Institute of Applied Ecology, University of Canberra, Bruce, ACT, Australia*

In northern South Australia, the Lake Eyre Basin's highly variable rivers and the Great Artesian Basin's isolated spring systems provide a challenging environment for the region's aquatic communities. For fish endemic to this landscape, decisions about dispersal, movement and feeding are critical to an individual's survival. To assess whether ecosystem variables like hydrology and community composition influence behaviour at an individual and population level, we investigated boldness, exploratory and dispersal behaviours in a fish, the desert goby (Chlamydogobius eremius). We predicted that populations from springs should be bolder as their environments generally do not include larger aquatic predators e.g. spangled perch. On the other hand, river populations are expected to be more exploratory and dispersive as their habitats are largely ephemeral and there are greater rewards associated moving through the landscape. Preliminary data supports the hypothesis that there are significant population differences in the exploratory and boldness behaviours between spring and river populations.

The importance of intraspecific variability has only recently been recognised, particularly as a stabilising force in population and community dynamics. This study helps explore how intraspecific variability develops in animals and will be used to investigate the importance of this to the stability of aquatic communities in northern South Australia.

Poster and Speed Talk Abstracts

216 To pass or not to pass? Testing fishway passage in the ACT

Matthew Beitzel[1], Katie Ryan[1], Mark Jekabsons[1]

1. ACT Government, Canberra, ACT, Australia

Barriers to fish passage such as dams, weirs and road crossings are a key threat to native freshwater fish. Fish need to move for many reasons including, breeding migrations, maintain population diversity, access refuge areas during drought and to re-establish in areas following disturbances.. A vertical slot fishway was constructed in the ACT on the Casuarina Sands Weir on the Murrumbidgee River when the weir was replaced in 2000 but it has been unclear whether it is effective or not. Funding from the Murray Darling Basin Authority's Native Fish Strategy facilitated a trial of fish passage through the fishway. The project included the installation of a PIT array on the fishway and the capture and tagging of over 100 fish from four species. 50 fish (41 carp *Cyprinus carpio* and 9 golden perch *Macquaria ambigua*) were placed in the lower section of the fish way and their assent monitored by the PIT array. A number of problems were encountered particularly in regards to high laminar flow velocity, lack of fish motivation and head loss at the entrance to the fishway. A number of solutions to these problems were trialed. By placing the fish in the first cell and installing a baffle in the entrance slot flow velocity and turbulence in the fishway were reduced and 100% fish placed in the fishway achieved passage upstream. The results indicate that the fishway needs modification to operate effectively at low flow levels.

217 Understanding the impacts of water extraction on ecosystem structure and function in remnant river pools

Mathew Birch[1], Darren Ryder[1], Ivor Growns[2]

1. University of New England, Armidale, NSW, Australia
2. NSW Office of Water, Armidale, NSW, Australia

Flow variation is a common feature among lotic aquatic systems. The known ecological effects of changing flow regimes vary, depending upon landscape, catchment and habitat characteristics. In upland intermittent streams the effects of low flow periods may be exacerbated by water extraction for human needs. The importance of these impacts magnifies when low flow refugia, threatened species (such as the Purple-spotted Gudgeon, *Mogurnda adspersa*) and water extraction points are found in the same place.

Water managers need to understand how biogeographical, ecological and physical factors interact to determine the resilience and resistance of wetland pool ecosystems during low flow and no flow conditions in order to sustain ecological condition and extractive needs in variable settings.

This study aims to develop an understanding of the factors underpinning ecosystem structure and function of wetland pools in upland intermittent streams under varying conditions. A further aim is to produce conceptual models of categorised upland refugia demonstrating the major biogeographical, physical and ecological factors driving variation in trophic pathways, food sources and fish population dynamics. Outcomes from the project will lead to principles to guide cease-to-pump management rules in river systems.

The proposed methods will assess medium-term variation in fish and macroinvertebrate community structure, trophic pathways and landscape factors over changing flow and among refugia with varied characteristics at catchment and macro-habitat scales. Experimental in-situ flow manipulation will be utilised to assess short-term responses to water extraction in Tenterfield Creek.

Poster and Speed Talk Abstracts

218 The ecological response of insectivorous bats to coastal lagoon degradation

Bradley K Clarke-Wood[1], Kim Jenkins[1], Brad Law[2], Rachel Blakey[1]

1. *The Australian Wetlands, Rivers and Landscape Centre, The School of Biological, Earth and Environmental Sciences, UNSW, Sydney, Australia*
2. *Department of Primary Industries, New South Wales Government, Sydney, NSW, Australia*

Coastal floodplains, wetlands and lagoons are key habitats for bats, providing a rich food supply and abundant water to meet their high energy demands. However, urbanisation has degraded coastal lagoon systems, with pollution (i.e. heavy metals, herbicides and pesticides), eutrophication and urban sprawl reducing the extent of viable habitat and biodiversity. We investigated the impact of habitat degradation on insectivorous bat activity and community structure across a disturbance gradient from degraded lagoons in Sydney to medium quality lagoons in Sydney or regional NSW and high quality lagoons surrounded by extensive bushland. We examined whether the food web structure varied across the disturbance gradient using stable isotope analysis and tested sediments, bats and their prey for contamination by heavy metals. We predicted that bat activity and diversity would be reduced in low quality lagoons and that the threatened Large-footed Myotis (*Myotis macropus*), an obligatory aquatic species would be significantly impacted by the decline in aquatic habitat quality. Using Anabat detectors, we found bat activity within high quality coastal lagoons was up to nine times greater than at low quality lagoons. Furthermore, the number of species present at higher quality lagoons was almost double the number detected at low quality lagoons. Consistent with this, the Large-footed Myotis was only recorded at high and medium quality lagoons. Heavy metal concentrations were higher in Myotis hair at the medium than the high quality lagoons. These findings inform managers about the state of bat populations in coastal lagoons, providing targets and mechanisms for rehabilitation efforts.

219 Sources of carbon supporting fish recruitment in regulated and unregulated floodplain rivers

Luke McPhan[1], Kim Jenkins[1]

1. *Australian Wetlands Rivers and Landscapes Centre, School of BEES, University of New South Wales, Randwick, NSW*

Understanding the origin of carbon in floodplain river systems is integral to ecosystem health, and overall biotic growth. It is also a contentiously argued topic with various hypotheses (river continuum concept, flood-pulse concept, and riverine productivity model) that assign the sources of carbon as either allochthonous or autochthonous. Despite the significance of this issue for ecological understanding and adaptive management of environmental water, there is little knowledge of the sources of carbon that underpin larval fish food webs in Australian floodplain rivers. It is known that fish recruitment is strongly influenced by the availability of suitable food resources, particularly microinvertebrates that provide critical prey for larval fish of all species. Due to this strong link between larval fish and microinvertebrates, a limited supply of microinvertebrates can be a key factor causing failed recruitment and high initial mortality of larval fish. In a food-web based approach, focusing on larval fish and their prey, stable isotope analysis (SIA) will be performed to investigate relationships between and within biota, their diet and surrounding environment. The nutritional value of a range of microinvertebrate taxa will also be examined. The food webs of larval fish in regulated and unregulated catchments will be compared to investigate the impact of water abstraction and dams on sources of carbon. Knowledge from this research will support adaptive management of fish recruitment in regulated rivers

Poster and Speed Talk Abstracts

220 Micro-scale trophic relationships in floodplain river systems

Claire Sives[1], Kim Jenkins[1], Martin Forest[1], Luke McPhan[1], Debashish Mazumder[2]

1. *Australian Wetlands Rivers and Landscapes Centre, UNSW, Randwick, NSW, Australia*
2. *ANSTO, Kirrawee, NSW, Australia*

Microinvertebrates form an important trophic link between basal carbon resources and higher predators such as waterbirds and fish. These tiny creatures have a wide-ranging diet including; algae, bacteria, other microinvertebrates and detritus, subsequently becoming either prey for larger animals or detritus. We used stable isotope analysis to explore the diet of freshwater microcrustaceans in the Macquarie Marshes. Data were taken from drought and flood years, channels and floodplains, ranging from 2006 to 2012. Ostracods consumed terrestrial vegetation carbon resources and cladocerans consumed aquatic vegetation carbon resources in channels during drought. As resources expanded, and inundated floodplain connected to channels, resource consumption expanded.

Ostracod carbon stable isotope ratios ($\partial^{13}C$) ranged from -15.8 to -14.3% in drought indicating a preference for terrestrial plants (C4 plants) or water couch. During floods, ostracod $\partial^{13}C$ ratios expanded and ranged from -22.6 to -13.3%. Cladoceran $\partial^{13}C$ ratios ranged from -29.6 to -23.4% in drought indicating a preference for the consumption of C3 algae and plants i.e. aquatic wetland plants. During flood Cladoceran $\partial^{13}C$ ratios expanded and ranged from -34.1 to -21.6%, with floodplain values towards the terrestrial range. Similar nitrogen stable isotope ratios ($\partial^{15}N$ - Cladocera= 0 to 7.2; Ostracoda= 0.3 to 8.7) indicate that both groups are at a similar trophic level i.e. one is not consuming the other. Understanding the link between microinvertebrates and carbon resources can inform the adaptive management of floodplain river systems, especially decisions about the duration of both dry phases and reconnection events.

221 Modelling wetland condition in Victoria

Phil Papas[1] , P Maloney[1]

1. *Arthur Rylah Institute for Environmental Research, Department of Environment and Primary Industries, Heidelberg*

The Index of Wetland Condition (IWC) is a method for assessing the condition of Victoria's wetlands. It has 13 variables that measure wetland catchment, salinity, nutrients, soil disturbance, water regime, physical form, extent and vegetation condition. Between 2009 and 2011, 830 wetlands were assessed using the method. To inform the management of wetlands not assessed, modelling was trialled to predict their condition. Several ordinal regression and classification techniques were explored. Modelling procedures were tested using IWC condition scores from the 830 wetlands and variables that could (1) affect wetland condition (e.g. land use) and (2) be measured remotely.

A principal components analysis of the individual IWC measures was performed to identify those which best correlated with wetland condition. From these, remote sensed surrogate variables and others that were likely to influence wetland condition were identified. Data for all the variables were obtained from spatial datasets for the 830 wetlands. Models were built by first randomly splitting IWC data into training data (used to calibrate) and testing data (used to assess predictive ability.

The models did not successfully predicted more than 50% of the condition categories of the test data. This demonstrates that the information contained in the variables was not sufficient to accurately classify most wetland condition. The relationships between these variables and wetland condition could be too complex and variable among wetlands to enable good predictions. Predictions may be improved by (1) basing the modelling on a coarser classification (i.e. poor and not poor), (2) ensuring there are additional wetlands in poor condition to increase the sample size of this category and (3) using updated spatial data as it becomes available to attribute wetlands.

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