



ABSTRACTS

SASAQS 2013 CONFERENCE

30 JUNE – 4 JULY 2013
ARNISTON, WESTERN CAPE



SOUTHERN AFRICAN
SOCIETY OF AQUATIC
SCIENTISTS

Hosted by:



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SOCIETY OF AQUATIC
SCIENTISTS

SASAQS 2013 CONFERENCE

30 JUNE – 4 JULY 2013
ARNISTON, WESTERN CAPE

CONFERENCE SECRETARIAT



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SOUTHERN AFRICAN SOCIETY OF AQUATIC SCIENTISTS

30 June – 4 July 2013, Arniston, Western Cape

PROGRAMME

SUNDAY 31 JUNE 2013

16:00	Registration
18:00	Dinner
19:00	Social Ice breaker

MONDAY 1 JULY 2013

Time	Session title	Presenter
	VENUE 1	
	Mediterranean Ecosystems	
	Chair: Helen Dallas	
08:00	Setting the scene: aquatic ecosystems of the Cape Mediterranean Region (Keynote)	Jenny Day
08:40	Spatial character of undisturbed Fynbos Riparian Vegetation longitudinally down a Western Cape river ecosystem	Mia Otto
09:00	What drives periphyton communities in south Western Cape Rivers? A shift from top – down to bottom up control.	Justine Ewart-Smith
09:20	Impact of non-native rainbow trout on headwater stream communities in the Cape Floristic Region, South Africa	Jeremy Shelton
09:40	Adaptive responses of Cape Floristic Region endemic freshwater fish species to hydrological, temperature and geomorphological regimes: the Mediterranean context	Bruce Paxton
10:00	Ecological status assessment in Mediterranean rivers: complexities and challenges in developing tools for assessing ecological status and defining reference conditions	Helen Dallas
10:20	Tea	



	Beyond borders	
	Chair: Justine Ewart-Smith	
10:40	Pushing geographical and technical boundaries: our evolution as aquatic scientists (Keynote)	Jackie King
11:20	The response of stationary trawl (Dai) fishery yields in the Tonle Sap-Great Lake system of the Mekong River, Cambodia to inter-annual variations in the flood pulse	Bruce Paxton
11:40	Floodplain fisheries of Liuwa Plain National Park, Western Province, Zambia	Richard Peel
12:00	Development of a biomonitoring protocol and its application in a preliminary assessment of the ecological status of Zambian rivers	Chris Gibbins
12:20	Zooplankton composition and succession in the Okavango Delta and its associated basins	Deidré West
12:40	Lunch	
	Wetland Ecology	
	Chair: Heather Malan	
14:00	Can the ecosystem services of the Papekuils social-ecological system be sustained? (Keynote)	Donovan Kotze & Samantha Adey
14:40	Variation in physico-chemical characteristics of pans in the North West, Free State and Mpumalanga	Wynand Malherbe
15:00	The development of a Framework for Wetland Assessment and a Decision Support Matrix for the assessment of wetland condition in South Africa	Dean Ollis
15:20	Tea	
	Wetland Ecology	
	Chair: Heather Malan	
15:40	Identification and delineation of wetlands in the Nelson Mandela Bay (NMB) area: a local refinement of a national initiative	Denise Schael
16:00	Role of landscape positioning in the distribution, structure and function of temporary wetlands in Nelson Mandela Bay Metropolitan (NMBM)	Brigitte Melly

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16:20	Macroinvertebrates as unreliable indicators of human disturbance in temporary depression wetlands of the south-western Cape, South Africa	Mathew Bird	A Microscopic Web of Intertidal Peritrich Ciliates	Linda Basson
16:40	-	-	Intertidal Symbiont Project At De Hoop Nature Reserve	Jo van As
18:00	Dinner			
19:00	Evening: WRC Workshop: Sustainable Utilization of Ecosystem Goods and Services			

TUESDAY 2 JULY 2013

	Management And Monitoring		Freshwater Ecosystems and alien invasions	
	Chair: Pierre de Villiers		Chair: Olaf Weyl	
08:00	From research to practice in adaptive water resource management (Keynote)			Chris Dickens
08:40	Regional Scale Risk Assessment methodologies incorporating Bayesian networks in the management of water resources in South Africa.	Gordon O'Brien	The occurrence, distribution and population structure of freshwater fishes in Free State dams and implications for inland fisheries	Leon Barkhuizen
09:00	Water availability and use under uncertain future climate and development scenarios in the Amatole System	Sukhmani Mantel	Development Of A Fish Kill Investigation Protocol For South Africa	Byron Grant
09:20	Water quality implications of uncertain future climate and development in the Amatole System, Eastern Cape, South Africa	Andrew Slaughter	Post-capture dispersal and mortality of tournament captured largemouth bass <i>Micropterus salmoides</i> in a South African impoundment	Geraldine Taylor
09:40	Case Study – Lourens River Flood Alleviation Project: the “Softer Solution”	Natalie Newman	Fish assemblages as an ecological indicator of low land rivers in sub-tropical Africa.	Hannes Venter
10:00	Development of Water Quality Index for Cape Town's aquatic ecosystems	Candice Haskins	Can we detect impacts of trout in small mountain streams by examining invertebrate communities using a multivariate approach?	Terrence Bellingan
10:20	Tea			
	Chair: Candice Haskins		Chair: Martine Jordaan	
10:40	Reporting and monitoring of enforcement activities on urban river reaches	Sam Braid	The influence of nutrient enrichment on the macro-invertebrate fauna of Loole Creek in the Limpopo Province	Alvar Koning

11:00	Does science add value to water management processes?	Nadene Slabbert	Double blow: First record of an alien crayfish, <i>Cherax quadricarinatus</i> von Martens, infested with an alien temnocephalan, <i>Diceratocephala boschmai</i> Bear, in South African waters	Nico Smit
11:20	Stakeholder mapping and the identification of benefits and services derived from Wilderness and Swartvlei lake systems	Aneri Vlok	Managing alien fishes in South Africa	Olaf Weyl
11:40	The use and abuse of SASS: why detailed taxonomic work is vital for conservation: a case study using Teloanodidae (Ephemeroptera)	Lyndall Pereira-da-Conceicao	Inter-basin water transfer schemes and the threat of fish invasions: a water management conundrum	DJ Woodford
12:00	Progress with the SAEON Long term Water quality monitoring of the Lower Olifants River.	Thabo Mohlala	Fish health and suitability for human consumption study of selected fish species in the Northe West Province	GM Wagenaar
12:20	Adult dragonflies as indicators of river health: A Case Study on the Crocodile-Incomati River, from South Africa to Mozambique.	Gerhard Diedericks	-	-
12:40	The Use Of Diatoms And Related Biotic Indices To Quantify The Effect Of Vineyard Pesticides And Efficacy Of Mitigation Measures	Steven Osmond	-	-
13:00	Lunch			
14:00	The influences of hydrological phases on the community composition of Simuliidae and Baetidae and the implications on biomonitoring in the Seekoei River	Ina Ferreira	Wetlands Workshop (Dean Ollis)	
14:20	The Cape Clawless otter: a useful indicator for determining environmental water requirements in ephemeral rivers	Esté Prinsloo		
14:40	Poster Session			
15:00				
15:20	Tea			
15:40	SASAQS AGM			
18:00	Dinner			
19:00	Student meeting			



WEDNESDAY 3 JULY 2013

Estuarine Ecology

Chair: Janine Adams

08:00	Nutrient Characterisation of River Inflow into the Estuaries of the Gouritz Water Management Area	Daniel Lemley
08:20	Responses of microalgae in the Great Brak estuary to changes in river flow	Gavin Snow
08:40	The role of submerged macrophytes and macroalgae in nutrient cycling in the Great Brak Estuary South Africa: a budget approach	Lucienne Human
09:00	Present state and future fate of mangroves in South Africa	Janine Adams
09:20	In situ growth rate of <i>Solen cylindraceus</i> (Mollusca: Euheterodonta: Solenidae) in the St Lucia estuarine lake, South Africa	Holly Nel
09:40	Role of sand prawns as ecosystem engineers in temporarily open/closed southern African estuaries	PW Froneman
10:00	Mediating interactions among lower trophic levels: community stability, induced by early life-history fish, in the estuarine plankton	Ryan Wasserman
10:20	Tea	

Estuarine Ecology

Chair: Janine Adams

10:40	Preliminary Results From Selected Estuaries Monitored As Part Of The National Estuarine Monitoring Programme (Nesmp) In South Africa.	Gerhard Cilliers
11:00	Development of an estuary management plan: Lessons learned in the CAPE estuaries programme	Pierre de Villiers

Ecotoxicology and pollution

Chair: Victor Wepener

11:20	Field Validation of Metal Contamination at the Richards Bay Harbour	Refiloe Mofokeng
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Ecotones

Chair: Jeanne Gouws

The role of amphibians in linking terrestrial and aquatic habitats in the Kowie catchment	Likho Sikutshwa
Reciprocal aquatic/terrestrial trophic subsidies through aquatic birds in a South African hydrological catchment: Project outline and preliminary findings.	Jeff Hean
Ecotones	
Chair: Jeanne Gouws	
The importance of ecotones for the classification of biomonitoring sites: A case study from the Marico River	Hermien Roux

11:40	Imposex in Marine Gastropods from the Atlantic coast of South Africa	N Roos	Links between lateral vegetation zones and flow	Karl Reinecke
12:00	Lysosomal membrane stability in the mussel <i>Mytilus galloprovincialis</i> , as a biomarker of Tributyltin exposure	Reinette Snyman	Habitat Connectivity between Salt Marshes and Terrestrial Vegetation: Indicators of Change	Dimitri Veldkornet
12:20	The risk of eating fish from the Olifants River (Limpopo)	Sean Marr	A method for determining appropriate buffer zones for wetlands, rivers and estuaries	Ian Bredin
12:40	The health status of the African longfin eel, <i>Anguilla mossambica</i> , from three Eastern Cape Impoundments, South Africa.	Kyle Mc Hugh	INR Training Workshop: A method for determining buffer zones for wetlands, rivers and estuaries (WRC Project:K5/2200) Ian Bredin & Doug Macfarlane	
13:00	Lunch			
14:00	Frogs and acid rain – is there a threat in the Kruger National Park?	Wynand Vlok	INR Training Workshop: continued	
14:20	Aquatic ecosystem sensitivity to the effects of sulphur and nitrogen deposition in South Africa	Chris Curtis		
14:40	The hatching success of branchiopod crustaceans from selected South African pans and the impact that Acid Mine Drainage has on this success	Aidan Henri		
15:00	The impact of Acid Mine Drainage from Coal Mining Activities on the riverine invertebrates of the Mpumalanga Highveld: A case study on the Boesmanspruit.	Christa Thirion		
15:20	Tea			
15:40	The challenges of maintaining environmental realism in aquatic nano-ecotoxicology: a bit of the same old or a new science?	Victor Wepener	WRC Workshop: Ecosystems and Global Change	
16:00	Workshop: “How can ecotoxicology contribute to water resources management in South Africa?”			
19:30	Gala dinner			

THURSDAY 4 JULY 2013				
09:00	Optional workshop and fieldtrips			
09:30	Leg 1 Depart From: Die Herberg To: Heuningnes Estuary Transport & Guide: R 120.00 pp	Excluding Refreshments Lunch: R 75.00 pp	Leg 2 Depart From: Die Herberg To: ABI Wetlands Transport & Guide: R 120.00 pp	Excluding Refreshments Lunch: R 75.00 pp
09:30	Leg 3 Depart From: Die Herberg To: Historic Features Agulhas Transport & Guide: R 120.00 pp	Excluding Refreshments Lunch: R 75.00 pp		

Please note: All Field Excursion return to Die Herberg Hotel at 15:00



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KEYNOTE SPEAKERS

Prof Jenny Day

Jenny Day has many years experience in the field of aquatic ecology, and the conservation and management of aquatic ecosystems. The biology of freshwater crustaceans has always been of particular interest and she has developed a database of African freshwater invertebrates, as well as acting as Scientific Editor-in-Chief of a series of nine volumes on their identification. Mostly together with her post-graduate students, over the last few years she has published papers on water quality; the invertebrates of wetlands from the south-western Cape and Lake Kariba; the endangered native fishes of the south-western Cape; the heavy-metal content of fish scales; ecotoxicology of heavy metals and pesticides; tools for assessing the biotic integrity of wetlands; and the phytoplankton of Lake Chivero (Zimbabwe). As well as teaching generations of undergraduate students, she has supervised the dissertations of numerous postgrads and has taught students attending region-wide coursework Masters and other programmes in Tanzania, Botswana, Rwanda and Zimbabwe. To provide local source material for her students she and Brian Davies co-authored *Vanishing Waters*, a textbook on the inland water ecosystems of southern Africa.



Dr Jackie King

Jackie King lives and works in Cape Town, South Africa. She was a researcher at the University of Cape Town for almost four decades, but now owns and runs Water Matters, a water-resource consultancy specialising in river flow management. She is an aquatic ecologist with 38 years' experience of ecological research on the rivers of southern Africa. For the last 25 years she has specialised in developing methods for assessing the water requirements to sustain river ecosystems (Environmental Flows). She led the early development of such methods for South Africa, which resulted in their inclusion in the country's 1998 Water Act, before starting to work internationally in 1997.



She frequently speaks as a keynote or invited speaker at international conferences, and has more than 100 refereed items in books, international journals and conference proceedings. From 1997 to date she has been contracted to lead scientific teams working on environmental flows and river basin management for the Senqu River, Lesotho; the Pungwe River, Zimbabwe; parts of the Zambezi Basin; the Blue Nile, Ethiopia; the lower Mekong River system (Cambodia, Lao PDR, Thailand and Viet Nam); the Pangani Basin, Tanzania; the Okavango River system (Angola, Namibia, Botswana); and the headwaters of the Indus River system in Pakistan. She has also been contracted to do work of a similar nature for World Fish and the World Commission on Dams, and in Taiwan, Costa Rica, USA, Guatemala, Australia, Mozambique, and the UK. She has just completed and published a book, with co-editor Harrison Pienaar, which comprises a major situation assessment of the environmental protection measures in South Africa's 1998 National Water Act. From 2009 to date she is acting as scientific advisor to the Government of Pakistan in a dispute with India over a dam in the Himalayas, and in this respect served as an expert witness at the International Court of Arbitration at The Hague in August 2012. She has recently completed for WWF a plan for setting and implementing Environmental Flows for the complete Zambezi basin.

Her work in South Africa was recognised in the 1990s with a Silver Medal from the Southern African Society of Aquatic Scientists and in 2003 through the government awarding her the national Women in Water award. In 2010 she was appointed as an inaugural member of the National Water Advisory Council to advise the South African Minister of Water Affairs. In 2012 she was appointed Extraordinary Professor at the University of the Western Cape, Cape Town.

She has made a few feeble attempts to retire but has not yet been successful.

Dr Donovan Kotze

The focus of Donovan's PhD and his professional work over the past 12 years has been on wetland ecology and the sustainable use of wetland systems. He has gained experience in working in a great variety of wetlands under many different land-uses, from communal traditional use to intensively used private land. He is especially interested in wetlands within an agricultural context, and collaborates with many different government and non-government organizations. Currently, Donovan is an associate of the Mondi Wetlands Programme and an Honorary Research Fellow with the University of KwaZulu-Natal.



Donovan has a particular interest in promoting the concepts of wise use and conservation through production, notably through using wetland plants for producing wetland crafts. He also has extensive experience in planning and assessing wetland rehabilitation and in the assessment of wetland ecosystem services and integrity for a variety of purposes, including management planning and impact assessment for proposed developments.

Donovan remains actively involved in applied research, which has included the following recent publications:

Kotze D C 2011. The application of a framework for assessing ecological condition and sustainability of use to three wetlands in Malawi. *Wetlands Ecology and Management* 19: 507-520.

Kotze D C, Ellery W N, Macfarlane D M, and Jewitt G P W, 2012. A rapid assessment method for coupling anthropogenic stressors and wetland ecological condition. *Ecological Indicators* 13: 284-293.

Kotze D C, and Traynor C H, 2011. Wetland Plant Species Used for Craft Production in KwaZulu-Natal, South Africa: Ethnobotanical Knowledge and Environmental Sustainability. *Economic Botany* 65: 271-282.

Dr Samantha Adey

The focus of Samantha's PhD and professional work is the role of institutional development in sustainable subsistence agriculture. In particular, homestead gardens; the wise-use of wetlands; and indigenous crop production. Samantha has also recently worked in the water sector with institutional development and stakeholder relations. She has an applied interest in community based natural resource management and the facilitation and implementation of participatory learning and action.

Most recent publications include:

Adey, S. 2012. The Role of Water User Associations in Decentralisation for Adaptive Management: lessons learned from the Breede Water Management Area. International Conference on Freshwater Governance for Sustainable Development, 5-7 November 2012, Champagne Sports Resort, Drakensberg, South Africa.

Adey, S. 2011. Community-Based Approach to Catchment Management. In: Responding to Climate Change; Publication for the Conference of Parties 17, Climate Change Conference, Durban 5-11 November 2011.

Pollard, S. du Toit, D. Cousins, T. Kotze, D. Ridell, E. Davis, C. Adey, S. Chuma, E. and Mkhabela, B. 2010. Sustainability indicators in communal wetlands and their catchments. *WRC Report 1701/1/1*

Dr Chris Dickens

Pr Sci Nat



Chris has a PhD in Botany/Plant Physiology with 25 years of experience in aquatic science, in particular aquatic ecology and the management of water resources. He has published 70 peer reviewed papers and reports and presented papers at over 50 conferences including being an invited panel member at the World Water Forum in The Hague in 2000, a European Commission workshop on Urban Water in Brussels in 2003, the World Water Week in Stockholm in 2006 and 2010, the first CAIWA conference on IWRM held in Switzerland in 2007, the International Environmental Water Allocations conference in 2009 and the IUCN Congress in Korea in 2012. He has also served as a project reviewer for the European Commission on four occasions.

Chris serves as Chief Scientist at the Institute of Natural Resources (INR) based in Pietermaritzburg South Africa. In this role he co-ordinates staff in two programmes, namely Water Resources & Biodiversity and Land Resources & Biodiversity. His particular interests relate to aquatic ecology (rivers, freshwater lakes wetlands), the monitoring and assessment of these ecosystems, and how this relates to management (IWRM, adaptive management). A special interest is in Environmental Flow Assessments (the Ecological Reserve in South Africa). Recently he has been involved in the drafting of Policy and Regulations for the management of downstream river releases in the Lesotho Highlands and also drafted the procedure for the determination of Resource Quality Objectives in terms of the South African Water Act, which was followed up by implementation of the procedure in three water management areas in South Africa. He also designed the Aquatic Ecosystem Monitoring Programmes for ORASECOM and also the Okavango Delta and was the project leader to determine the environmental flow requirements for the Mzimkhulu, Limpopo, Tana (Kenya) and Senqu (Lesotho) Rivers. He has worked extensively on EU funded projects and presently is case study leader for a project on integrated natural resources management across Africa. He has successfully managed several multi-disciplinary and complex projects in countries across Africa.



MONDAY 1 JULY 2013

MEDITERRANEAN ECOSYSTEMS**Setting the scene: aquatic ecosystems of the Cape Mediterranean Region**Jenny Day¹ and Ferdy de Moor²¹ Freshwater Research Centre, Cape Town and Dept of Biological Sciences, University of Cape Town² Albany Museum, Grahamstown

“Mediterranean” regions, including the fynbos biome of the south-western Cape in South Africa, are characterized by winter rainfall and summer drought. The Cape region in South Africa is further characterized by extremely oligotrophic soils. Summer drought and oligotrophy have resulted in characteristic features of the terrestrial vegetation: low growth; small, hard sclerophyllous leaves; adaptations to fire; and the production of phenol-rich secondary plant compounds. These compounds are weak organic acids that impart a dark colour and low pH to natural waters into which they leach. The waters of much of the fynbos are therefore dark in colour, acidic, very pure, and low in N and P. Despite the apparent harshness of such waters, they support a diverse, well adapted and highly endemic fauna. The various elements of the fauna originated in the area long before the onset of mediterranean conditions. The mountains of the region are ancient (ca 500 My) and geologically stable (some river valleys can be traced back for at least 80My) As a result, many members of the aquatic fauna have very long evolutionary histories in situ and must be of Gondwanan origin. Isolation of individual clades has resulted in remarkable genetic diversity even within morphologically indistinguishable taxa; some are narrowly endemic, even to within single river tributaries. Too little is known about the biology of most taxa to make informed statements about common biological traits but individuals do tend to be small, life cycles tend to be less than a year long, and diapause or dormancy is common in the eggs.

Spatial character of undisturbed fynbos riparian vegetation longitudinally down a Western Cape River EcosystemMia Otto¹, Shayne M Jacobs ², Cate A Brown¹, Karl M Reinecke¹¹ Southern Waters Ecological Research and Consulting cc, PO Box 12414, Mill Street, 8010, Cape Town, South Africa, mia@southernwaters.co.za, cate@southernwaters.co.za² Department of Conservation Ecology and Entomology, Faculty of AgriSciences, University of Stellenbosch, Private Bag X1, Matieland, 7602, Stellenbosch, South Africa, sjacobs@sun.ac.za

Longitudinal studies of riverine ecosystems in the past have been more focused on instream biota and this study aimed to describe the lateral riparian zonation differences down the length of a Western Cape river ecosystem. Rivers are complex and multi-dimensional systems across which interactions and exchange occur in three physical dimensions; longitudinal, lateral and vertical. Lateral zonation was identified by using an objective Primer 6, Cluster and MDS ordination, approach which enabled community comparisons between sites in the longitudinal dimension. The scale at which these comparisons were made was based on the geomorphological classification system for South African rivers. Riparian vegetation responded at a longitudinal zone scale and not at a finer, unit scale. Different longitudinal zones, mountain stream, transitional and upper foothills, had different abundances of species present in different lateral riparian zones. Physical habitat characteristics were used to quantify the relationship between riparian vegetation and longitudinal change. Elevation and horizontal distance from the active channel was found to be the most important environmental

variables. Different substrate compositions contributed to the lateral zonation pattern but did not have the same significance that the combination of elevation and horizontal distance had. The biodiversity of the mountain stream sites were higher than that of the upper foothills sites even though the riparian zone in the mountain stream was much more constricted than that of the upper foothills. The transitional longitudinal zone varied in width and had the highest species diversity of all longitudinal zones. The wetbank in the mountain stream sites contained species usually considered part of the drybank (adult *Brabejum stellatifolium*) this may be due to the spatial constraints in the upper reaches. Lateral zonation differences in the longitudinal dimension emphasize the use of objective analyses for the identification and assessment of riparian vegetation communities. In terms of ecological research and management practices the longitudinal dimension is therefore an important aspect of consideration.

What drives periphyton communities in South Western Cape Rivers? A shift from “Top Down” to “Bottom Up” control

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This paper examines patterns in periphyton community composition and biomass and the environmental factors responsible for shaping these communities in south-western Cape open-canopied rivers which fall within a Mediterranean Climate. The study focused on the Berg and Molenaars Rivers and temporal dynamics in periphyton communities were measured over a 21-month period between September 2007 and May 2009. Under natural flow conditions, periphyton communities follow a cycle of peak biomass towards the end of the growing season in late summer/early autumn, and minimum biomass during mid-winter with a small peak during late winter/early spring. Winter and early spring communities were dominated by diatoms, whereas the peak in late summer/early autumn 2008 was dominated by green filamentous taxa and cyanobacteria. Based on distance based linear modelling, it is evident that flood frequency is the single most important ‘top-down’ driver of periphyton communities in rivers of the south western Cape. However, ‘bottom-up’ factors, particularly nutrient availability enhance growth and accrual of the periphyton mat during the late spring and summer months when floods are rare or absent. There is some evidence to suggest that grazers maintain a low steady-state in periphyton biomass over the late spring and first few months of summer when it was expected that resources would be favourable for rapid algal growth. This study therefore suggests a shift from top-down abiotic control of periphyton communities over the wet season, to bottom-up control during the dry season. During the late spring and early summer, bottom-up control of periphyton may work antagonistically with the top down biotic control imposed by grazing pressure. This research contributes to our understanding of the factors which drive Mediterranean river ecosystems. Finally, these findings have implications for the management of South African rivers impacted by flow and nutrient alterations.

Impact of non-native rainbow trout on headwater stream communities in the Cape Floristic Region, South Africa

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Rainbow trout (*Oncorhynchus mykiss*) is one of the most widely introduced fish on the planet, and has had negative ecological impacts in many parts of the world. It was introduced to the Cape Floristic Region (CFR) of South Africa in the late 1890s and established self-sustaining populations in many

headwater streams. Little is known about its effect on native stream communities, but this information is needed for managing freshwater biodiversity. We surveyed stream habitat, fish, invertebrates and algae in 24 headwater streams (12 containing trout and 12 without trout), and conducted two field experiments to investigate impacts of rainbow trout on native stream communities in the CFR. Native fish were abundant in streams without trout, but were rare or absent in streams with them, suggesting that trout largely displace native fish in these streams. In a predation experiment conducted in stream mesocosms, large trout consumed small native fish, indicating that they may reduce native fish populations by size-selective predation. Herbivorous invertebrates were more abundant and algal biomass lower in streams with trout than in streams without them. This suggests that trout consume fewer herbivorous invertebrates than native fish do, reducing grazing pressure on algae. Results from an in-stream cage experiment comparing the relative effects of trout and native fish on lower trophic levels, were consistent with the invertebrate results from the surveys, but not with the algal results. Collectively, our data indicate that in the study area, trout displace native fish, with cascading effects on organisms at lower trophic levels.

Adaptive responses of Cape Floristic Region endemic freshwater fish species to hydrological, temperature and geomorphological regimes: the mediterranean context

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The rivers of the Cape Floristic Region (CFR) share features common to other Mediterranean rivers including hot-dry summers, cool-wet winters and seasonal predictability combined with high inter-annual variability. Other shared features include elevated topographies, short source-to-sea distances, constrained river channels and narrow floodplains. The freshwater fish fauna of the CFR is distinguished by its low species diversity, high levels of endemism and marked susceptibility to biological invasion. Based on evidence from the literature and a two-year life history study of an endemic Western Cape cyprinid, a model of a typical CFR river is proposed where the hydrological year is divided into three periods deemed important for the successful completion of fish life cycles: (1) Spawning and Migration, (2) Growth and Development and (3) Over-wintering. For each period, the relative importance of a range of aquatic habitat categories, together with considerations of connectivity, productivity, food availability and refugia are discussed. The spatial dynamics of CFR fish populations is considered in terms of the Dynamic Landscape model of river fish ecology and the concept of the 'Riverscape'. The Low Flow Recruitment Hypothesis is presented as an alternative to the Flood Pulse Concept for explaining flow-recruitment processes among local fish species. These concepts are discussed in terms of their importance for the selection and management of aquatic protected areas and for the provision of Ecological Water Requirements. Future research directions are recommended.

Ecological status assessment in mediterranean rivers: complexities and challenges in developing tools for assessing ecological status and defining reference conditions

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Rivers in mediterranean regions are subject to hydrological extremes. They range from highly stable, perennial ground- or snow-fed systems to highly ephemeral, unpredictable ones in semi-arid environments. This paper reviews bioassessment tools developed in the five mediterranean regions namely in the Mediterranean Basin, United States (California), Chile (central), South Africa (south-western Cape), and Australia (the south-western and south). It identifies key factors contributing to the spatial and temporal complexity inherent in these systems and which present challenges for

ecological status assessment and defining reference conditions, particularly as many areas have been extensively transformed through anthropogenic activities.

Temporal variability driven by sequential and predictable, seasonal events of flooding and drying accentuates the need to take season and/or hydrological period into account. Intermittent streams, which are common in mediterranean regions and which have aquatic communities distinct from perennial streams, are often not incorporated in bioassessment and present distinct challenges. Med-regions are also known for their high biodiversity and rates of endemism, as well as large numbers of introduced species. Med-regions are expected to be among the most affected by global climate change and, in these systems, climate change is an additional driver influencing ecosystems that are already stressed.

It is evident that an understanding of responses of indices, metrics, and models to climate change in comparison to existing stresses, and the development of thermally specific bioassessment tools are needed for this region. Directed research and the establishment of long term monitoring sites is considered critical for this region given the existing anthropogenic impacts and predicted global climate change.

BEYOND BORDERS

Pushing geographical and technical boundaries: our evolution as aquatic scientists

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Three decades ago most South African aquatic scientists worked within their own local area, with others of the same or similar disciplines, largely pursuing pure research topics. Today many, possibly the majority, may be seen as applied scientists, applying their science across the country, the continent and even the world in real management situations. They work with specialists from a range of biophysical, chemical, engineering, social and economic disciplines, learning new perspectives and finding new ways to communicate. They are at the centre of Integrated Water Resource Management (IWRM), helping to define what that means and offering practical advice designed to support more informed and balanced decision making and management of inland water ecosystems.

This paper traces key shifts that I have noticed taking place in our science, with examples:

- 1) the growing discourse with water engineers and water managers;
- 2) the emergence of large multidisciplinary teams;
- 3) the move to international advisory work on transboundary rivers;
- 4) IWRM and the challenges of working with political decision makers; and 5) the entry into law courts and transboundary conflict resolution.

The response of stationary trawl (DAI) fishery yields in the Tonle Sap-Great Lake System of the Mekong River, Cambodia to inter-annual variations in the flood pulse

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The Tonle Sap-Great Lake (TS-GL) system in Cambodia, is the most distinctive hydrogeomorphic feature in the Mekong River Basin. The Great Lake is the largest wetland system in southeast Asia and supports one of the most productive inland fisheries in the world. Flow regulation by hydropower dams being proposed for construction upstream of the TS-GL in Laos and Cambodia is likely to contribute to declines in fish production. In this study, 12 years of catch survey data from stationary trawl boats (*dais*) located on the Tonle Sap River were used to investigate the effects of the annual flood pulse on fish production in the system. An annual Flood Index was developed that takes account of flood duration, magnitude and percentage inundation in the Great Lake. A general linear model was employed to test the ability of the Flood Index to explain seasonal variations in *dai* catch rates with month, lunar phase and *dai* location included as additional categorical explanatory variables. Correlations between the Flood Index and daily catch rates were positive and highly significant with the model explaining up to 66 % of the variation in *Dai* catches. The predictions emerging from the model suggest that reduced flooding will result in a proportional non-linear decline in fish yield with a reduction in the Flood Index. The findings therefore provide strong evidence to suggest that reduced flows downstream of impoundments will negatively impact fisheries in the TS-GL system.

Floodplain fisheries of Liuwa Plain National Park, Western Province, Zambia

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Liuwa Plain National Park lies between the Luanginga and Luambimba rivers on the west bank of the Upper Zambezi River in Western Province, Zambia. Originally declared a royal hunting ground and game reserve by the Litunga (Lozi King) in the 19th century, it was proclaimed a national park in 1972. The park and its surrounding areas support a large human population (26 500) with rights to utilise much of the park's resources, including fish.

The most important component of the park's fishery targets *Clarias gariepinus* in some 300 pans within the park. The r-selected nature of *C. gariepinus* and the unpredictable hydrology of the pans mean that this fishery can withstand near-depletion every year. Other park fisheries primarily target cichlids in the Luanginga and Luambimba rivers, although the habitats, fishing methods and species caught differ markedly between the two rivers. *Tilapia sparrmanii* and other small cichlids are sustainably harvested using small meshed (2–3") gillnets in swamps bordering the Luanginga River. Destructive fishing methods used in the Luambimba River have resulted in the collapse of large cichlid (*Oreochromis* spp.) stocks. The results are discussed with reference to fisheries management interventions.

Development of a biomonitoring protocol and its application in a preliminary assessment of the ecological status of Zambian rivers

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Pressure on water resources in Zambia is likely to increase in future decades as a result of exceptionally high predicted population growth. To underpin sustainable water management, an international group of scientists and practitioners has been involved in the development of protocols to assess the ecological status of Zambian rivers. This paper describes the development of the protocols and their application to provide the first extensive assessment of the ecological status of rivers in the country.

The protocols were designed to be simple, and hence rapid, easy and relatively inexpensive to apply. Status scores are derived for individual sites using sensitivity weightings from 3 major groups (macrophytes, diatoms and macroinvertebrates). The general approach was based on schemes used successfully elsewhere, with species and family sensitivity weightings modified so as to be appropriate to Zambia. Modifications were based on a survey of 140 Zambian rivers, incorporating data on species distributions, physical habitat conditions and water quality.

Survey data indicate that most of the spatial variation in biological assemblages across the country reflects major hydroclimatological gradients and hydrochemical differences linked to geology. Site status scores suggest that rivers are generally in good health; exceptions occur in some large urban areas and a small number of catchments with major industrial activity. Data form an important baseline against which to assess future changes related to population growth and climate change.

Zooplankton composition and succession in the Okavango Delta and its associated basins

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As secondary producers, zooplankton play a crucial role in any aquatic ecosystem. Therefore, in order to understand these ecosystems it is of vital importance to have sound knowledge of zooplankton succession. Many of the freshwater systems in Botswana are ephemeral. Observations so far indicate that ephemeral systems, when inundated, rapidly stabilise and become highly productive and, therefore, warrants the reference as instant ecosystems. The ephemeral water bodies associated with the Okavango Delta, being dry for 20 to 40 years and now being inundated again, provides the perfect opportunity to study the succession of zooplankton species, from the first inundation, until the ecosystem is stabilised. Against this background, the following are the primary aims and objectives of the study (amongst others): to identify all zooplankton species, geographically map the species collected, determine the succession of zooplankton and to add new information to existing keys for identification. Other aims include the monitoring of water quality to determine the limiting environmental factors for different groups of zooplankton. Various habitats in the Okavango Delta and its associated basins were sampled using plankton nets of different mesh sizes since 2006. A wide variety of Cladocera species were recorded, including the very rare *Iliocryptus sordidus*. Among the Copepoda, a possible new species of the genus *Metadiaptomus* was collected. The Okavango Delta, Lake Ngami and the Boteti River are freshwater systems, while the more eastern systems are saline, hence playing a role in the distribution of species.

WETLAND ECOLOGY

Can the ecosystem services of the Papenkuils social-ecological system be sustained?

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A multi-disciplinary, integrative framework was used to better understand the overall social-ecological system of the Papenkuils wetland, Western Cape. It was used to address the question of how to sustain the ecosystem services supplied by the wetland; through examining the interactions between the wetland, the users of the wetland, the public infrastructure providers, and the public infrastructure. A number of users, including commercial wine farmers, cattle owners, downstream water users and waterblommetjie harvesters benefit from the services of the wetland. The conflicts between the different uses are generally low, except for the conversion of wetland area to vineyard and, to some extent, where the wetland is very frequently burnt and intensively grazed.

Public infrastructure includes several statutes that govern the use of water and land, as well as incentive-based mechanisms promoting the stewardship of areas valuable for biodiversity. A number of public service providers with overlapping mandates (e.g. CapeNature, Department of Agriculture and the Breede Overberg Catchment Management Agency) are responsible for administering the public infrastructure. The Mondi Wetlands Programme is currently working with several of these organizations to promote better informed management of the Papenkuils wetland and other wetlands in the Upper Breede catchment. These organizations are connected with each other and the users through several formal and informal relationships (e.g. between the waterblommetjie [*Aponogeton distachyos*] harvesters and the landowners; and the service providers and the landowners). Resilience of the social-ecological system and the well-being of its users ultimately depend on the trust underpinning these relationships.

Variation in physico-chemical characteristics of pans in the North West, Free State and MpumalangaW Malherbe¹, M Ferreira², and JHJ van Vuren¹¹ Department of Zoology, University of Johannesburg, PO 524, Auckland Park, 2006² Jeffares and Green Pty Ltd, 37 Sunninghill Office Park, Peltier Drive, Sunninghill, Johannesburg, 2191, South Africa

Pans occur in a band across South Africa from the western Free State, through North West, Gauteng and Mpumalanga. Limited studies have been completed on pans in recent times and with the increasing mining pressure on these systems, increased knowledge on the water quality of these systems are necessary. The knowledge is needed to help in the protection of these systems and to ensure pollution due to anthropogenic activities is minimized. Water samples were collected from pans in the North West, Free State and Mpumalanga provinces during three sampling periods from May 2012 to April 2013. As far as possible, only pans without any impacts were selected for inclusion. Water samples were analysed at a SANAS accredited laboratory for nutrients, anions, cations and metal concentrations. In situ water quality variables were also taken at each pan. The sampling period was especially dry in the North West and Free State provinces and as such many pans did not have water for every sampling visit. However, each sampled pan in Mpumalanga contained water throughout the sampling period. The physico-chemical characteristic results indicated that the dominant ions in the water were chlorides and sodium. Multivariate statistical analysis indicated that certain pans from North West have similar water quality than pans in Mpumalanga while others were

found to be different. Seasonal differences in the physico-chemical characteristics within a pan were also evident in pans in Mpumalanga. Water quality results will possibly be used to classify pans based on their trophic state.

The development of a framework for wetland assessment and a decision support matrix for the assessment of wetland condition in South Africa

Mr Dean Ollis, Dr Heather Malan, Dr Justine Ewart-Smith, Ms Nancy Job and Prof Jenny Day

The Water Research Commission (WRC) of South Africa initiated a project, on behalf of the national Department of Water Affairs, to develop a “Decision Support Tree” to aid in the selection of the most appropriate method/s for the assessment of wetland condition. A team of researchers and consultants started work on the project in July 2012. To date, a review of available methods for the assessment of wetland condition in South Africa has been completed, and a draft Decision Support Matrix (DSM) has been compiled to aid in the selection of appropriate methods for the rapid assessment of wetland condition, together with a draft Framework for Wetland Assessment (FWA) to contextualises the assessment of wetland condition. The draft DSM and FWA are currently being peer-reviewed, tested and refined, with the aim being to finalise these tools by the end of the year. A User Manual will be produced to explain how to use the tools that are developed. The draft tools that have been developed will be presented, and delegates will be provided with an opportunity to give input and suggestions for the further development and refinement of the tools.

Identification and delineation of wetlands in the Nelson Mandela Bay (NMB) area: a local refinement of a national initiative

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Within the last decade wetland research has gained considerable interest, much of it centred on methods toward better management and conservation. One important method recently developed is the National Wetland Classification System (NWCS) initiated by SANBI, who has been working on delineation and classification of wetlands on a national level. In order to assist with this national initiative we are working applying the NWCS and delineating wetlands in the Nelson Mandela Bay Metro area (NMB). Wetlands within the NMB were digitised using aerial photos obtained from the Municipality including existing shape files of the national SANBI wetlands database, rivers and two-metre contours that were overlaid onto the map as guidelines for identifying wetlands. Information from the digitised attribute data produced data tables used to determine the types and number of each type of wetland based on available information. A desktop delineation and preliminary classification survey of NMB wetlands has revealed a greater number of wetlands (excluding rivers, estuaries and floodplains with direct connectivity to a river or estuary) than expected given previous information gathered from a national initiative. Our results also demonstrate a greater range of types of wetlands widely spread throughout the metro, whereas the previous available data was skewed toward permanent and artificial wetlands. From this data it is clear that there is a need for finer scale, local application of the NWCS to be fed back to the national system in order to better assess, manage and conserve wetlands in South Africa.

Role of landscape positioning in the distribution, structure and function of temporary wetlands in Nelson Mandela Bay Metropolitan (NMBM)

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To date, there has been no systematic approach to research on small temporary wetland systems in NMBM. Wetlands form a critical component of a region's water resources, found at the interface between aquatic and terrestrial environments. Recently (Ramsar 2010), it was noted that South Africa still lags behind on fundamental information and baseline knowledge on wetlands. The need for this knowledge was further highlighted by the diversity of the wetland systems that exist in different regions in South Africa. NMBM is no different, with a wide range of rainfall, geological, geomorphological and vegetation types within a relatively small area (1951 km²). A desktop analysis has shown that there are approximately 1600 wetlands in NMBM, primarily comprised of ephemeral natural systems dominated by seeps, depressions and flats. A wide range of wetland vegetation community types have been observed within the different wetland types, with associated differences in surface and groundwater physico-chemical properties, including nutrient availability and soil characteristics. Field data indicate that larger landscape elements (e.g. climate, underlying geology and regional hydrology), combined with the position of a wetland within a landscape, have had a greater influence on the associated abiotic (soil and wetland hydrological regime) and biotic (vegetation communities) variables than more localised processes around temporary wetland systems in the NMBM area. Understanding the spatial scale at which the landscape processes are influencing wetland distribution patterns, structure and function will aid in determining the resolution at which management (conservation and rehabilitation) of these systems needs to occur.

Macroinvertebrates as unreliable indicators of human disturbance in temporary depression wetlands of the South-Western Cape, South Africa

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Macroinvertebrates have a successful history of use as indicators of human impact in lotic environments. More recently, macroinvertebrate indices have been recommended for use in certain wetland types. Yet some authors do not recommend macroinvertebrates indices of wetland condition in areas with pronounced natural environmental heterogeneity. Our study provides a preliminary assessment of the feasibility of using macroinvertebrates for bioassessment of temporary isolated depression wetlands in the south-western Cape region of South Africa. We expected natural environmental heterogeneity among wetlands to exert a stronger influence on macroinvertebrates than human disturbance factors. Partitioning of the variation in macroinvertebrate assemblage composition that could be attributed to human disturbance factors (within and adjacent to wetlands), environmental variables and spatio-temporal factors indicated that environmental and spatio-temporal factors independent of human disturbances largely determined assemblage composition, whilst human disturbance played a relatively minor role. Linear regressions of taxon richness/diversity measures, individual families and a collation of metrics against measures of habitat transformation around wetlands and scores from a rapid-assessment index of human disturbance revealed poor relationships. The univariate and multivariate patterns observed in this study do not lend themselves to the creation of a macroinvertebrate index of human disturbance for temporary wetlands in the region.

MPA BIODIVERSITY

Depth related changes in the benthic invertebrate community of warm-temperate reefs in the Tsitsikamma Marine Protected Area

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Very little is known about subtidal benthic invertebrate species composition on warm-temperate rocky reefs in South Africa, and most of the available knowledge is based on research conducted within safe SCUBA diving depths (<30m). To date, the deeper photic rocky reef ecosystems (40 - 80m) have received almost no attention, even though they host a unique community of benthic invertebrates which provide habitat that supports commercially important fish species. To overcome this lack of information, the benthic invertebrate community composition of the deep photic warm-temperate reefs in the Tsitsikamma Marine Protected Area were investigated and compared to shallower reefs. Photo-quadrates on shallow reefs were collected by SCUBA divers, while deeper reef photo-quadrates were obtained by employing a remotely operated vehicle. Percentage cover of invertebrates was estimated by random point counts. Shallow reefs were dominated by low-growing algae and encrusting ascidian species and deep reefs by sponges and the noble coral *Stylaster nobilis*. Compared to the dominant invertebrates on shallow reefs, the dominant invertebrates on deeper reefs demonstrated upright fan-like growth forms. Almost half of the surface of deep reefs was covered with settled particles compared to <1% of shallow reef surfaces. This may be attributed to the high energy environment of shallow reef habitats resulting in less siltation, while frequent perturbations favour the establishment of smaller lower growing species. More stable conditions in the deep facilitate high levels of siltation, resulting in clogging of encrusting species, while the reduced frequency and intensity of disturbances may allow for upright growth forms that promote filter and suspension feeding.

Prosobranchia and Protozoans

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During parasitological surveys of the intertidal zone along the South African coastline, ciliophorans were found on a variety of gastropod hosts. This presentation deals with the Sessilida and lcnophorids found on the snails and the phenomena of hypersymbionts. Our coastline is known for its endemic limpet fauna (genera *Cymbula*, *Scutellastra*, *Helcion*), five *Haliotis* species (including the endangered *H. midae*) and the turban and topshell (*Turbo* and *Oxystele*) fauna. Field-work was carried out along the coastline, snails were collected and maintained live in a field laboratory until examination. Snails were dissected, wet smears of the gill tissue were prepared, live observations as well infestation levels were recorded. Infested gill sections were fixed for SEM and other investigation in the laboratory in Bloemfontein. Five *Mantoscyphidia* and two *Lcnophora* species were described: all the limpets were host to *M. branchi* and the *Oxystele* species were infested with *M. fanthami*. Two species, i.e. *M. spadicea* and *M. midae* were found on the *Haliotis* species. *Lcnophora limpetae* was found on the limpets, *L. bassoni* was found on the *Turbo* species and *L. rosa* was found on *O. sinensis*. The phenomena of hypersymbiosis was observed as *Endoshaera* was found in *M. branchi* and *Ellobiophrya maliculiformis* was found attached around the scopula of *M. branchi* and *M. midae*. These symbionts were found in high numbers, with an almost 100% infestation. No pathology to the hosts could be found and we hypothesise that the symbionts can extend the surface area of the gills. Due to their abundance and own ciliary activities they can play an important role in ventilating the gills and is therefore essential for the survival of these snails.

A microscopic web of intertidal Peritrich Ciliates

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Peritrich ciliophorans consist of two groups, i.e. the sessilines and the mobilines. These symbionts are very widespread in the aquatic, but also in terrestrial environments associated with a wide diversity of hosts, ranging from sponges, coelenterates, flatworms, molluscs, echinoderms, sea squirts, amphibians and fish. This presentation will deal specifically with peritrichs we collected during parasitological surveys along the South African coastline. These peritrichs were found associated with molluscs and fishes in intertidal pools along the South African coast. Various chitons (*Acanthochiton*, *Ishnociton*, *Chiton*), abalone (*Haliotis*), limpet species (*Cymbula*, *Scutellastra*, *Helcion*), turban (*Turbo*), topshells (*Oxystele*), red bait (*Pyura*), as well as a variety of fish species were investigated and found to harbour various species of sessilines (*Mantoscypidia*, *Riboscypidia*, *Ellobiophrya*) and mobilines (*Urceolaria*, *Leiotrocha*, *Trichodina*). When studying these various hosts in the intertidal pools, two different patterns emerged along our coast. In pristine, unpolluted habitats fish hosts showed typical overdispersion patterns in their symbionts, while the symbionts on invertebrate hosts were evenly distributed. When one, however, looked at conditions where persistent low-level pollution was present, the patterns switched around. The change in symbiont association in the two different scenarios speaks to the evolutionary time that these ciliophorans have had with their hosts. Furthermore it leads to the hypothesis that ciliophorans are vital role players in a healthy, unpolluted intertidal environment, and that this intricate web of ciliophorans may be disrupted by adverse environmental conditions, such as pollution with potentially dire consequences for their hosts.

Intertidal symbiont project at De Hoop Nature Reserve

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The Department of Zoology & Entomology of the University of Free State has been involved in studying intertidal symbionts at the De Hoop Nature Reserve since 1995. The main purpose of our annual visits to the park is practical work for our Zoology third year Ecology class. These students do projects on biodiversity and aspects of intertidal ecology as part of their Freshwater and Marine Ecology course. Our research group's main field of study is symbionts and parasites of freshwater fish, but with the wonderful opportunities at the De Hoop coast we soon realised that we could extend our research to also include the symbionts of intertidal invertebrates and fish. It turned out that the symbionts of many species of marine invertebrates belong to the same taxonomic groups as those that we find associated with fresh water hosts, but includes very different and distinct species. In this presentation I will present an overview of the findings. Our association with the De Hoop Reserve resulted in the completion of ten Honours projects, six Masters dissertations and four Doctoral theses. The topics investigated ranged from mobile peritrichs from limpets, winkles and red bait; sessile peritrichs from limpets, winkles, abalone and tidal pool fishes; Myxosporea from fish; trematode metacercaria infections from estuarine fishes; trematode symbionts of limpets; caligid copepods from tidal pool fishes; copepods and amphipods from red bait; copepod parasites from blue coral worms; tongue replacement isopods as well as scanning electron microscope studies of the radula's of different molluscs. Apart from the dissertations and theses the results were presented at eight international and 39 national conference as well as 26 international scientific papers.

TUESDAY 2 JULY 2013

MANAGEMENT AND MONITORING**From research to practice in adaptive water resource management**

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This paper will consider the value of international participation in science and scientific research for South African scientists and water resource managers. By way of an example, the paper will describe how involvement in an international water resource management question has brought a new personal perspective to water resources management in SA. This case study highlights what is as yet unappreciated paradigm shift in water resources management - the move to Adaptive Management principles. While widely acknowledged as a necessity and even being adopted by management agencies, the true principles of adaptive management are seldom adhered to.

Personal involvement in several projects has enabled the principles of adaptive management to be incorporated into new ways of doing things. From the development of guidelines for wetland management, to methods of river monitoring and the setting of quality objectives, and most recently the determination of environmental flow requirements, the move towards true adaptive management will enable a management regime that will be more in tune with social needs and thus more likely to be effective.

Regional scale risk assessment methodologies incorporating Bayesian Networks in the management of water resources in South Africa

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The recently established regional scale risk assessment approach for South Africa is being applied to address a range of South African water resource management issues. The approach is being used to evaluate numerous threats associated with multiple sources and stressors to numerous socio-economic and ecological endpoints. Bayesian networks (BN) are graphical models that use conditional probability distributions to describe cause and effect relationships between defined driver and responder ecosystem variables. In regional scale risk assessments, BNs can be effectively used to represent uncertainty in understanding ecosystem response variability, and the influence of uncertainty and variability associated with adaptive management in natural resource management. In this paper we describe the nature and capabilities of the regional scale risk assessment approach incorporating BNs and discuss its applications to water resources management in South Africa. Finally we demonstrate its use in a case example risk assessment of threats associated with numerous sources to a range of endpoints established by stakeholders in the Klip River, Gauteng.

Water availability and use under uncertain future climate and development scenarios in the Amatole system

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Estimating uncertainty under future climate and socio-economic development is essential for sustainability of water resources. The Water Evaluation and Planning model (WEAP; a system level model) was calibrated for present conditions of water availability and use, with supply exceeding demand, for the Amatole System, Eastern Cape. This was followed by model runs for the near future (2046–2065) using development scenarios alone, climate change alone, and combined development and climate scenarios. Under three development scenarios (lower, intermediate and upper), the human and industrial demands will not be met under the intermediate and upper scenarios, if the water infrastructure is not extended. Next, using nine downscaled Global Climate Models (SRES A2 emission scenario) the WEAP model showed increased flows that translate into no demand deficit if water demands do not change. Finally, under the combined development and climate change scenarios, the present water infrastructure is not sufficient to meet water demands under the intermediate and upper development scenarios, even with increased flows under climate change. The reconciliation strategy options of increases in water treatment capacity and interbasin transfers should provide sufficient water to meet the intermediate development demands; however, water deficits are expected under the upper development scenario. The estimated future water deficits are conservative since environmental flows have not been included in the WEAP model. The main recommendation is that sustainable system management will greatly rely on continued (and additional) monitoring of the system to assess which future scenarios (climate and development) come into play and how the system responds.

Water quality implications of uncertain future climate and development in the Amatole System, Eastern Cape, South Africa

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Development within the Amatole System is currently limited by poor water quality with impacts including salinisation and eutrophication. Future development and climate change within this region may have dramatic effects on water quality, with quantification of these effects subject to high levels of uncertainty. An estimate of this water quality uncertainty is required to facilitate sustainable development and management of water resources in this region. The Water Evaluation and Planning Model (WEAP) calibrated against historical data for water availability and use, was further calibrated against historical water quality data for salinity (electrical conductivity) and nutrients (nitrates + nitrites and phosphates). An intermediate development scenario, combined with nine downscaled Global Climate Models (SRES A2 emission scenario) for the near future (2046–2065) was investigated, with the upper and lower bounds of uncertainty indicated by the range of values obtained by the climate model predictions. Salinity simulations showed considerable seasonal uncertainty due to lower winter flows and generally, marginally lower salinities due to slightly greater dilution. Planned regionalisation of the waste water treatment works in the middle Amatole indicate that nutrient concentrations will increase dramatically within the middle Buffalo River between King William's Town and Laing Dam, while concentrations will decrease dramatically within the Yellowwoods River. Climate change effects indicated considerable seasonal uncertainty for nutrients. This research highlighted some important shortcomings within the WEAP model when modelling water quality. Consistent with the recommendations for water use and availability, continued monitoring of the system is required to facilitate adaptive management.

Case Study – Lourens River Flood Alleviation Project: the “Softer Solution”

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In the City of Cape Town (COCT), watercourses are integral to the stormwater management system, are an important component of the City’s biodiversity network, and represent an essential element in restoring the urban fabric of the City by providing recreational, environmental and economic opportunities.

It is the City’s responsibility to reduce the impact of flooding on community livelihoods and regional economies, and protect natural aquatic environments.

This has resulted in the implementation of multi-disciplinary projects to alleviate flood impacts on surrounding communities, while limiting the impact on, and enhancing the natural and biophysical environment.

One such case study is the Lourens River Flood Alleviation Project, being implemented on the Lourens River, Somerset West. The Lourens River is a declared Protected Natural Environment in terms of the Environmental Conservation Act, Act 73 of 1989. The primary objective of the project was to increase the flow capacity of the Lourens River, while minimising the impact of the river on the urban fabric it flows through, in flood season. Engineering solutions such as concrete channeling, deepening of river beds, or straightening of the natural river meander, were not appropriate as these would not restore and maintain the river’s ecological integrity.

This paper focuses on how the City ensured the river’s diversity and natural state were retained and restored, the multidisciplinary approach to planning such a project, the integration of the surrounding communities in the planning and implementation of the project, and how the impacts of the project on the aquatic environment were assessed using bio monitoring to determine if the “softer solution” has improved the ecological function of the river.

This case study is an award winning project illustrating how the City of Cape Town is working towards better, more sustainable solutions rather than hard engineering.

Development of Water Quality Index for Cape Town’s aquatic ecosystems

Candice Haskins, Development of a Water Quality Index for Cape Town’s aquatic ecosystems
(Catchment, Stormwater and River Management – City of Cape Town)

The City of Cape Town has an extensive monthly water quality monitoring programme which includes some 100 locations on a range of river, wetland and estuarine ecosystems. Several chemical, physical and microbiological constituents are measured in these systems and the resulting information is used variously to inform managers, politicians, environmental interest groups and public about the condition of these systems. However the quantity and complexity of the data is often not conducive to easy dissemination to this diverse audience. The City therefore appointed specialists to assist with the task of producing simplified water quality information. An environmental index (E-WQI) was developed using a selection of variables, each having been selected due to its influence on the ecological health of aquatic ecosystems. Water quality data for a particular site and date is processed within the index which evaluates each of the applicable variables against a series of ecological thresholds specifically relevant to Cape Town’s aquatic ecosystems. The variable thresholds reflect concentration ranges which are related to Categories A through to F, corresponding respectively to natural conditions

through to extreme changes from natural condition. The overall E-WQI Category for a site is essentially a reflection of the “worst” score assigned to a variable. Spider diagrams can be used to illustrate the variable results on a unitless scale and provide insight regarding which variable is more problematic and therefore responsible to the assignment of the overall E-WQI Category.

Reporting and monitoring of enforcement activities on urban river reaches

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“There appears to be reluctance among environmental authorities to give compliance advice to the regulated community for fear of being held liable for inappropriate advice” (Craigie *et al.*, 2009). Further, enforcement reporting is only quantitative (DEA, 2012) i.e. number of cases reviewed and not qualitative i.e. what is the measured improvement of environmental enforcement. Both of these issues occur because enforcement officials don’t have the capability, time or budget to run detailed Ecostatus assessments on every site inspection. This paper presents a set of tools developed under the WRC project ‘*Procedures to determine enforcement activities on urban river reaches K5/2036*, to aid compliance and enforcement officials in determining the impacts of contravening activities, thereby being more informed when identifying what functions/impacts the specialist studies and rehabilitation plans need to address, as well as for the monitoring of the effects of these directed rehabilitation measures on the site.

The tools include: Legislation Search Tool – a database of environmental legislation related to rivers. The database can be searched against a specific section of legislation or using a search word. The database identifies other sections of legislation that may be relevant or overlap.

Rapid Site Assessment – an interactive form that the enforcement officials complete when conducting their site assessments. The completed form provides a comparable record of the state of the site on the days of inspection.

Decision Support Tool – based on the completed Site Assessment form, the selected answers are linked to indicators of basic riverine function. The DST automatically calculates the impact of the contravening activity on the riverine environment. Based on this, the official can then better inform the perpetrator as to what ecosystem functions the specialist studies and rehabilitation plan need to address.

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Does science add value to water management processes?

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The Department of Water Affairs gazetted the “seven step” methodology for classification in 2010, and there were comprehensive guidelines published on the process to classify rivers in South Africa. Since then, the classification process has been completed for 3 water management areas, and the classes will be gazetted as soon as the determination of Resource Quality Objectives (RQOs) for each water

management area is finalised. During these processes, the data available from the Department's national monitoring programmes, completed reserve studies and other scientific tools have been used extensively to contribute to and improve the confidence of the final results. This presentation will critically evaluate the value of scientific methods and tools as well as monitoring data during the classification process. In addition, it will highlight the importance of relative "simple science" in management processes, as well as the contribution more complex scientific tools and even expert knowledge are making. Lastly, the lessons learnt and early gaps identified, will be briefly discussed.

Stakeholder mapping and the identification of benefits and services derived from Wilderness and Swartvlei lake systems

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Scientific assessment indicates that human activities now threaten many geophysical and ecological processes at global as well as local scales. It is therefore important to understand the interdependence between people and the myriad of 'free' benefits and services derived from these ecosystems. This research focuses on the identification of stakeholders and the benefits derived from the Wilderness and Swartvlei lakes which form part of one of the most integrated urban parks in South Africa; the Wilderness section of the Garden Route National Park.

Stakeholders play a significant role in the success of any conservation effort. Identifying and understanding collective identities that affects/or is affected by the management of the natural resource is imperative for the successful management of an affected social-ecological system. Using literature from the business sector the various collective identities were categorised and mapped. During interviews with individuals from these various groups the benefits derived from the lake ecosystems was identified and categorised using the criteria from the Millennium Assessment Report. The results of the stakeholder map as well as the benefits and services will be presented together with recommendations for future management decisions.

The use and abuse of SASS: why detailed taxonomic work is vital for conservation: a case study using Teloganodidae (Ephemeroptera)

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Conservation management relies to a large degree on detailed knowledge of the fauna that managers are aiming to conserve. While standard SASS5 biomonitoring is a valuable tool for assessing the gross water quality changes in South African river systems, such biomonitoring methods cannot provide enough information for reliable conservation management and can never replace the need for detailed species knowledge. Too often, important conservation decisions are based on inadequate information produced from interpreting biomonitoring results incorrectly. These techniques rely on family level identifications only, thus providing a very limited amount of information about more subtle faunal changes. This study highlights the importance of detailed taxonomic research and its conservation implications, focussing on one mayfly family, the Teloganodidae. These mayflies are restricted to pristine, mountainous rivers in the Western and southern Cape. They are sensitive to habitat disturbances and are not found downstream of any forms of anthropogenic developments or cultivated lands. Presently there are four genera within this family, occurring from the Cederberg

through to the Amatola Mountains. Three of the four genera are currently monospecific, and one has only two described species. Preliminary results indicate that there are in fact many more species, with each endemic to specific regions, often demarcated by mountain ranges. The relationships and new taxa shown by the genetic work clearly tie in with morphological differences. Once all of the new species have been clearly delimited and described, identification keys will be designed to make species identification more manageable in field applications for conservation managers.

Progress with the SAEON long term water quality monitoring of the Lower Olifants River

Mr Thabo Mohlala SAEON KNP Scientific Services Phalaborwa
Dr Anthony Swemmer SAEON KNP Scientific Services Phalaborwa

The Olifants River in Mpumalanga South Africa is presently one of the most threatened river systems in South Africa. The Olifants River has been long subjected to prolonged and increasing pollutants due to anthropogenic activities, particularly in the upper catchment area that adversely impact on the water quality downstream. While fairly little known about the status of the middle and lower Olifants catchment. A long term monitoring research project was initiated to identify stressors in the Olifants River. Physico chemical variables are recorded on site; Invertebrate surveys are conducted every month using the SASS5 protocol, while fish surveys are conducted using electro fishing methods. Data pooled together shows that,

At Ga Selati SASS data indicate a constant decline in water quality at both Selati River sites, from the time that the project started (June 2009) until the end of 2012, with more stable values during 2012 . Values at the start of the period indicated that the river was “moderately modified” By 2012, the river had deteriorated to “seriously modified” (band E) at both sites. As declines occurred at both sites, it is likely that the cause of the declining water quality is located upstream of the Sela-R40 site. Regular SASS sampling revealed large variation from month to month, particularly at the more degraded sites, a gradual decline in water quality at some sites, which would have not been detected with only annual or tri annual sampling. Protected areas provide a means to ameliorate pollution

Adult dragonflies as indicators of river health: a case study on the Crocodile-Incomati River, from South Africa to Mozambique

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Adult dragonflies and damselflies (Insecta: Odonata) were sampled at 29 sites along the Crocodile River, from its headwaters near Dullstroom in Mpumalanga, South Africa, to below Lake Chualu in Mozambique. The adult dragonflies were recorded and the Dragonfly Biotic Index (DBI) applied, in an effort to test the outcomes of the application. The DBI is a rapid bioassessment method, developed to measure the ecological integrity of streams and wetlands. A total of 75 dragonfly species were recorded along the river, representing 47% of the South African species. Several stenotopic species (habitat specialists) were recorded in different reaches of the river, along with eurytopic (widespread) species. The DBI shows great potential in detecting catchment related problems, mainly in terms of habitat quality, climate change (e.g. water temperature) and provides invaluable background data against which future changes can be compared.

The use of diatoms and related biotic indices to quantify the effect of vineyard pesticides and efficacy of mitigation measures

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Viticulture represents an important agricultural practice in many countries. The long term use of organic and inorganic pesticides in vineyards has resulted in increased concentrations of such pollutants in sediments, water and other environmental compartments. Mitigation measures in agriculture, especially vineyard agriculture, are a prerequisite to the sustained integrity of the natural environment, and specifically the aquatic environment. Mitigation presents itself in the form of water bodies, riparian buffer strips, ground vegetation cover, grassed field paths, natural or artificial wetlands and modification of pesticide application rate. However, to our knowledge no studies exist which assess the effectiveness of these mitigation measures in South Africa. The study aimed to quantify the effect of pesticides (fungicides, herbicides and insecticides) on aquatic ecosystems while assessing the effectiveness of employed mitigation measures. Epilithic diatom community structure assessment and identification of sensitive diatom species; zooplankton community structure assessment; analysis of sediment samples for pesticide residues and characterization of mitigation measures were carried out at nine study sites on wine farms in the Western Cape, South Africa. Pesticide risk assessment models PRIMET and PERPEST were employed to assess the risk that pesticides pose at each site. PRIMET results yielded different risk categories across the sites, ranging from no risk to high risk. Diatom community structure displayed variation in accordance with pesticides spraying regimes as well as observable diatom frustule abnormalities and the presence of various types of mitigation measures that are in place. The reference sites chosen displayed different diatom community structure and responses over the study period which infers that the presence of pesticides and use of mitigation measures does play a role in the integrity of the aquatic ecosystem.

The influences of hydrological phases on the community composition of Simuliidae and Baetidae and the implications on biomonitoring in the Seekoei River

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SASS5 (South African Scoring System version 5) is the standard biomonitoring method used for rapid bio-assessment of the present state of macro-invertebrates in South African rivers. The SASS5 method however, was developed for use in perennial rivers, but is also used in non-perennial rivers. During a Water Research Commission (WRC) project (WRC research project K5/1587) on the development of a method to determine the environmental water requirements for non-perennial rivers, it was found that SASS5 is not entirely effective in non-perennial rivers. This study aims to test the influence of species identification on the interpretation of biomonitoring data in non-perennial rivers.

The Seekoei River is situated in the Northern Cape and is part of the Upper Orange Water Management Area. The March/April (2006 – 2010) samples from two sites, EWR 3 and EWR 4, collected during the Seekoei River field visits for the WRC project was used. These sites were chosen due to their habitat and the two main hydrological stages experienced during the sampling period: Flow and Pools (low or no flow). The Flow phase was experienced during the wet years, and the Pools phase during the dry years. Two macro-invertebrate families, Simuliidae and Baetidae, were used to determine how community composition was influenced by hydrological phases.

The Cape Clawless Otter: a useful indicator for determining environmental water requirements in ephemeral rivers

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The aim of environmental water requirements (EWRs) is to protect the ecological integrity of rivers and streams. In a prototype method proposed by Seaman et al (2010), a number of system attributes or indicators were used to determine the environmental water requirements of ephemeral rivers. These indicators should be sensitive to changes in flow or water levels and cover the physical, chemical, biological and social aspects of river ecosystems. Terrestrial predators that feed in and along rivers could be useful as indicators in this method, but needs to be further investigated. This study examines the usefulness of the Cape Clawless Otters (*Aonyx capensis*) as an indicator of ecosystem integrity in an ephemeral river. Previous studies on otters in perennial rivers indicated that prey switching could occur when the density of one prey group increase relative to another (e.g. Ligthart et al. 1994, Parker et al., 2006, Rowe-Rowe, 1977). Preliminary results so far display that prey switching is occurring, although final results will confirm or reject the occurrence of prey switching. Little is known on the species' feeding ecology in the ephemeral rivers of the dry South African interior, thus it would be of interest to understand how fluctuations in surface flow and water level impact relate to otter diet.

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FRESHWATER ECOSYSTEMS AND ALIEN INVASIONS

The occurrence, distribution and population structure of freshwater fishes in Free State Dams and implications for inland fisheries

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Inland fisheries in South Africa are poorly developed and the fish resources in the approximately 400 dams in the Free State Province are thought to be under-utilised. Historically at most of these impoundments, freshwater fish were utilised mostly for recreational angling, while commercial harvesting was allowed at some state dams. On a national level various initiatives have been launched to investigate the possibility of freshwater fish to be utilised as a resource to address the South African government's imperatives of job creation, poverty alleviation, economic development and food security. It is therefore important that a fisheries development strategy is formulated at provincial level. To develop such a fisheries development strategy requires information on the fish communities and their relative abundance. Unfortunately such information is not available for many South African dams. The current paper presents results from fish surveys conducted in 12 dams from November 2012 to April 2013 on the species composition, distribution and population structure of the fishes and will highlight the implications this may have for the further development of inland fisheries in the Free State.

Development of a fish kill investigation protocol for South Africa

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The occurrence of large-scale fish kills have become a common phenomenon that is increasing internationally, and has been attributed to natural causes, rapid environmental changes, disease incidents or pollution events, or a combination thereof. An understanding of the causes of fish kills and why they occur is fundamental in order to implement preventative measures to reduce their frequency and magnitude. However, despite the advancements in fisheries and aquatic sciences, the science of fish kill investigations at an international level is still considered rudimentary, having advanced little since the 1960s despite significant economic damage to fisheries and disruption of aquatic ecosystem dynamics. The purpose of this study therefore seeks to adapt and refine current internationally-applied protocols and local guidelines for fish kill investigations specifically for the South African context, taking into consideration recent critical commentary on the key challenges that need to be addressed in order to advance the science and practice of fish kill investigations internationally. In doing so, this study seeks to promote a consistent national approach in response to the investigation of such incidents and improve the management thereof through recommended minimum requirements for each stage of such investigations.

Post-capture dispersal and mortality of tournament captured largemouth bass *Micropterus salmoides* in a South African impoundment

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Largemouth bass *Micropterus salmoides* is an alien invasive species that has been introduced into and translocated within South Africa due to their popularity with freshwater anglers. Although their impacts have been recognised, their economic and social value has deemed them a permanent fixture within South Africa's ichthyofauna, and hence need to be managed as a fisheries species. The aim of this study was to assess post-capture dispersal and mortality rates of largemouth bass released at a common site during fishing tournaments held at Wriggleswade Dam in the Eastern Cape Province (South Africa). A total of 786 fish were tagged, of which 15.6% were recaptured within 494 days. Initially recapture locations seemed to be random throughout the dam, however dispersal distance was found to increase significantly with time at liberty for up to 50 days, after which the two were not related. Recapture location was weakly correlated to the distribution of fishing effort, which was mapped during three tournaments. Initial mortality, estimated by counting those fish brought to the weigh station dead, was low at 1.4% of fish retained and subsequently released, while instantaneous annual total mortality calculated using catch curves from tournament results between 2004 and 2012 was also very low at $Z = 0.43 \text{ yr}^{-1}$. In conclusion, the impact of catch-and-release tournament angling at Wriggleswade Dam has little impact on the largemouth bass population and released fish disperse widely soon after release.

Fish assemblages as an ecological indicator of low land rivers in sub-tropical Africa

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The implementation of fish community structures as biological indicators for the determination of the ecological integrity, state or health of aquatic ecosystems is worldwide well established. Fish assemblages provide valuable tools for assessing aquatic environments as they can be used as indicators over wide temporal and spatial ranges and cover all trophic levels of consumer ecology. The Fish Response Assessment Index (FRAI) is commonly used in South Africa to determine the ecological integrity of freshwater fish assemblages. The aim of this study was to use fish assemblages as ecological indicators for the lowland reaches of the Amatikulu, Thukela and Umvoti Rivers in KwaZulu-Natal, South Africa. Methods used to sample fish included electronarcosis and a 5m wide 12mm meshed seine net. Fish were sampled during both high and low flow periods. Current (2011 and 2012) and historical (1999 – 2010) data of high and low flow surveys were included in this study. FRAI and multivariate statistical analyses were implemented in order to determine the ecological integrity of the lower Amatikulu, Thukela and Umvoti rivers. Results revealed that the automated FRAI integrity classes were constantly lower than the adjusted FRAI integrity classes. Automated and adjusted FRAI integrity classes of the Amatikulu River ranged from largely natural (Class B) to largely modified (Class D) while the Thukela and Umvoti rivers ranged from natural (Class A) to seriously modified (Class E/F).

Can we detect impacts of trout in small mountain streams by examining invertebrate communities using a multivariate approach?

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The Cata and Mnyameni tributaries of the Keiskamma River provide a unique opportunity to study the impacts of non-native, invasive Brown Trout (*Salmo trutta*) and Rainbow Trout (*Oncorhynchus mykiss*) respectively. These fish have been present and naturalised in the Keiskamma River system for over a century, with stocking records dating from as early as 1898 (de Moor & Bruton 1988). The upper limits of the distribution of each trout species are known, and the construction of dams in the upper catchments of the tributaries prevents the downstream movement and survival of trout. Invertebrate communities were sampled where fish are absent, where trout are present and downstream of the dams where trout are absent and only native fish are present. Multivariate analyses were employed to study patterns in community structure across these regions. Preliminary results suggest that trout act as a non-specific biological filter, affecting a wide variety of drifting invertebrates rather than selecting specific taxa.

The influence of nutrient enrichment on the macro-invertebrate fauna of Loole Creek in the Limpopo Province

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Tarebia granifera is an aquatic gastropod mollusk in the family Thiaridae. Originally this snail is native to south-eastern Asia, but it has become an invasive species in numerous countries, including South Africa.

Invasive aquatic species, such as this gastropod, can cause ecological disturbances and potentially reduce biodiversity by displacing indigenous invertebrates.

According to De Kok and Wolmarans (2006), no specimens of *Tarebia granifera* were found in the Kruger National Park (KNP) during either of their 1995 and 2001 surveys of selected water bodies. However, during a 2006 survey, *Tarebia granifera* was recorded at 12 localities in the KNP. The Kruger National Park is South Africa's largest declared protected area and the presence of this gastropod in its water bodies highly undesirable.

During the annual SASS5 biomonitoring of the Looile Creek in the Phalaborwa area, it was observed that the abundance of *Tarebia granifera* has significantly increased over the last 5 years below a dam. The Looile Creek is a tributary of the Selati River, a tributary of the Olifants River that ultimately makes its way into the KNP. It was observed that these gastropods cover substantial areas on the substrate of the Looile Creek downstream of the dam. An increase in abundance has also been recorded in the Selati River, downstream of the confluence with the Looile Creek. Due to algae being a possible food source for the snails, a study was conducted to determine if the abundance of *Tarebia granifera* and the concentration of chlorophyll present can directly be correlated.

Double blow: first record of an alien crayfish, *Cherax quadricarinatus* von Martens, infested with an alien temnocephalan, *Diceratocephala boschmai* Bear, in South African waters

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Trade in live, freshwater crayfish for ornamental markets, as well as aquaculture, has grown rapidly and has become the major pathway of introduction for non-indigenous crayfish species to several countries worldwide. At least four crayfish species have at some stage been imported, or been considered for importation, into South Africa. These include the 'redclaw' (*Cherax quadricarinatus* van Martens), the 'yabby' (*Cherax destructor* Clark), the 'marron' [*Cherax tenuimanus* (Smith)] and the 'red swamp crayfish' [*Procambarus clarkii* (Girard)]. To date reports of naturalised populations in South Africa exist for *P. clarkii* at an impoundment near Dullstroom, on the Crocodile River (Schoonbee 1993) and for *C. quadricarinatus* in Swaziland at the Sand River Dam. Here, we report on the first record of the Australian "redclaw" *Cherax quadricarinatus* in the natural waters of a game reserve in South Africa. To compound the situation, these redclaw crayfish were infected with a non-indigenous temnocephalan flatworm parasite. Both crayfish and temnocephalan were in full breeding condition, with young. Further spreading of this crayfish in the sub-tropical, water-rich, northern Kwa-Zulu Natal province of South Africa and in southern Mozambique is predicted. Not only might the crayfish compete with indigenous aquatic invertebrates but the non host-specific temnocephalan might transfer to local decapods, such as freshwater crabs.

Managing alien fishes in South Africa

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South Africa has a long history of alien fish introductions. Alien fish such as common carp, brown trout and largemouth bass were introduced because native fish faunas contained few species that had potential for fisheries development. Coupled with introductions for bio-control, aquaculture and the pet trade, alien fishes now outnumber natives in many river systems and South Africa is considered a global fish invasion hotspot. Although government mediated stocking programmes ceased in the late 1980s alien fishes continue to increase their distributional ranges through illegal private stocking,

escape from aquaculture and via inter-basin water transfers. Alien fish introductions are considered one of the main threats to aquatic biodiversity because they impact on native biota through predation, habitat alteration, disease transfer and hybridisation. As is the case for other invasive biota, the control and management of alien fishes is included in the National Environmental Management: Biodiversity Act. Implementation measures include import and movement controls and, more recently, alien fish eradication in conservation priority areas. Management actions are however complicated because many alien fish are important components in recreational and subsistence fisheries that contribute towards regional economies and food security. As a result management of these conflict species often meets with considerable resistance, particularly from angling organisations. In this paper, I provide an overview of fish introductions and their associated impacts in South Africa and describe both existing and evolving national policies and legislation for the management of alien fishes. The implementation strategies used by provincial conservation authorities are discussed with regard to the available human capacity and the sometimes innovative approaches that have been used to prioritise and manage fish invasions at local levels.

Inter-basin water transfer schemes and the threat of fish invasions: a water management conundrum

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The invasion of river networks by alien fish species is an on-going biodiversity crisis in many parts of the world. Inter-basin water transfers (IBWT) provide a well-known, yet poorly understood and managed pathway for fish invasions. By linking donor and receiving catchments, these engineering projects create an invasion corridor that provides continuous opportunities for introductions of non-native species. This invasion pathway has the potential to enable complete homogenisation of the fish communities in the interlinked catchments. To quantitatively assess the threat posed by IBWT to freshwater fish conservation, we used a case study of the Sundays River, Eastern Cape, which is linked to the Orange and Great Fish catchments via an IBWT. Research conducted in the Sundays River irrigation network, which consists of multiple storage impoundments fed by water from the IBWT, allowed us to quantify the effect of immigration from the IBWT on establishment success of introduced fishes. We also assessed the conservation consequences of these introductions by examining alien fish invasions in the nearby Addo Elephant National Park, which has three tributaries linked to the IBWT. The study has revealed the logistical challenge inherent in trying to manage fish movement within water distribution infrastructure. We demonstrate that engineering and financial decisions to mitigate this threat must be made prior to commencement of operations to have a realistic chance of success.

Fish health and suitability for human consumption study of selected fish species in the North West Province

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Carp and catfish have been removed to shift the fish community structure to favour desirable fish species in 3 dams in the North West Province. These species were selected for the fish health and suitability for human consumption part of the Resource Management Plan for the Hartbeespoort Dam. This study was initiated during 2009/2010 and has currently been completed.

The fish health assessment is divided broadly into three categories:

- 1) Macroscopic health assessment,
- 2) Histological assessment of selected target organs and
- 3) Suitability for human consumption.

Both the catfish and the common carp were assessed using a macroscopic health assessment index (HAI), which is a rapid way to assess the general health status of fish. According to the HAI both species had a higher than normal HAI score as a result of external and internal abnormalities of the various organs assessed. When compared to other dams, with lower pollution levels especially eutrophication, the HAIs were higher in general for both species.

Histological alterations were noted in the liver, kidney and the gills of both species, with the liver showing more variations in abnormalities.

The human health risk assessments were done using muscle tissue from the carp, *Cyprinus carpio* and the catfish, *Clarias gariepinus*. All the Hazard Quotients and risks of developing cancer are low with the exception of chromium which is an over prediction based on the VI versus III speciation. Thus no predicted adverse health effects are anticipated based on consumption of fish on a daily basis.

WEDNESDAY 3 JULY 2013

ESTUARINE ECOLOGY

Nutrient characterisation of river inflow into the estuaries of the Gouritz Water Management Area

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Prof. Janine Adams - Botany Department, Nelson Mandela Metropolitan University
Dr. Susan Taljaard - CSIR, Stellenbosch

Eutrophication is a global concern due to its adverse effects on biodiversity and ecological functioning of coastal ecosystems. Riverine inputs are a major source of macronutrients to estuaries and the ocean that must be monitored in order to provide input to conservation and management of aquatic ecosystems. The aim of this study was to provide a comprehensive overview of the nutrient status of the river catchments within the Gouritz Water Management Area (WMA) of South Africa. The study used dissolved inorganic nitrogen (i.e. NO_3^- , NO_2^- , and NH_4^+) and phosphorus (i.e. PO_4^{3-}) long-term water quality monitoring data collected by the Department of Water Affairs and Forestry (DWAF). The results indicated that dissolved inorganic phosphorous concentrations exceeded the eutrophic limits, set by the DWAF for aquatic ecosystems, in 65% of the catchments assessed. The inorganic N:P ratios were low ($< 5:1$) in 75% of the systems assessed, however the Blinde (12:1) and Gwaing (9.7:1) rivers had the highest nutrient ratios. For the majority of the river systems there was no significant correlation ($p > 0.05$) between inorganic nutrients and freshwater inflow from the catchments. This suggests that anthropogenic activities such as agriculture, wastewater discharge, urbanisation, and afforestation are significant factors controlling nutrient levels within the rivers of the Gouritz WMA. This study highlighted the benefit of water quality monitoring within coastal ecosystems which can be used to assess trends and identify management priorities.

Responses of microalgae in the Great Brak Estuary to changes in river flow

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The Great Brak Estuary, a temporarily open/closed system on South Africa's south coast, has experienced a broad range of river flows associated with an extended drought and large localised floods within the past three years. Water quality and microalgal biomass – phytoplankton and microphytobenthos (MPB) – were measured on ten occasions during the period 2 September 2010 to 16 July 2012. The aim of this Water Research Commission funded study is to relate water quality and microalgal biomass (using chlorophyll a as an index) to river flow, and to compare the results to the 2008 freshwater reserve study.

In September 2010 there was negligible river input and salinity was near uniform through the estuary (25.2 to 27.7). Ammonium, Total Oxidised Nitrogen (TOxN) and Soluble Reactive Phosphorus (SRP) concentrations were relatively low, reaching maxima of 2.5 μM , 6.3 μM and 0.7 μM respectively. The mouth of the estuary was closed for an extended period (>1 year) so there had been no exchange of the nutrient-poor water, supporting a low biomass of phytoplankton (chl a; 1.1 – 4.0 $\mu\text{g.l}^{-1}$). In contrast, conditions favoured the MPB and biomass ranged from 5.7 to 100 mg.m^{-2} . As river flow increased, the mouth of the estuary opened and the concentration of nutrients increased, where ammonium was the dominant form of nitrogen and phytoplankton growth appeared to be limited by the concentration of phosphorus, based on the Redfield Ratio, and on the residence time of water in the estuary.

The role of submerged macrophytes and macroalgae in nutrient cycling in the Great Brak Estuary South Africa: a budget approach

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The Great Brak (34°03'23"S; 22°14'18"E) is a temporarily open/closed estuary located on the south coast of South Africa. The overall aim of this Water Research Commission funded study was to determine the importance of the role that submerged macrophytes and macroalgae play in storing and removing N and P from an estuary. A budget approach was used in order to compare this vegetation to other contributing sources of N and P. During the closed phase, sediments were the highest contributors of TN and TP to the system, followed by the submerged macrophytes and macroalgae. The sediment constantly contributed approximately 30% of the TN and 40% TP, while the submerged macrophytes and macroalgae 20 to 30% TN and 30 to 38% TP toward the nutrient budget. River water and precipitation contributed less than 3% of the TN and TP inputs.

It was previously believed that the sediments of South African TOCE's did not have the necessary organic stock to fuel subsequent production. Two important findings arose from this work; the sediment does have the necessary organic stock to fuel production and that the submerged macrophytes contribute significantly to nutrient cycling. Nutrient budgets often do not take the vegetation within an estuary into account, particularly in TOCE's. This is the first detailed account of incorporating vegetation into a nutrient budget without relying solely on C:N:P ratio's.

Present state and future fate of mangroves in South Africa

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Although the mangrove area in South Africa is small (~2000 ha) they are important in terms of biodiversity conservation and contribute to livelihoods in some rural areas. Mangroves occur along the east coast from Kosi Bay (27°0' S, 32°50' E) to a small natural population at Kwelera Estuary and a thriving planted mangrove forest further south at Nahoon Estuary (32°59' S; 27°56' E). For a long time species composition has been largely unaltered; however a shift in the geographic ranges with climate change has been projected. Mangroves have been lost from 11 small KwaZulu-Natal estuaries since Ward and Steinke's 1980s surveys due to encroaching sugarcane farms, development, modified freshwater inflow, prolonged mouth closure and poor catchment practises. A recent study on 17 Eastern Cape estuaries identified other threats such as harvesting of trees, livestock browsing, trampling and footpaths which occurred in approximately 70% of the estuaries. Mangroves had re-established in three Eastern Cape estuaries where they had been previously lost but mouth closure due to drought and sea storms resulted in the complete die back in the Kobonqaba Estuary. Population structure data showed that some mangrove forests are aging as there is little recruitment. This was evident from a high adult: seedling ratio for *Bruguiera gymnorhiza* in Mgeni Estuary, *Rhizophora mucronata* in Sipingo Estuary and for *Avicennia marina* in Durban Bay. The future fate of mangroves in South Africa is discussed in relation to human impacts and climate change effects of increased temperature and sea level rise.

In situ growth rate of *Solen cylindraceus* (Mollusca: Euheterodonta: Solenidae) in the St Lucia Estuarine Lake, South Africa

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Solen cylindraceus (Hanley, 1843), an infaunal bivalve, can reach a maximum length of 95 mm. However, in the St Lucia estuarine system specimens are seldom larger than 55 mm. Thus, the primary aim of this study was to investigate the growth rate and morphometrics of *S. cylindraceus* in St Lucia. Growth lines of this species are too indistinct and irregular to be of any use. The present study, therefore, adopted a more direct method of monitoring the shell length of individuals, by caging them *in situ*. Shell measurements were taken from individuals in the cages and the surrounding environment at monthly intervals for a period of one year. Thereafter, salinities decreased below their tolerance range and the experiment was terminated. Caged and uncaged animals had a size of 31.0 ± 4.5 and 31.7 ± 2.3 mm after a year of growth, respectively. An overall growth rate of 0.049 ± 0.059 mm.d⁻¹ was derived for the caged animals. In conclusion, first year growth rates appeared lower than previously recorded for *S. cylindraceus* in other estuaries. Additionally, it may be assumed that animals are unable to survive in the prevailing harsh environment in St Lucia, before they are able to reach maximum size.

Role of sand prawns as ecosystem engineers in temporarily open/closed Southern African estuaries

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The role of the sand prawn, *Callichirus kraussii*, as a ecosystem engineer was experimentally assessed in the lower reach of the temporarily open/closed Kasouga Estuary using caging experiments. The presence of the sand prawn contributed to a significant increase in bioturbation which contributed to a significant decrease in the microphytobenthic algal concentration. In addition, the presence of the sand prawn also contributed to a significant decrease in the abundance and biomass of both the epi- and infauna. Results of the study indicate that sand prawns can be considered as important ecosystem engineers in the lower reaches of temporarily open/closed South African estuaries.

Mediating interactions among lower trophic levels: community stability, induced by early life-history fish, in the estuarine plankton

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Within the context of trophic cascades, various treatments using *in situ* mesocosms were established in a closed estuary to highlight the importance of predation in stabilizing estuarine plankton abundances. Through either the removal (filtration) or addition of certain planktonic groups, four different trophic systems were established. These treatments containing varied numbers of trophic levels and thus different “predators” at the top of the food chain. The abundances of zooplankton (copepod and polychaete), ciliate, micro-flagellate, nano-flagellate and bacteria were investigated in each treatment, over time. The reference treatment containing apex zooplanktivores (early juvenile mullet) and plankton at natural densities mimicked a natural, stable state of an estuary. Proportional variability (PV) and coefficient of variation (CV) of temporal abundances were calculated for each taxon and showed that apex predators in this experimental ecosystem, when compared to the other systems, induced stability. The presence of these predators therefore had consequences for multiple trophic levels, consistent with trophic cascade theory.

ESTUARINE ECOLOGY

Preliminary results from selected estuaries monitored as part of the National Estuarine Monitoring Programme (NESMP) in South Africa

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The design of the NESMP was initiated in 2008 and has progressed to pilot testing on selected South African estuaries. The paper presents physico-chemical data collected from selected estuaries, indicating the importance of the collection of basic robust data for water resource management. Technical problems of the implementation of estuary specific monitoring are identified and solutions proposed, based on this preliminary data.

Development of an estuary management plan: lessons learned in the Cape Estuaries Programme

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CapeNature

According to Chapter Four in the NEM:ICMA (2008) an estuary management plan needs to be developed for each estuary in South Africa. The development process for each of these estuary management plans is guided by the National Estuary Management Protocol (ICMA, 2008). While the protocol provides guidance with regards to the structure and content of an estuary management plan, a great deal of practical experience has been gained whilst developing in excess of 20 estuary management plans in South Africa as part of the CAPE Estuaries Programme. Estuary selection, the process of engaging with stakeholders, funding options, structure of Situation Assessment and plan and finally the implementation of the plan are discussed. Finally the links between an estuary management plan, Municipal Coastal Committees, Provincial Coastal Committees and Coastal programmes will be discussed.

ECOTOXICOLOGY AND POLLUTION

Field validation of metal contamination at the Richards Bay Harbour

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Richards Bay is currently the largest deep –water port in South Africa used primarily for the export of coal. Furthermore, there are plans to expand the port in the next 40 years, which will see the port increasing up to 5 times its surface area. A Field validation study was conducted in the Richards Bay harbor where metal contamination was evaluated. Aluminium (Al), Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Mercury (Hg), Nickel (Ni), Lead (Pb) and Zinc (Zn) concentrations were measured. Concentrations were determined using the microwave digestion method and analysed by inductively coupled plasma atomic emission spectrometry (ICP-AES). Aluminium and Fe concentrations were higher than that for all other metals analysed for in sediment and tissue samples. The highest concentrations recorded were 21800.00 µg/g for Al and 207147.00 µg/g for Fe. For most of the metals analysed, the concentrations were within the recommended water quality guidelines as stipulated by the department of water affairs and forestry, the Canadian council for ministries of the environment and the 'accepted world average. Pelican Island was chosen as a reference site and was found to be significantly different from the rest of the sites ($P > 0.05$). The amphipod, *Melitazeylanica*, was used for biomonitoring of the Richards Bay system with the LC50 and EC 50 values determined at each site. Statistical results -were determined using ANOVA-based pie charts. The data from this study was compared with existing data and results helped with identification of highly contaminated areas within the harbor and provided statistical value on trends for metal content in 2012.

Imposex in marine gastropods from the Atlantic Coast of South Africa

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TBT is an organotin compound (OTC) used as an antifouling agent in paint that is applied to the hulls of vessels to prevent the formation of biofilms. This highly toxic antifouling compound leaches into the water and subsequently has various negative effects on marine life, especially marine gastropods. One of the most serious effects of exposure to TBT is the growth of a penis/vas deferens in female gastropods; this phenomenon is referred to as imposex. Marine gastropods are useful bioindicators as imposex is related to TBT exposure. It may affect the reproduction of these organisms and thus affect coastal ecology. The consumption of TBT-contaminated foodstuffs may also pose a risk to human health. The use of antifouling paints containing organotin compounds such as TBT still continues in developing countries, despite the fact that the International Maritime Organization (IMO) banned the global use of organotin compounds (OTCs) in antifouling paints applied to ships in 2008. This study assessed the current state regarding TBT-induced imposex in marine gastropods along the Atlantic coastline of South Africa by collecting caenogastropods from sites based on presumed high and low impacts of TBT activity and using various indexes: the Relative Penis Length Index (RPLI), Relative Penis Size Index (RPSI), Male:Female ratio (M:F), Percent Imposex (% I). The first cases of imposex have been found. The results of the assessment will be made available to interested and affected parties and may in turn generate the need for protective measures.

Lysosomal membrane stability in the mussel *Mytilus galloprovincialis*, as a biomarker of Tributyltin exposure

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The effect of TBT on the stability of hemocytic lysosome membranes of the mussel, *Mytilus galloprovincialis*, and the use thereof as a biomarker of TBT-induced stress, was investigated in this study. Two groups of mussels were exposed to different environmentally relevant concentrations of tributyltin (0.1 µg/l and 1.0 µg/l) for four weeks. A third group served as control. Membrane stability of hemocytic lysosomes was tested weekly by means of the neutral red retention time (NRRT) assay, using a light microscope. Subsequent to cell counts, the animals were used for TBT analysis by methanolic acid digestion with *in situ* derivatization by 1% sodium tetraethylborate (NaTEB₄). The analyses were done using GC-FPD. The two groups exposed to TBT exhibited significantly increased ($P \leq 0.05$) whole body TBT concentrations (0.08 ± 0.00010 µg/g and 0.70 ± 0.00030 µg/g dry mass, respectively) and significantly shorter ($P \leq 0.005$) NRR times (14.00 ± 3.005 min and 10.00 ± 2.006 min, respectively) after four weeks of exposure. For the control group, no TBT was detected and the NRR times were significantly longer when compared to the exposed groups. For both exposure groups NRR times became progressively shorter as TBT concentration increased with time (R^2 values of 0.85 and 0.971 were calculated respectively for these groups). This study has revealed that the two contributing factors influencing lysosomal responses are exposure concentration and exposure time of TBT. It was concluded that the NRRT assay could be considered as a useful technique, and lysosomal membrane destabilization a useful early warning and cellular biomarker of stress due to tributyltin exposure in *M. galloprovincialis*.

The risk of eating fish from the Olifants River (Limpopo)

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Communities who regularly consume fish are potentially at risk to contaminants that have bioaccumulated in fish tissue. An exposure assessment can evaluate the potential human health risk of specific contaminants from the consumption of fish based on (1) the amount of fish consumed on a regular basis, and (2) the levels of contaminants present in the fish tissue consumed. For this study, the dorsal muscle tissue was selected to evaluate bioaccumulation of metals in fish and the related Human Health Risk posed by regular consumption of four fish species from Flag Boshielo Dam and the Phalaborwa Barrage to determine whether consumption of these fish poses a threat to human health. A human health risk assessment was carried out according to the methodology outlined by the Environmental Protection Agency of the United States (US-EPA 1997) and the World Health Organization (WHO 2003). The results of the study paint a grim picture for the rural communities currently consuming fish from the two impoundments considered. The study confirmed that metals assimilated into the muscle tissue of fish, viz. lead, antimony, arsenic, chromium, cobalt, barium, vanadium and iron, are so high that a 70kg adult consuming a modest 350 g portion once a week is placing themselves at a serious health risk. On the basis of the findings of this study, we recommend that an advisory be put out by the Department of Health warning the rural communities of the health risk of consuming fish from these impoundments.

The health status of the African longfin eel, *Anguilla mossambica*, from three Eastern Cape Impoundments, South Africa

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Worldwide eel populations are on the danger of collapsing, largely due to fisheries and chemical pollution. Freshwater eels are important components of the South African freshwater ecosystem mainly due to them being the only native predator. African longfin eel *Anguilla mossambica* (Peters, 1852) is the most common and wide spread eel in South Africa. The aim of this study was to determine the health of wild populations of *A. mossambica* by means of a macroscopic fish health assessment and a microscopic fish health assessment. The first objective was to compare any possible macroscopic abnormalities and the second was to assess the histology of selected target organs (gills, liver, Kidney and gonads). Eels were sampled with fyke nets from three impoundments located in the Eastern Cape province of South Africa. The sites are Binfield Park Dam, Sandile Dam and Wriggleswade Dam. March 2012 ($n = 14$) revealed that macroscopically 42% of the eels had discoloured liver with a HSI of 0.53 ± 0.05 , an SSI of 0.08 ± 0.01 and fulton's CF of 2.26. August 2012 ($n = 5$) showed that macroscopically 40% of the eels had discoloured livers with a HSI of 0.79 ± 0.29 , an SSI of 0.05 ± 0.02 and fulton's CF of 2.54. Main histological alterations noted in the liver were intercellular deposits, increase in melano macrophage centres and hepatocyte vacuolation. Kidney alterations observed were increase in melano macrophage centres, increase in Bowmans space and increase in glomerulus tuft. Despite the histological alterations noted above it can be concluded that the *A. mossambica* from the three selected impoundments are in a healthy condition.

Frogs and acid rain – is there a threat in the Kruger National Park?

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Multiple lines of evidence indicate that frog populations are declining globally and entire species have become extinct. Environmental factors such as acidification and pollution of water bodies are some of the potential factors that threaten the frog populations of the Kruger National Park.

The pans in the KNP are seasonal water bodies that are critical habitat for frogs and their life cycle. After good summer rains, frogs will emerge and lay their eggs in the pans where the froglets will complete their development into juvenile frogs. The close relationship between the frogs and water bodies are important in the diversity of amphibians and acid rain could therefore potentially have a negative impact on their sustained presence in the environment.

The aim of this study was to determine the physico-chemical quality water quality of 45 selected pans in the KNP and parameters included pH, water temperature, dissolved oxygen and electrical conductivity. An additional water sample was collected and analysed for anions, nutrients and metal concentrations (Inducible Coupled Plasma Optical Emission Spectrometer (ICP-OES)).

Results indicate that the water is generally slightly basic to neutral and related to the general geology of the site. Very few parameters measured were present in concentrations of concern. Nutrient results were varied and could not be linked to the geology or vegetation associated with these sites. It is clear that external nutrient inputs play an important role for each of the pans.

It is clear that although low pH precipitation does occur in the KNP, the current impact on the systems (pans) are negligible and the inherent buffering capacity of the water (as a result of the underlying geology) is able to keep the system in a near neutral to basic state. An aspect that requires further study is the increases in sulphates and the relationship with acid rain.

Aquatic ecosystem sensitivity to the effects of sulphur and nitrogen deposition in South Africa

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Problems of surface water acidification associated with emissions of sulphur and nitrogen compounds into the atmosphere from fossil fuel combustion are well recognized. In Europe and North America, acid deposition is regarded as an old problem which has to a large extent been dealt with as far as is politically and economically feasible. However, in developing economies in other parts of the world the problem is still increasing as the use of fossil fuels, especially coal, provides the energy basis for economic growth. In South Africa, only a few studies into the ecosystem effects of acid deposition have been published for surface waters, but they have been limited in geographical scope (mainly the Highveld) and some do not use primary data collected for the purpose. Furthermore, global interest in the impacts of reactive nitrogen on semi-natural ecosystems has increased hugely over the last decade. Emissions of nitrogen oxides from fossil fuel combustion and ammonia emissions from intensive agriculture may both contribute to the nutrient enrichment of natural or semi-natural ecosystems as well as acidification, but the potential ecosystem level impacts are very poorly researched. Here I review the limited studies available from South Africa in the context of approaches in Europe, and assess the knowledge gaps, with a particular focus on aquatic ecosystems. Acid-sensitive waters have been recorded in various parts of the country and demonstrate the need for national scale deposition datasets to assess the potential extent of adverse effects and allow application of critical load models.

The hatching success of branchiopod crustaceans from selected South African pans and the impact that acid mine drainage has on this success

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Pans are endorheic wetlands, and are abundant in South Africa in a band from the western Free State into Mpumalanga. The pan environment experiences daily and seasonal fluctuations in physico-chemical conditions, caused by variable hydroperiods. Branchiopod crustaceans are able to survive this variability through the production of dormant egg banks, which reside in the sediment through the dry phase and hatch during the following wet phase when conditions are favourable. These wetlands are vulnerable to anthropogenic activities. One activity of rising concern is mining. A decrease in the hatching success of Branchiopods could be detrimental to the biodiversity and ecosystem functioning of these wetlands. Pans were selected from the North West, Free State and Mpumalanga provinces to perform hatching experiments on the egg banks in the sediment. The sediment collected from each pan was inundated with two control sea salt solutions of 1000 and 1500 mg/l respectively. A third solution of decanted acid mine drainage (AMD) was used to determine hatching success with exposure to AMD. The experiments indicated that pans in the North West had high abundances and diversity of species hatching that included Anostracans and Cladocerans. Similar abundances and diversity were seen from the Free State pans but diversity was dominated by the Chydoridae family. Both salt solutions proved to be effective hatching mediums. The AMD had a negative effect on the hatching success in all of the provinces. Recovery experiments indicated that only a few eggs from North West pans were able to recover from exposure.

The impact of Acid Mine Drainage from Coal Mining Activities on the riverine invertebrates of the Mpumalanga Highveld: a case study on the Boesmanspruit

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The social-, economical- and ecological effects of acid mine drainage due to coal mining activities on the Mpumalanga Highveld was dramatically highlighted in January 2012 when the Boesmanspruit Dam underwent rapid deterioration after a large rainstorm. The pH in the Boesmanspruit Dam decreased to 3.7 and the concomitantly elevated iron-, aluminium-, manganese- and sulphate levels made the water unfit for use (McCarthy & Humphries, in Press). The resultant problems experienced with providing a safe drinking water supply to the town of Carolina has received considerable media coverage. The effects of the AMD on the aquatic ecosystems in the area was not highlighted at the time and received less attention.

The Department of Water Affairs together with Mpumalanga Parks and Tourism investigated the effects of the AMD on the Wetlands in the Boesmanspruit catchment as well as on the Fish and Macroinvertebrates of the Boesmanspruit. This presentation deals principally with the initial effect of the Acid Mine Drainage (AMD) on the macroinvertebrates of the Boesmanspruit and the possible recovery of the macroinvertebrate communities following mitigation measures to improve the water quality situation in the Boesmanspruit Dam.

Results from three sites in the Boesmanspruit sampled between April 2012 and April 2013 will be presented and evaluated in relation to the events resulting in the changes in the Boesmanspruit Dam and the mitigation measures implemented.

The challenges of maintaining environmental realism in aquatic nano-ecotoxicology: a bit of the same old or a new science?

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Over the past 40 years aquatic toxicology has evolved from “fish in a jar” test to ecotoxicological tests that take into account ecological relevance of the measured endpoints. The fundamental assumption has always been that the biological/ecological response is related to the administered dose. Therefore assessments have been developed to causally link environmental exposure to the observed effects. However in the field of nano-ecotoxicology determination of the environmental fate, transport, and effects of engineered nanomaterials (ENMs) have been hampered by a lack of adequate techniques for the detection and quantification of ENMs at environmentally relevant concentrations in complex media. Analysis of ENMs differs from traditional chemical analysis because both chemical and physical forms must be considered. Because ENMs are present as colloidal systems, their physicochemical properties are dependent on their surroundings. These all have direct implications on the manner in which we conduct effects assessment. In this presentation we will deal with methodological issues related to ENMs toxicity assessment such as experimental procedure, exposure and effects characterization. In this presentation examples of studies undertaken thus far on carbon nanotubules and gold nano particles will be used to demonstrate these concepts.

ECOTONES

The role of amphibians in linking terrestrial and aquatic habitats in the Kowie Catchment

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During their life cycles, amphibians move between aquatic and terrestrial habitats, and as a result the two habitats are connected via developmental changes and feeding dynamics of amphibian populations. Identification and quantification of such linkages through consumers are important for understanding the structure and function of different habitats. Fatty acid profiles, stable isotope signatures and stomach content analysis are being used to determine the role of amphibians as connectors of aquatic and terrestrial habitats in the Kowie River catchment. Frogs and tadpoles were sampled at two sites in the Kowie River, and preliminary results showed divergent diets among the life history stages and species collected. *Amietia angolensis* and *Strongylopus grayii* appear to be generalist feeders, whereas *Amietophrynus rangeri* and *Xenopus laevis* had fewer prey types in their stomachs. In combination with tracer techniques that provide measures of assimilated diets over longer time periods, we intend to determine the relative importance of aquatic versus terrestrial prey in the different species. Given the continued declines in amphibian diversity in many regions of the world, such information about trophic relationships will allow us to make predictions of the ecological consequences of species losses in the Eastern Cape.

Reciprocal aquatic/terrestrial trophic subsidies through aquatic birds in a South African hydrological catchment: project outline and preliminary findings

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Aquatic and terrestrial systems are often considered in isolation of one another. In recent years however, ecologists have shown that aquatic and terrestrial ecosystems are inescapably linked through cross-habitat transfers, whereby dietary food items originating elsewhere are eaten by consumers. These cross-habitat subsidies can strongly influence community dynamics, predator–prey interactions and food webs, while ecologists are increasingly recognising the fundamental role of these reciprocal subsidies. These reciprocal subsidies between aquatic-terrestrial ecotones can represent a significant component of organic carbon in streams and rivers, yet they remain poorly understood and are often difficult to accurately assess. Fresh- and saltwater-based avifaunas are typical examples of terrestrial-based consumers that utilise food sources that do not occur within their own habitat. Avifauna fill a myriad of feeding niches, with their diet ranging from aquatic plants and algae to insects, crustaceans, molluscs, bivalves and fish. They therefore play a significant role as vectors in reciprocal subsidies between aquatic and terrestrial ecosystems, particularly in estuarine habitats where avian species abundance and diversity is high. This project aims to determine the role that several avian species play in cross-habitat subsidy and the food web of the estuarine section of the Kowie River, Port Alfred. The project outline and preliminary results will be presented and discussed.

The importance of ecotones for the classification of biomonitoring sites: a case study from the Marico River

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The River Health Programme advocates the use of an *a priori* approach, combining ecoregions and longitudinal zonation components but excluding ecotones as a standardized site classification and resource delineation tool. Two classification procedures were investigated namely a) the *a priori* method based on the regional geographic site attributes to classify sites and b) the *a posteriori* method, based on a multivariate analytical approach of the macroinvertebrate data. The main question was whether these two classification procedures would generate an analogous categorization of biomonitoring sites in the Marico River catchment. It was hypothesized that the two methods did not place the sites within the same categories. The objective was to comparatively analyse the site classification results using the two approaches and provide alternative resource unit delineation for river management purposes. In the study 29 River Health Programme monitoring sites were used. The *a priori* approach per se did not result in homogenous units for river monitoring, ecological management and conservation planning when the analyses of the macroinvertebrate assemblage are considered. The *a priori* approach should be refined with a combination of field verification and the *a posteriori* approach to delineate resource units for the Marico River catchment. The refinement options for ecoregion and longitudinal classification should include the use of ecotone demarcation as this will refine the ecoregion delineations. This is of particular importance in mountainous areas where different vegetation types and structures can be present at the same site.

Links between lateral vegetation zones and flow

Karl Reinecke, Cate Brown, Karen Esler, Jackie King, Martin Kleynhans and Martin Kidd

The flow regime is considered the master variable responsible for the occurrence of lateral zones and authors have proposed links between inundation and plant distributions. The widely held belief that the boundary between a wet and dry bank occurs where the 1:2 year flood recurs was tested and held up. There were four lateral zones in two groups. The wet bank consisted of two zones, a marginal zone comprised of obligate riparian species and a lower dynamic zone situated between the marginal and lower zones, the next one up, and comprised of a mixture of the species from these two neighbours. The dry bank also consisted of two zones, a lower zone comprised of facultative riparian species and an upper zone, situated between the lower and the adjacent terrestrial community, comprised of a mixture of riparian and terrestrial species. It was not possible to discriminate the four lateral zones using flood recurrence alone but inundation duration distinguished them further as follows. The marginal was consistently inundated for longer periods of one to three months a year, every year, while the lower dynamic was inundated for up to one month a year, or not at all during dry years. The lower and upper zones separated from the wet bank hydraulically but not from one another since their distributions overlapped. There was no relationship between the upper zone and flood recurrence nor inundation duration. Inundation duration is an important hydraulic variable but is not something considered overtly in Environmental Water Requirements.

Habitat connectivity between salt marshes and terrestrial vegetation: indicators of change

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For effective estuary management defined estuary boundaries are important. The 5 m topographical contour is synonymous with estuarine functionality but may exclude salt marsh habitats, leaving them under development pressures and resulting in the loss of connectivity.

The aim of the study was to:

- 1) identify boundaries and establish the connectivity between salt marsh and terrestrial vegetation,
- 2) determine which environmental factors are forming boundaries,
- 3) determine how different landcover types affect the integrity of salt marshes and boundaries. In the Goukou, Gouritz and Keurbooms estuaries five transects were sampled capturing the estuary – terrestrial interface and sediment and groundwater characteristics were measured in the salt marsh, fringe and terrestrial habitats.

The estuarine area below the 5 m contour was divided into national landcover types and mapped in ArcGIS 10. Morisita dissimilarity analysis showed that all three habitats were 29.4 % similar with terrestrial vegetation being similar to the fringe habitat but had no similarity to salt marsh habitats. CCA showed that species distribution was significantly affected by environmental factors ($P < 0.01$) and was positively correlated with the sediment salinity and groundwater salinity in salt marshes and sediment organic content and elevation in terrestrial habitats. Agri Lourens River Flood cultural cultivation had the greatest area cover within the boundaries of the Goukou and Gouritz estuaries and while Urban Built-up areas were dominant in the Keurbooms Estuary. These estuarine- terrestrial boundaries should be incorporated into management and monitored with regard to global change in order to effectively conserve salt marsh habitats and functionality.

A method for determining appropriate buffer zones for wetlands, rivers and estuaries

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To date, good progress has been made to define and delineate wetland and riparian areas. This progress has culminated in the production of useful tools to assist in identifying and delineating wetland and riparian areas. However, limited guidance has been provided for the establishment of buffer zones. The objective was to address this gap by developing a method for determining appropriate buffer zones, which could be consistently applied to guide land use decision making around South Africa's wetland, river and estuarine resources. The method developed included a tiered approach to facilitate decision making. The relationships of the criteria used to model the buffer zone requirements, which include identifying core habitat areas, and the levels of risk associated with the proposed activity on water resources were the primary drivers. Site-based modifiers were developed to address site specific characteristics, which were identified to have either a reduced or enhanced effectiveness on buffer zones. Additionally, alternative mitigating measures, which are more effective at addressing a range of impacts, were investigated to support the development of buffer zones. Ultimately, the method for determining buffer zones aims to help reduce the impacts of adjacent land uses on wetland, river and estuarine resources.

POSTERS

Do we make the grade? A critical assessment of completed environmental flow requirement studies for South African estuaries

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In the past three decades South Africa has moved away from simplistic hydrological determinations of estuary water requirements to integrated ecosystem based approaches that incorporate numerous biotic and abiotic components. The National Water Act (36 of 1998) legalised the need to ensure supply of freshwater to aquatic ecosystems. Resource Directed Measures (RDM) studies fulfil this requirement as an official, scientifically defensible and repeatable method of determining environmental flow requirements. A 'learning by doing' approach was adopted in the development of this method, which is currently in its third revision since commencement in 1999. RDM studies have been completed for nearly 40 South African estuaries and ultimately all 250+ South African estuaries will be assessed at a comprehensive level.

South Africa is the only country that has consistently applied the same method for assessing Ecological Water Requirements (EWR) of estuaries and thus provides a unique situation for review of completed assessments. This study describes completed RDM assessments on estuaries of varying biogeography, type and size. Some of the RDMs completed were commissioned by external sources, often as sub-studies of catchment-wide EWR assessments, such as the Mtata and Outeniqua studies. Due to time and budgetary constraints these assessments were conducted at either desktop or rapid determination levels with low confidence levels. Rapid determinations, for example Siyaya

and Tsitsikamma Estuary, sometimes forego certain protocols of the RDM methodology, such as water quality or bird assessments, and thus preferably should not inform water use licences. This study illustrates the value of applying adaptive, yet consistent methods to complex systems to provide a quantifiable measurement of estuarine environmental flows, health and importance.

Research on freshwater copepoda in South Africa, a glimpse into the past

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Many of the early taxonomists who contributed to our knowledge of freshwater Crustacea did so many years ago and often at an advanced age. Sars was 80 years old when in 1927 he produced his magnificent account of the freshwater Copepoda of the Western Cape. They were medical doctors, teachers, university lecturers, ministers of religion. Electronic communication was virtually unknown. The study of entomology (and zoology) began when pupils of Linnaeus came to South Africa to collect specimens. Thunberg (from 1770-1803), Sparrmann (from 1772-1776) and Wahlberg (from 1838-1845) sent many hundreds of specimens back to Europe for description. Wahlberg, who was killed by an elephant in 1856, had sent 5000 specimens to Sweden to be described by Wallengren. The first freshwater calanoid copepod to be described from southern Africa, *Lovenula falcifera*, was collected by Wahlberg and described by Loven in 1845. In addition to Sars and Loven, scientists who contributed to freshwater copepod taxonomic research in southern Africa were: Brady, Daday, van Douwe, Gurney, Rühe, Kiefer, G. Evelyn Hutchinson, and South African scientists Arnold Cooper and William Purcell. Keppel Harcourt Barnard (1887-1964), Director of the South African Museum in Cape Town, Fellow of the Linnean Society, Fellow of the Royal Society of South Africa and the recipient of numerous scientific awards, established a centre of excellence for research on marine and freshwater invertebrates.

Using free and open source software for spatial analysis of biomonitoring data – putting the “R” in “RHP”

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The Rivers Database is a repository of biomonitoring data, mainly from the South African River Health programme. The database includes an advanced client-server data entry and storage system and has been archiving data for nearly two decades.

As the system stands, the user needs to perform several intermediate steps in order to analyse the data, starting with a graphical user interface running in Microsoft Internet Explorer™ to synchronise the data with the server and then extract the required dataset. The user must then import the results into the data analysis system of choice, usually a spreadsheet package.

The free and open source R software can read data from the Rivers Database through open database connectivity (ODBC) or via intermediate CSV files. Production of graphs and maps of habitat indicators is a simple process with R scripts and the maptools library. The potential for standardising internal reports and performing rapid data assessments is great.

The main difficulty is that the Rivers Database software is in desperate need of an update to run correctly under new versions of Microsoft Windows™ and to transfer data and software updates safely across an unfriendly Internet. Furthermore, the tight integration of the software with Microsoft Internet Explorer™ excludes many potential applications on mobile and Unix-based operating systems.

While continuing to develop applications using an old computer operating under Windows XP, we strongly recommend the updating of the database software to a level where users can install and operate it from the latest Microsoft Windows™ platforms.

Residents along river courses: view and knowledge of alien invasive plants

Miss Abigail G. Crisp and Miss Samantha J. Mc Culloch
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Alien Invasive Plants (AIP) pose a major threat to biodiversity around the world and research has shown that AIP use considerably more water than indigenous species. As South Africa is a water stressed country implementing projects and programs that would eradicate AIP is important. While many conservation plans and management programs have attempted to address the AIP problem, implementation of best available knowledge remains problematic. It has been suggested that this implementation failure is due to a knowledge gap between natural resource managers and stakeholders, living in the areas of project implementation. Previous studies have shown that stakeholders have varying views with regard to AIP and their management and that these views have the potential to sway the outcome of the implementation. This project focused on identifying the varying degrees of knowledge between demographic groups in order to determine if a knowledge gap could be responsible for the continued expansion of AIP in the Kat and Malgas Rivers of George, South Africa. Data was collected through semi-structured interviews and the data analysed by means of content analysis. Overall it was found that environmental importance ranked low across all the property demographic groups, even though they all indicated a high use of their biophysical environment. The lowest level of awareness on invasive alien plants came from the low property demographic and results showed that awareness and responsibility towards the environment was greatest amongst participants that practice knowledge sharing. It is recommended that follow up educational visits be made to the participants and that information regarding AIP is distributed widely and is more accessible to the public.

Catchment to coast: considering ecological infrastructure

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Ecological infrastructure (EI) sustains the delivery of ecosystem services that provide a range of biophysical and socio-economic benefits. Examples of EI include strips of riparian vegetation, wetlands, or coastal and estuarine ecosystems such as salt marshes and fore dunes. Socio-economic systems are embedded within natural ecosystems where humans rely on services provided by these ecosystems. If ecosystems are degraded or land uses are changed the ability for these system to provide services are generally reduced. A valuable service provided by EI is that of energy absorption and regulation. In the southern Cape the integrity of built infrastructure has been compromised through the degradation of EI, during the period 2003 – 2008 built infrastructure damage amounted to R2 billion due to severe weather events and flooding. This project aims to determine the level of understanding regarding the term EI and whether or not mandated organisations and professionals in the planning and development sector are protecting and maintaining EI for the benefit of ecosystem services. Data capture methods that will be used include semi-structured and in-depth interviews, focus groups, policy and implementation comparisons and detailed questionnaires. Data will be analysed through content analysis and multivariate analysis. This project will allow us to determine the absorptive capacity of mandated organizations to adopt and utilize the concept of EI while exploring the extent to which professionals in the planning and development sector understand and consider EI.

Preliminary data on population structures and health of two cichlids in the Nyamity Pan, Kwazulu Natal

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Water resource management is the most important aspect of environmental management as this affects all forms of life. Flood releases, or the lack thereof, impact the habitat of aquatic inhabitants in floodplains below a manmade lake such as the Pongolopoort Dam in the Phongolo River to a great extent. Community and population structures along with fish health are generally used to assess the integrity of such systems. Two species of the Cichlidae family, *Oreochromus mossambicus* (Mozambique tilapia) and *Tilapia rendalli* (Redbreast tilapia), were selected as target species for this study. Both these species are considered to be of economic importance as they are extensively used in local Phongolo floodplains fisheries. A total of 127 *O. mossambicus* and 38 *T. rendalli* were caught using a 25m seine-net at Nyamity Pan situated in the Ndomu Game Reserve. All the fish were measured, weight and tagged with dart tags before they were released. Results indicate that the *O. mossambicus* community is much bigger and more established, but not as healthy as the *T. rendalli* community with average K- values (body conditioning factor) of 3.5122 and 4.4843 respectively. The difference between community structures of fish from inside and outside the Ndomu Game Reserve is currently being studied to determine the effect (if any) conservation has on population structures of these two species.

Macroinvertebrates as an ecological indicator of low land rivers in sub-tropical Africa

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The use of macroinvertebrates as biological indicators in the determination of the ecological integrity, state or health of lotic ecosystems is globally well established. The South African Scoring System, version 5 (SASS), the Macroinvertebrate Response Assessment Index (MIRAI) and multivariate statistical analyses are the most commonly used methodologies to assess the response of macroinvertebrate communities to stressors in South Africa. The aim of this study was to use macroinvertebrates as ecological indicators for the lowland reaches of the Amatikulu, Thukela and Umvoti Rivers, KwaZulu-Natal, South Africa. Macroinvertebrates were sampled during both high and low flow periods following the standardised SASS 5 protocol. For accurate identification of specimens, samples were preserved in 10% neutral buffered formaldehyde, transported back to the laboratory and identified with the aid of a dissection microscope. Current (2011 and 2012) and historical (1999 – 2010) data of high and low flow surveys were used during this study. SASS 5, MIRAI and multivariate statistical analyses were implemented in order to determine the ecological integrity of the lower Amatikulu, Thukela and Umvoti Rivers. Results revealed that the SASS 5 integrity classes were generally one class higher than the integrity classes of MIRAI. SASS 5 and MIRAI integrity classes of the Amatikulu River ranged from natural (Class A) to largely modified (Class D/E) while the Thukela and Umvoti rivers ranged from natural to seriously modified (Class E/F).

Spatial and temporal variability in water quality characteristics of the Swartkops Estuary

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Water quality within the heavily urbanised and industrialised Swartkops River catchment has been poor, with frequent sewage spills from wastewater treatment works (WWTW) in the upper reaches and polluted stormwater from residential townships and industries in the middle reaches. During a South African National Biodiversity Assessment (2011), the Swartkops Estuary in the Eastern Cape was classified as one of 14 permanently open estuaries with a Present Ecological State of category C, meaning the system is *moderately modified*, and further classified as having an ecosystem threat status of *critically endangered*. To evaluate the impact of pollution sources and the influence of freshwater inflow, spatial and temporal variability in water quality characteristics were investigated in September 2012, November 2012 and February 2013. All nutrients (total oxidised nitrogen, ammonium, total inorganic nitrogen, soluble reactive phosphorus) showed significant spatial and temporal differences and strong correlations with salinity, total suspended solids and chlorophyll-a concentrations, with concentrations increasing from the mouth towards the tidal head. Conflicting trends between the relationships involving salinity levels and flow rate with both nutrients and chlorophyll-a concentrations, suggested that freshwater inflow is not the main driver of spatial variability, but rather nutrient rich inputs from downstream stormwater, WWTW and industrial discharges. This observation is further supported by significant differences in nutrient concentrations detected between channel sites when the non-channel / point source sites were included in the analyses. Bacterial loads revealed spatial and temporal variability, with counts regularly exceeding the national water quality guidelines in the estuary channel (faecal coliforms, 39%; *Escherichia coli*, 39% and enterococcus, 22%) and at the non-channel / point source sites (faecal coliforms, 58%; *E. coli*, 50% and enterococcus, 35%).

Using remote sensing tools to assess the degradation of wetland ecosystems in conserved and non conserved area in the Nelson Mandela Bay Area

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Wetlands in South Africa are increasingly coming under threat from agriculture and urban development and rapidly disappearing, especially smaller and ephemeral systems. In response to the many threats to wetlands South Africa has seen an increased interest in wetland research, which has brought about many important methods that help standardize the approach to research, management and conservation of wetlands. Remote sensing (RS) can be a powerful tool to monitor changes in wetland size and degradation leading to losses in wetlands. Four Landsat TM satellite images taken within a 20 year period were analysed to detect changes in wetland size and vegetation structure over different years and seasons. Change detection involves the use of multitemporal data sets to discriminate changes in area of land cover between dates of imaging. Post classification change detection was carried out and landcover classes were classified using unsupervised classification. Changes in vegetation cover were analysed using Normalized Difference Vegetation Index (NDVI). Two wetlands within a newly created conservation area were compared to two wetlands in a municipality open space adjacent to the conservation area. Each area has a different level of management and land usage. The sites were used to validate the use of RS to detect changes in vegetation as a result of land use and management. The results of this study will give an indication regarding the usefulness of RS tools in assessing the health status of wetlands and how RS can be used effectively for rehabilitation, management and protection of threatened wetlands.

Abundance, biomass and phosphorus distribution among selected abiotic and biotic components of two Kwazulu-Natal Estuaries, South Africa

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Dr. Ursula Scharler, School of Life Sciences, University of KwaZulu-Natal, Westville Campus, Durban

Phosphorus is an essential element as it can control primary productivity in aquatic ecosystems and its excess can lead to eutrophication. The aim of this project was to determine phosphorus distribution in living and non-living nutrient pools of two KwaZulu-Natal estuaries.

Samples of dissolved inorganic phosphorus (DIP), particulate phosphorus (PP), phytoplankton, microphytobenthos, zooplankton, macrozoobenthos and sediment were collected in the temporarily open/closed Mpenjati (MP) and permanently open Mlalazi Estuary (ML) during May (ML), September (MP) and November (ML+MP) 2011 using standard methods. Chlorophyll a concentrations as well as species richness, abundance and biomass of zooplankton and macrozoobenthos were analysed. Biotic and abiotic nutrient pools were then analysed for phosphorus and were compared between stations, sampling sessions, estuaries and taxa.

Sediment comprised the highest phosphorus content in both Mlalazi ($4871.1 \text{ mgP}\cdot\text{m}^{-2} \pm 5888.9 \text{ SD}$) and Mpenjati ($2578.6 \text{ mgP}\cdot\text{m}^{-2} \pm 1828.0 \text{ SD}$) estuaries followed by DIP ($120.5 \text{ mgP}\cdot\text{m}^{-2} \pm 177.7 \text{ SD}$ and $5.9 \text{ mgP}\cdot\text{m}^{-2} \pm 6.0 \text{ SD}$ respectively). The least phosphorus biomass was contained in zooplankton with both estuaries containing zooplankton P biomass of $0.001 \text{ mgP}\cdot\text{m}^{-2} \pm 0.002 \text{ SD}$. Particulate phosphorus and DIP concentrations were higher in the upper reaches indicating that rivers were the main sources of this nutrient in these systems. The Mlalazi had higher nutrient levels than the Mpenjati Estuary. Such elevated nutrients can be enhanced by the continuous river flow together with nutrients into the permanently open estuary. No significant differences in P content between taxa were observed in this study.

Predicting the response of macrophyte habitats to management scenarios in the St Lucia Estuary

Miss Kelly Rautenbach, Nelson Mandela Bay Metropolitan University
Professor Janine Adams, Nelson Mandela Bay Metropolitan University
Dr. Ricky Taylor

The St. Lucia Estuary, a Ramsar site, a World Heritage site, and the largest estuary in South Africa, has been subject to many natural (a decade long drought) and anthropogenic (sugar cane farming and mouth manipulation activities) impacts over the years. The altered freshwater inflows and management decisions influence its mouth condition and health and distribution of the biota. The macrophyte habitats included in this study were the reeds, sedges, mangroves, grass and shrubs, salt marsh, swamp forest, submerged macrophytes and groundwater-fed communities. GIS data were used to estimate the total area per macrophyte habitat for five different estuary regions (False Bay, North Lake, South Lake, Narrows, Mfolozi Estuary). These data were used with the eco-physiological tolerances of the dominant macrophyte species to predict the response of the different habitats to various management scenarios as set out by the Global Environmental Facility (GEF) project, which include: 1) the “do nothing” scenario; 2) maintain separate Mfolozi and St Lucia mouths with water transfer schemes; and 3) actively facilitate a single mouth. The results indicated that the best management scenario would be to actively facilitate a single mouth as the as the estuary habitats will increase significantly because of tidal and saline conditions. This would represent more natural conditions for the different macrophyte habitats. The results of the study will be made in the form of recommendations for future “adaptive management” strategies (part of the GEF Project currently being run by Anchor Environmental).

Hepatic responses in fish inhabiting a hyper-eutrophic freshwater system

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The Roodeplaat Dam is located in the Gauteng Province of South Africa. As a result of various human activities, this system is highly polluted and classified as hyper-eutrophic with severe seasonal algal blooms. This paper reports on the macroscopic and microscopic changes identified in the livers of the sharptooth catfish *Clarias gariepinus* and the Mozambique tilapia *Oreochromis mossambicus* inhabiting these systems. Fish were collected using gill nets. Each specimen was measured and weighed and a standard necropsy was performed. The livers were weighed for the calculation of the liver somatic index and liver samples were fixed in 10% formalin solution for light microscopy analysis. Macroscopically, the affected livers of *C. gariepinus* appeared nodular with focal discolouration. In severe cases, the affected livers no longer had a cohesive, firm structure, and rather consisted of multiple fatty nodules of varying sizes and shapes and regions of green and yellow discoloured tissue. The primary histological changes identified in the sampled catfish included hepatocellular vacuolation characteristic of steatosis, inflammatory responses, peri-cellular fibrosis and nuclear inclusions. Other distinct histological features in this species included increased numbers of large melano-macrophage centres and intracellular pigmented deposits, foci of hepatocyte hypertrophy and atrophy, hepatocellular pleomorphism, and hepatocellular necrosis. One *O. mossambicus* specimen showed bile duct hyperplasia. The exact causative agent of the liver pathology identified is still unclear, but could be related to microcystin exposure and needs further investigation. The severe hepatic response in fish inhabiting these systems raises concern for possible human health effects if exposed to the same water.

An assessment of the histology and edibility of *Clarias gariepinus* and *Cyprinus carpio* from two impoundments in the North West Province, South Africa

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Established mining and agricultural activities taint surface runoffs that may pollute adjacent freshwater impoundments within the Bojanala Platinum district of the North West Province. Two major dams within the region, namely the Roodekopjes and Vaalkop Dams support subsistence fishing, which makes the health of these fish a potential concern, as they nourish some of the local communities' sole dietary protein.

The study aim was to determine the health and edibility of these fish by: (1) determining the presence of selected pollutants in the water and sediment; (2) performing a semi-quantitative histology-based fish health assessment on selected target organs of *Clarias gariepinus* and *Cyprinus carpio*; (3) measuring bio-accumulated levels of selected pollutant in the muscle tissue of collected fish; and (4) determining the potential health risk/s to humans following consumption of these fish in the form of cancer and/or disease.

Tissue samples were processed for light microscopy assessment using standard histological techniques. Muscle samples were analysed by accredited laboratories and a human health risk assessment was performed. Results from the two exposed sites were assessed against a reference site, the Marico-Bosveld Dam.

The histological analysis of selected target organs showed few to moderate histological alterations, of which were primarily regressive and vascular in nature. The mean fish index, indicator of the overall

histological response, showed only *C. carpio* at Roodekopjes Dam to differ significantly from the reference site (Mann-Whitney Test, $U=26.5$, $z=-2.454$, $P<0.05$). The edibility study showed no major toxic or cancer risk/s for either species at any sites.

Ovarian cholesterol granuloma in Sharptooth catfish from the Rietvlei Dam, Gauteng Province

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This paper reports on the histology of an ovarian cholesterol granuloma identified in a Sharptooth catfish *Clarias gariepinus* from the Rietvlei Dam located in the Gauteng Province of South Africa. Cholesterol granuloma is a rare, benign growth and is usually associated with middle-ear disease in humans but has also been described in other mammals before. With regards to fish, Magi *et al.* (2009) identified this lesion in the cardiac tissue of a piper gurnard *Trigla lyra*. However, to our knowledge, there is no reported case in the literature of cholesterol granuloma in the ovarian tissue of fish, and specifically the sharptooth catfish, as yet. Histologically, the lesion had characteristic unstained cholesterol clefts with surrounding granulomatous tissue. This growth was identified during a standard necropsy procedure and was visible as a free-floating spherical mass within the ovarian tissue. The ovary was in the mature stages of oogenesis with the majority of ovarian follicles in the late vitellogenic stage. The histological assessment of the surrounding ovarian tissue also showed atretic follicles within the same organ.

Are the Berg and the Olifants River facing the same changes in silicon content?

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Riverine floodplains are highly dynamic, valuable ecosystems, providing a wide range of ecosystem goods and services (nutrient control, water supply,...). The quality and availability of river water on the long run is strongly coupled with human changes in the biogeochemical cycle. Changes in land use therefore influence soil properties and vegetation communities impacting the flow pathway that water, sediments, nutrients and pollutants follow. This changed river quality will have a devastating impact on the riverine communities resulting in a degradation of the biodiversity.

This study aimed to identify Si stocks in the ecosystem, including the riparian zone, of the Berg and Olifants River. In a space-for-time approach, current gradients in land use will be assumed representative for historical changes in land cover. Smaller sub-basins, representing a gradient from still largely pristine to either largely in use for agriculture, mining or largely replanted with alien vegetation, or a combination of these factors, will be sampled for nutrients, suspended matter and pollutants.

Vegetation, sediment and pore water in riparian ecosystems were collected at 4 sampling locations within the upstream catchment area of the Berg River. For the Olifants River 15 points were selected for sampling surface water in relation towards different land-use types.

Our results show that nutrient concentrations in the riparian sediments of the rivers reflect nutrient concentrations in the river. N concentrations in the sediment increased up to 1 000%, while P concentrations rose up to 200% with increasing human influence.

Metal concentrations in the muscle tissue of four indigenous fish species from two impoundments of the Olifants River (Limpopo Province)

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The Olifants River is presently the third most polluted river in South Africa, particularly at the upper catchment area which is characterized by major agricultural activities, coal-fired power stations, industrial and coal mining operations. Anthropogenic impacts (including frequent sewage spills) have resulted in the gradual deterioration of the water quality amongst others by unacceptable levels of metals. The study was conducted to measure concentrations of metals in muscle tissue of *Clarias gariepinus*, *Schilbe intermedius*, *Labeo rosae* and *Oreochromis mossambicus*, collected from Flag Boshielo Dam (FBD) and the Phalaborwa Barrage (PB) in the Olifants River. Metal concentrations were determined by an accredited laboratory by means of ICP-OES. The metal concentrations in the fish muscle tissue from FBD were significantly higher than those from the PB. There was a significant difference in the metal concentration in the muscle tissue of fish from the two impoundments. About 75% of the dissimilarity between the fish from the two impoundments can be attributed to iron, vanadium, barium, antimony, zinc and silver. Similarity in the metal concentration in muscle tissue of fish from FBD can be attributed to iron, antimony, cobalt, strontium zinc and tin. For the PB, similarity in metal concentration can be attributed to arsenic, strontium, tin, selenium, antimony, barium and boron. Concentrations of several metals in the fish muscle tissue from both impoundments were higher than WHO/FAO certified values, hence regular monitoring of metals in fish tissue is warranted. Many rural communities in the vicinity of the dams, make use of fish as an additional protein source, thus metal contaminated fish can pose a serious human health risk.

The bioaccumulation of selected metals in *Tilapia zilli* from the Ivory Coast, West Africa

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Anthropogenic activities occurring within a catchment area pose a risk to the integrity of the receiving aquatic ecosystems due to the release of various metals into the system. The release of the metals may alter the state of the system from the natural (reference) conditions. Due to the increase in anthropogenic activities and the subsequent increase in the risk posed to the receiving systems, a comprehensive baseline investigation was required in order to facilitate future monitoring programmes. Metals which have entered into a system are then partitioned into the various features associated with the aquatic ecosystem, namely the sediment, water column and biota.

This study aims to determine the baseline concentrations of metals within the various partitions of the aquatic environment of a dam in the Northern Cote D'Ivoire. Sediment, water and *Tilapia zilli* muscle tissue were analysed for a variety of metals. The findings from the study indicate the concentrations associated with the sampled sediment, water and fish tissue and show trends between bioaccumulation and concentrations within the ambient environment. The results of the study contribute towards the establishment of baseline conditions within West Africa.

Fishing the Phongolo floodplains: trends in subsistence fisheries

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Following the construction of the Pongolapoort Dam in 1974, concerns related to the influence of the resulting changes in water flows into the Phongolo floodplain led to extensive studies on the fishes of this region. These studies emphasized the importance of the system in the maintenance of social and ecological services of fish communities. Between the early 1980s and mid 1990s the human population increased from 30,000 to 100,000. With a greater population increase over the last 15 years there is concern regarding the lack of updated studies on the general status of the Phongolo floodplain system. As part of a larger study on the lower Phongolo River and Floodplains fish catch records data obtained by Ezemvelo KZN Wildlife from line and hook subsistence fishers in the Ndumo region were analysed. The data extends over the period from 2001 to 2011 and included species identity, bag number and fish sizes. The three main species caught by the anglers were the sharptooth catfish, *Clarias gariepinus*, Mozambique tilapia, *Oreochromis mossambicus* and the redbreast tilapia, *Tilapia rendalli*. The size of caught specimens showed a downward trend (non-significant) for all three species during the 11 year period. Bag sizes showed a similar insignificant downward trend. Interestingly, smaller species and possibly non target species such as the imberi, *Brycinus imberi* and brown squeaker, *Synodontis zambezensis* only started appearing from 2008 in the catch records. This possibly indicates a switch due to reduction in the numbers of the preferred target species.

Chlorophyll concentrations in the macrophyte *Ceratophyllum demersum*, introduced to a metal-polluted South African river

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Chlorophyll a, b and total chlorophyll contents were measured in the submerged macrophyte *Ceratophyllum demersum*, introduced to the Diep River, Cape Town, South Africa. Previous studies on this river have shown high levels of metal contamination, however, studies on metal bioaccumulation and toxicity in aquatic macrophytes in this river is very limited. Plants were obtained from a reference site and placed in baskets at two sites within the river, one upstream (site 1) and one downstream (site 2) from urban pollution sources. Plants (introduced at both sites, as well as existing plants at site 2) were collected every fortnight for twelve weeks. Leaf samples were measured for chlorophyll a, b and total chlorophyll contents using a spectrophotometer. Results showed that plants at site 2 had significant ($p < 0.05$) increases in all chlorophyll groups over the experimental period, possibly due to higher nutrient content in the water, originating mainly from the nearby sewage works and industries. Chlorophyll concentrations in existing plants at site 2 were generally significantly lower ($p < 0.05$) than those of the reference plants, indicating that long-term metal exposure and the energy demands associated with metal regulation and stress, may result in permanent effects on chlorophyll production and photosynthesis. It was concluded that chlorophyll contents of *C. demersum* can potentially be used as biomarker of metal exposure but its use as early warning biomarker needs further research as present results were inconclusive.

Western Cape Wetland critical biodiversity area ground-truthing in pilot catchments

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CapeNature, Working for Wetlands and the Mondi Wetlands Programme have partnered in the Western Cape to undertake ground-truthing of CapeNature's provincial conservation plan wetland priority areas ("Critical Biodiversity Areas"). The outputs of the recent National Freshwater Ecosystem Priority Areas project are also considered. Regional staff contribute their knowledge of the area and develop further competence in evaluating wetland systems (e.g. field identification/delineation, key condition, unique/scarce wetland types) and key actions for their conservation and wise use. A catchment approach is adopted for more comprehensive wetland CBA ground-truthing, with the aim of:

- generating a catchment map showing a hierarchy of importance within the CBAs and FEPAs, an explanation of their importance, and identifying key opportunity areas and rehabilitation priorities
- taking a strong social learning approach, where skills from across the organisation, as well as from partners in the catchment, are tapped into
- developing protocols for data collection (GIS mapping, collecting information on wetland type and condition)
- testing the provincial (CBA) and national (NFEPA) priorities at a detailed, local catchment scale and providing feedback on the findings
- developing protocols for long-term wetland data management and future updates of a province-wide wetland inventory and conservation plan

Heavy metal concentrations in *Mytilus galloprovincialis* off the West Coast of the Cape Peninsula, Cape Town

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The concentration of trace metals (Fe, Mn, Cu, Zn, Cd and Pb) in the mussel (*Mytilus galloprovincialis*) were measured along the west coast of the Cape Peninsula, Cape Town, from autumn 2010 to autumn 2011. Sampling took place at Scarborough (considered an unpolluted site), Hout Bay, Green Point, Milnerton and Bloubergstrand. The samples of whole animal soft tissue were analysed using an Atomic Absorption Spectrophotometer (AAS). Metals in *M. galloprovincialis* were significantly lowest at Scarborough and at the other sites differed significantly between seasons, with winter having the highest significant difference. The efficiency of metal accumulation was measured using the Biosediment Accumulation Factor (BSAF). The results showed that the BSAF was highest in Cd, Pb, Zn and Cu, with the lowest BSAF reported in Fe and Mn.

Evaluating the minimum effective dose of rotenone for the eradication of alien smallmouth bass (*Micropterus dolomieu*) from a South African river

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The Rondegat River, situated in Cape Floristic Region, was the first river in South Africa where the piscicide rotenone was evaluated as a potential biodiversity restoration tool. The presence of alien invasive smallmouth bass *Micropterus dolomieu* has caused a local extirpation of the highly threatened endemic fish community and the removal of this species will potentially allow recolonization of the native species. In preparation for this treatment, the sensitivity of smallmouth bass to various concentrations of the rotenone formulation CFT Legumine (5% active rotenone) was evaluated using standard toxicity tests to determine the minimum effective dose (MED) that would result in 100% mortality after an exposure of 4 hours. The MED was 0.0125 mg/L rotenone, resulting in complete mortality of smallmouth bass within four hours of exposure. Adverse effects, which included erratic swimming, loss of equilibrium, and death, occurred in a dose-dependent manner with smaller fish responding faster than larger fish. Standard operating procedures for the use of rotenone in streams recommend treatment at twice the calculated MED but due to the uncertainty associated with rotenone losses under field conditions (e.g. through hydrolysis and photolysis) and the possible occurrence of smallmouth bass larger than those tested, a concentration of twice the recommended treatment dose (0.050 mg/L rotenone) was finally used to treat the Rondegat River for a duration of 6-hours. This resulted in the reduction of smallmouth bass to undetectable levels, providing strong evidence for successful eradication.

