

ESTUARINE, COASTAL AND OCEANIC ECOSYSTEMS: BREAKING DOWN THE BOUNDARIES



**ABSTRACT BOOKLET FOR THE
14TH SOUTH AFRICAN MARINE SCIENCE
SYMPOSIUM /
49TH ESTUARINE AND COASTAL SCIENCES
ASSOCIATION INTERNATIONAL CONFERENCE**



**RHODES UNIVERSITY
GRAHAMSTOWN
4-7 APRIL 2011**



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**National Research
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SAIAB
South African Institute
for Aquatic Biodiversity

BOOK OF ABSTRACTS & SYMPOSIUM GUIDE

14TH SAMSS / 49TH ECSA
INTERNATIONAL CONFERENCE

Hosted by:



RHODES UNIVERSITY
Where leaders learn

GRAHAMSTOWN
4-7 APRIL 2011

Disclaimer:

Please note that all reasonable endeavours have been taken to ensure that the information included in this document is correct at the time of printing. The organisers, however, accept no responsibility for any inaccurate statements that may appear, or any changes in the programme that may occur. Organisers reserve the right to make changes to the programme from time to time as may be necessary or appropriate at their absolute discretion.

Introduction:

The organising committee of the South African Marine Science Symposium (SAMSS) and the Estuarine and Coastal Sciences Association (ECSA) would like to take this opportunity to welcome all the delegates to the conference. We trust that your stay in Grahamstown will be enjoyable and that the symposium will be interesting and rewarding. This volume contains general information that may assist you during your stay in Grahamstown as well as the detailed programme of the SAMSS/ECSA 2011 conference. Abstracts for all the oral and poster presentations and an index of authors are listed in the booklet.

Scientific Committee:

Professor Alan Whitfield (South African Institute for Aquatic Biodiversity)

Professor William Froneman (Rhodes University, South Africa)

Dr Isabelle Ansorge (University of Cape Town, South Africa)

Professor Mike Elliot (University of Hull)

Professor Victor de Jonge (University of Hull)

Dr Reg Uncles (Plymouth Marine Laboratory)

Symposium sponsors:

The SAMSS/ECSA organising committee would like to acknowledge the generosity of the following organisations that contributed towards the reducing of the symposium fees and student prizes:

Sponsors (in cash or kind):

South African Institute for Aquatic Biodiversity (SAIAB)

Rhodes University (RU)

National Research Foundation (NRF)

South African Network for Coastal and Oceanographic Research (SANCOR)

Prizes for best student oral and posters are sponsored by SANCOR

Instructions for Presenters

As the programme is very full and time is limited, we request that the following be taken into consideration when presenting:

- PowerPoint presentations should be loaded onto the computer in the relevant venue prior to the presentation. This can be done early in the morning or a tea/lunch times. Technical assistants have been assigned to venues to assist with equipment and the loading of presentations.
- Arrive at the venue at least 30 minutes before the presentation is due.
- All presenters will be introduced by the session chair as per the programme. Please make yourself known to your chair where possible.
- Presentation slots are 15 minutes – please allow for question time after your presentation. It is suggested that presentations be 10 minutes with 5 minutes for questions.

Instructions for Chairs

To ensure that all presenters receive a fair opportunity to present their work, please note the following:

- Familiarise yourself with the given time constraints for speakers and signal 5 minutes before time is up
- To encourage interaction between delegates, make sure that there is enough time between presentations for questions
- Please introduce yourself to the student who is assisting with technical requirements in your venue. Should any concerns pop up they will then know who to address

Internet/Email access during the conference

A wireless network is available in the Barratt Complex. Delegates who wish to connect to the Internet using their own laptops need to obtain a user name and password to connect through the wireless network. In order to obtain a user name and password, delegates are required to provide a copy of either their South African identity document or a passport at the registration desks. Student helpers will be available throughout the conference to assist delegates who wish to connect to the wireless network. Delegates are requested to familiarise themselves with the policies before logging on.

What to do in Grahamstown

For those who have spouses or partners on the trip and those interested in getting to know our city a bit better, take a stroll down High Street past the Cathedral where you will find Makana Tourism – our local tourism office – on your left. They will be able to provide you with information about museums and places of interest in and around Grahamstown. Ask about the follow:

- The Observatory
- Cathedral
- Albany Museum
- 1820 Settlers National Monument
- Guided Tours

Contact names and numbers of importance

Technical Support

Eric Icweku	082 229 5078
Jerri Chigwande	076 289 5064
Tafadazwa	076 666 6677

Conference Manager

Carolyn Stevenson-Milln	082 801 1393
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Emergency telephone numbers (Grahamstown)

Emergency services	10177
Doctors – Drs Marx, Bennet & Gainsford	046 636 2063
Settlers Hospital	046 600 2215
Pharmacy – Grahamstown Pharmacy	046 622 7116
Police	046 622 10111
Ambulance (Emergency)	10177
(Non emergency)	046 622 915
Rhodes Campus Security	046 603 8146

Conference Catering & Social Events

SAMSS/ECSA Cocktail Function

Date: 3 April 2011

Time: 18:00 – 20:30

Place: Marquee outside the Barratt

Early-Morning, mid-morning & afternoon refreshments

Date: 4 – 7 April 2011

Time: As indicated in the programme

Place: The Barratt foyer

Lunches

Date: Daily 4 – 6 April 2011

Time: As indicated in the programme

Place: Marquee outside the Barratt

Themed Dinner

Date: 5 April 2011

Time: 19.00

Place: Marquee outside the Barratt

Gala Dinner (cash bar will be available)

Date: 6 April 2011

Time: 19:00

Place: Nelson Mandela Hall

Take a look at the map Rhodes Campus Map to find your way around

Friday 8th April - Day Excursion

KARIEGA GAME RESERVE DAY SAFARI

Kariega Game Lodge offers a unique combination of awesome Big 5 game viewing with an expansive variety of fauna and bird life in a landscape that incorporates five different eco-systems, displaying the most dramatic views and vistas.

10:00: Welcome drink on Arrival

11:00: Game drive and Majestic River Cruise including mineral water/juice

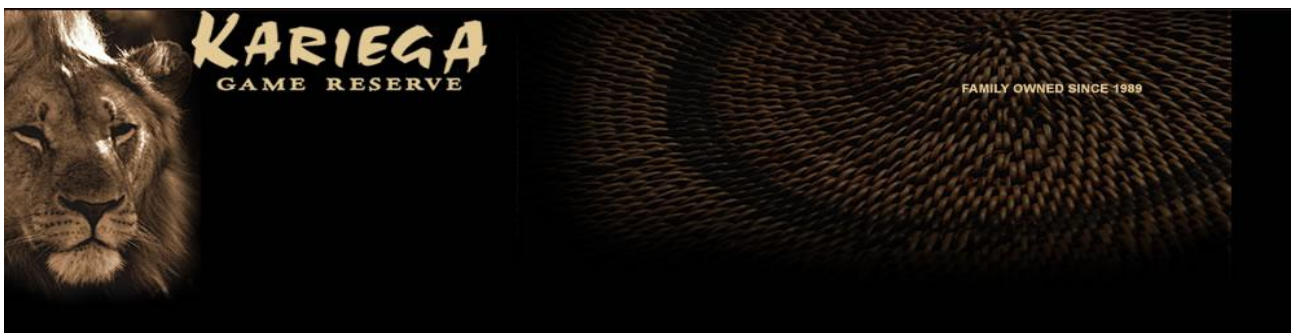
13:45: Lunch in Karega Lodge Restaurant

15:00: Depart

Cost: **R850.00** per person including transport to Kariega Game Reserve

Space is limited - **Maximum 60 guests**

For more information, visit their website: www.kariega.co.za



OVERALL PROGRAMME

	SUNDAY 3 RD	MONDAY 4 TH			TUESDAY 5 TH			WEDNESDAY 6 TH		THURSDAY 7 TH		
		PLENARY – BADAT			PLENARY			PLENARY		PLENARY		
09:00		ESTUARIES	LARGE MARINE ECOSYSTEMS	EDUCATION, RESEARCH & MANAGEMENT	ESTUARIES	MARINE & COASTAL MANAGEMENT	DIETS & FOOD WEBS	BIOTIC RESPONSES TO ABIOTIC DRIVERS	FISHERIES MANAGEMENT	BIODIVERSITY	MARICUTLUTRE	
10.30		TEA / COFFEE										
11.00		ESTUARIES	LARGE MARINE ECOSYSTEMS	EDUCATION, RESEARCH & MANAGEMENT	TOP PREDATORS IN MARINE ECOSYSTEMS	MARINE & COASTAL MANAGEMENT	DIETS & FOOD WEBS	BIOTIC RESPONSES TO ABIOTIC DRIVERS	FISHERIES MANAGEMENT	BIODIVERSITY		
12.30		LUNCH										
14.00	REGISTRATION	BIOGEOCHEM IN MARINE ECOSYSTEMS	METHODS FOR MONITORING ECOSYSTEMS		TOP PREDATORS IN MARINE ECOSYSTEMS	GLOBAL CHANGE	ECOSYSTEM STRUCTURE & FUNCTION	GENETICS & PHYLOGEOGRAPHY	FISHERIES MANAGEMENT			
15.30		TEA / COFFEE										
16.00		BIOGEOCHEM IN MARINE ECOSYSTEMS	METHODS FOR MONITORING ECOSYSTEMS		INVASION BIOLOGY	GLOBAL CHANGE		GLOBAL CHANGE	FISHERIES MANAGEMENT			
17.00-18.00		POSTER SESSION										
18.00		COCKTAIL FUNCTION										
19.00 -			FREE EVENING			THEMED DINNER			GALA DINNER			

DETAILED PROGRAMME

Day 1: SAMSS/ECSA Conference (MONDAY 4 APRIL 2011)

Time slot	Lecture venue 1	Lecture venue 2	Lecture venue 3
08:00	Opening ceremony (Dr S Badat, Vice Chancellor, Rhodes University)		
08:30	Plenary 1 A. Borja: Biotic responses to human pressures: moving from research to management issues		
	ESTUARIES	LARGE MARINE ECOSYSTEMS	EDUCATION, RESEARCH & MANAGMENT
09:00	<i>A.K. Whitfield & P.D. Cowley: Conservation of fishes in South African estuaries at a crossroad</i>	<i>J.A. Huggett, S. Ockhuis & T. Lamont: Zooplankton biomass and community structure associated with mesoscale eddies in the Mozambique Channel</i>	<i>V.N. de Jonge: Bridging fundamental science, policy making and management in practice</i>
09:15	<i>P.D. Cowley, A-R. Childs & R.H. Bennett: The trouble with estuarine fisheries in South Africa, illustrated by a case study on the Sundays Estuary</i>	<i>S. Jaquemet, B. Dyers, E. Bemanaja, S. Kaehler & J.F. Ternon: Seabird distribution in relation to mesoscale eddies in the Mozambique Channel</i>	<i>M. Moodley: Is Marine Science a language?</i>
09:30	<i>F. Valesini: Classifying estuarine habitats and predicting their fish faunas</i>	<i>L. Guastella, M. Roberts & F. Shillington: Dynamics and role of the Durban cyclonic eddy in the KwaZulu-Natal Bight ecosystem</i>	<i>D. Vousden, T.G. Bornman & M. Ngoile: Toward an effective management and governance approach within Large Marine Ecosystems based on predictive monitoring and early warning systems</i>
09:45	<i>A. McKinley, L. Ryan, M. Coleman, N. Knott, G. Clark, M. Taylor & E.L. Johnston: Putting sanctuaries into context: a comparison of estuary fish assemblages over multiple levels of protection and modification</i>	<i>M.J. Roberts, R. van Ballegooyen & C. Nieuwenhuys: Influence of the Agulhas Current on circulation patterns, hydrological structures and retention of shelf waters in the KZN Bight, South Africa</i>	<i>A. Jarre, B. Paterson, L.J. Shannon, J. Basson, E. McGregor, W. Osman, L-A. Rowbotham & M.D. Smith: Models for synthesis and communication: decision support tools in support of an ecosystem approach to fisheries management in the Benguela</i>
10:00	<i>N.A. Strydom: Ichthyoplankton in temperate South African estuarine nurseries: an assessment of local, regional and geographic community trends</i>	<i>M.J. Ayers & U.M. Scharler: Comparative ecosystem analysis of a data-limited marine ecosystem - the KwaZulu-Natal Bight, South Africa</i>	<i>P.J. Britz, S. Raemaekers, W.H.H. Sauer & M. Markovina: Governance challenges facing African fisheries</i>
10:15	<i>S.P. Weerts: The influence of mouth condition in temporary open closed estuaries on populations of estuarine fishes with different recruitment strategies</i>	<i>R. Barlow & T. Lamont: Phytoplankton absorption and pigment photoadaptation on the Natal Bight</i>	<i>J. Mann: Social and natural sciences - breaking down boundaries</i>

TEA			
	ESTUARIES	LARGE MARINE ECOSYSTEMS	EDUCATION, RESEARCH & MANAGEMENT
11:00	<i>M. Elliott</i> & A. Whitfield: Challenging paradigms in estuarine ecology	<i>C. Collins</i> , C. Reason & J. Hermes : The Comoros Gyre: a numerical modelling approach	<i>M.K.S. Smith</i> & E. Bester: Roving creel surveys, more than just catch and effort
11:15	<i>F. MacKay</i> & A. Whitfield: Macrobenthic distribution used to support abiotic derived ecological boundaries in a subtropical estuarine lake system	<i>A. Muller</i> , V. Mohrholz & M. Schmidt: Mesoscale structure and dynamics of a northern Benguela upwelling filament during October 2010	<i>A. Kock</i> , S. Titley, W. Petersen, M. Sikweyiya, P. Davids, S. Tsotsobe, D. Colenbrander, H. Gold & G. Oelofse: Shark Spotters: a pioneering shark safety program in Cape Town, South Africa
11:30	<i>U.M. Scharler</i> & F. MacKay: Macrozoobenthos as indicators of carbon and nitrogen processing and productivity in estuaries	<i>R.E. Roman</i> & J.R.E. Lutjeharms: Flow and transport of the East Madagascar Current system	<i>A. Bernard</i> , A. Götz, S. Kerwath & C. Wilke: FIN: The development of a volunteer based long-term monitoring programme for subtidal reefs around the Cape Peninsula
11:45	<i>J. Earl</i> , S. Dittmann, A. Fowler & Q. Ye: Variation in the diet of greenback flounder (<i>Rhombosolea tapirina</i>) affected by freshwater inflows in Australia's largest temperate estuary	<i>S. Swart</i> , P. Monteiro, I.J. Ansorge & S. Speich: The variability and dynamics of the Antarctic Circumpolar Current using altimetry-applied proxy techniques	<i>J. Basson</i> : Is our seafood sustainable? The considerations behind how WWF SASSI helps consumers make more sustainable seafood choices
12:00	A. McKinley, <i>A. Miskiewicz</i> , M. Taylor & E.L. Johnston: An assessment of the impacts of metals contamination and anthropogenic habitat modification on estuarine larval fish assemblages in southern New South Wales, Australia	<i>R. Williamson</i> , J.G. Field, F.A. Shillington, A. Jarre & A. Potgieter: A probabilistic modelling approach for estimating primary production from satellite remote sensing	<i>H.O.N. Ndjaula</i> , K. Gerow, C.D. van der Lingen, C. Moloney & A. Jarre: Establishing a baseline for evaluating population and condition dynamics of sardine (<i>Sardinops sagax</i>) in the Southern Benguela
12:15	<i>A. Becker</i> , P.D. Cowley, A.K. Whitfield, J. Järnegren & T.F. Næsje: Use of a dual frequency identification sonar (DIDSON) to examine the size structure and distribution of fish within a small closed estuary	M. Schapira, <i>C.D. McQuaid</i> & J.R.E. Lutjeharms: Spatial dynamic of picophytoplankton communities along the continental shelf adjacent to the Northern Agulhas Current	<i>T. Mtontsi</i> : High school deep sea monitoring
LUNCH			
	BIOGEOCHEMISTRY IN MARINE ECOSYSTEMS	METHODS FOR MONITORING ECOSYSTEMS	EDUCATION, RESEARCH & MANAGEMENT
14:00	<i>G. Pitcher</i> , T. Probyn & A. du Randt: Seasonal hypoxia and episodic anoxia on the southern Namaqua shelf of the Benguela upwelling system	<i>S. Dittmann</i> : How useful are monitoring derived data for ecological risk assessment?	R. Nel & <i>S. Bachoo</i> : Sea turtle monitoring in KwaZulu-Natal

14:15	<i>A. Flohr</i> & <i>T. Rixen</i> : Biogeochemical dynamics of the Benguela Upwelling with emphasis on the carbonate system	<i>E.S. McGregor</i> , <i>A. Jarre</i> & <i>C.D. van der Lingen</i> : Assessing the implementation efficacy of EAF in the South African sardine fishery	<i>N. Schell</i> : Perceptions of co-management theory and practice in small-scale fisheries in South Africa
14:30	<i>A.J. Smit</i> , <i>R.J. Anderson</i> , <i>J.J. Bolton</i> & <i>M. Roberts</i> : An in-shore <i>in situ</i> temperature climatology for the South African coast	<i>L.K. Blamey</i> , <i>L.J. Shannon</i> , <i>A. Jarre</i> & <i>K. Agenbag</i> : Developing ecosystem indicators for the southern Benguela inshore region	<i>N.P. Mbatha</i> : The influence of institutional arrangements in enabling access and facilitating equitable benefit sharing of coastal resources in rural coastal communities: Case studies from the Eastern Cape and KwaZulu-Natal
14:45	<i>M. Golubkov</i> : Influence of geochemical barrier on primary production of phytoplankton and decomposition of organic matter in water column in the Neva Estuary (Baltic Sea)	<i>A. Götz</i> & <i>S. Kerwath</i> : An alternative method for estimating the status of resident reef fish stocks, based on differential fishing effort across a marine reserve boundary	<i>S. Williams</i> & <i>M. Sowman</i> : Recognising the customary rights of traditional fishers in conservation planning and management: Lessons from Covie and Ebenhaeser-Papendorp
15:00	<i>J.S. Paimpillil</i> & <i>K.K. Balachandran</i> : Seepage of groundwater through coastal sediment layers: coastal 'mudbanks' formations with greening of near shore waters	<i>N.M. Twatwa</i> , <i>J.C. Coetzee</i> & <i>D. Yemane</i> : Towards acoustic discrimination between finfish and jellyfish in the southern Benguela system	<i>M. van der Merwe</i> & <i>B. Snow</i> : The use of learning support materials in the rural schools of Maputaland, KwaZulu-Natal, South Africa
15:15	<i>H. Asmus</i> , <i>R. Asmus</i> & <i>D. Baird</i> : The dependence of internal cycling of material within benthic communities on benthic pelagic exchange	<i>E. Tew-Kai</i> , <i>E. Walker</i> , <i>C. van der Lingen</i> , <i>J. Coetzee</i> , <i>N. Bez</i> , <i>J. van der Westhuizen</i> & <i>D. Grémillet</i> : Analysing fishing patterns of purse-seiners in the southern Benguela using Vessel Monitoring Systems (VMS)	
TEA			
	BIOGEOCHEMISTRY IN MARINE ECOSYSTEMS	METHODS FOR MONITORING ECOSYSTEMS	
16:00	<i>R. Uken</i> & <i>N. Mkize</i> : Sediment and heavy mineral distribution within the KwaZulu-Natal Bight	<i>N.B. Richoux</i> : Fatty acid ecology in aquatic ecosystems: potential for development in South Africa	
16:15	<i>R.C. van Ballegooyen</i> , <i>M.J. Roberts</i> , <i>A. Meyer</i> , <i>C. Nieuwenhuys</i> & <i>S. Taljaard</i> : Temporal variability of nutrient fluxes onto the northern Natal Bight offshore of Richards Bay and from adjacent catchments	<i>G.F. Matcher</i> , <i>R.A. Dorrington</i> , <i>T.O. Henninger</i> & <i>P.W. Froneman</i> : Characterization of eubacterial diversity profiles in the freshwater deprived Kariega Estuary using 16S rRNA analysis	
16:30	<i>N. du Plessis</i> , <i>I. Ansorge</i> , <i>T. Bornman</i> , <i>J. Read</i> & <i>J. Lutjeharms</i> : The hydrology and biogeochemistry across the Subtropical Convergence Zone in the	<i>D.M. Webber</i> , <i>M.J. Smale</i> , <i>W.H.H. Sauer</i> , <i>N.J. Downey</i> & <i>M.J. Roberts</i> : Studying squid spawning behaviour using Acoustic Telemetry Techniques	

	Southwest Indian Ocean region		
16:45	<i>B.S. Malauene, M. Roberts, F. Shillington & C. Moloney: Shelf edge upwelling off northern Mozambique</i>	<i>A. Barkai: Introducing electronic data logging to the South African and International commercial fishing industry</i>	
17:00-18:30	POSTER SESSION		

Day 2: SAMSS/ECSA Conference (TUESDAY 5 APRIL 2011)

Time slot	Lecture venue 1	Lecture venue 2	Lecture venue 3
08:15	Plenary 2: C.D. McQuaid: Time, space and generality in marine ecosystems		
	ESTUARIES	MARINE & COASTAL MANAGEMENT	DIETS & FOOD WEBS
09:00	<i>J. Largier: Anoxia in bar-built stratified estuaries: the Russian River as a case study</i>	<i>A. Oosthuizen, S. Holness & R. Chalmers: A systematic conservation plan for the proposed Addo ENP MPA</i>	<i>J. Sheppard, A. Whitfield, P. Cowley & J.M. Hill: Stable carbon isotopes and the possible role of aquatic macrophytes in the diet of estuary-associated fish species</i>
09:15	<i>D. Cyrus & L. Vivier: Lake St Lucia in crisis status after eight years of mouth closure, impacts on the meta system and options for recovery</i>	<i>L. Harris, R. Nel & D. Schoeman: Sandy beach conservation: getting around MPAs for amphipods...</i>	<i>N.K. Carrasco & R. Perissinotto: The comparative diet of the dominant zooplankton species in the St Lucia Estuary, South Africa</i>
09:30	<i>R. Lawrie: Anthropogenic impacts on the water and salt budgets of Lake St Lucia: the occurrence and persistence of water levels and salinities</i>	<i>M. Gulekana: Towards developing the first South African National Coastal and Marine Atlas</i>	<i>C. Mablouke, A. Cuvillier, G. Potin, J. Kolasinski, L. Bigot, P. Frouin, M. Potier & S. Jaquemet: Use of ¹³C/¹²C and ¹⁵N/¹⁴N isotope ratios to characterize trophic webs associated to artificial reefs: a case study from Reunion Island</i>
09:45	<i>C.A. Stow & C.F. MacKay: Response of estuarine macrobenthos to episodic flooding in urban and non-urban temporarily open/closed estuaries in KwaZulu-Natal, South Africa</i>	<i>K. Hutchings, B.M. Clark, K. Tunley & G. Wilson: Monitoring the environmental impacts of reverse osmosis desalination plant discharges on the marine environment off the Garden Route, South Africa</i>	<i>F. Porri, J.M. Hill & C.D. McQuaid: Associations in ephemeral systems: do close links between sandhoppers and beach wrack reflect trophic relationships?</i>
10:00	<i>T. Riddin & J. Adams: Dynamics of macrophytes in the East Kleinemonde, a small temporarily open/closed South African estuary</i>	<i>J. Turpie: Development and application of the Estuary Health Index in South Africa in the context of setting freshwater flow requirements</i>	<i>S. Vizzini & A. Mazzola: Food web structure in Mediterranean coastal lagoons under different trophic conditions</i>
10:15	<i>B.M. Clark & J.K. Turpie: The Pangani and Rovuma - a tale of two east African estuaries</i>	<i>S. Taljaard, J.H. Slinger & J.H. van der Merwe: An implementation model for integrated coastal management in South Africa - from legislation to practice</i>	<i>E.L. Allan, N.B. Richoux & P.W. Froneman: Regional variations in the diets of the benthic community around the Prince Edward Islands: Fatty acid signatures</i>
TEA			
	TOP PREDATORS IN MARINE ECOSYSTEMS	MARINE & COASTAL MANAGEMENT	DIETS & FOOD WEBS

11:00	<i>G.S. Penry</i> , P.B. Best, V.G. Cockcroft & P.S. Hammond: Conservation concerns for the South African inshore Bryde's Whale	<i>C. Floros</i> , M. Schleyer & L. Celliers: Fish as indicators of diving and fishing pressure on South African coral reefs	<i>B. Grote</i> , W. Hagen, M.R. Lipinski, H.M. Verheye, E.K. Stenevik & W. Ekau: Lipids and fatty acids as indicators of condition and maternal effects in <i>Merluccius paradoxus</i> and <i>M. capensis</i> early life stages
11:15	A. Brandão, <i>P.B. Best</i> & D.S. Butterworth: Monitoring the recovery of the southern right whale in South African waters	<i>L.E. Beckley</i> , C.B. Smallwood, S.A. Moore & H.T. Kobryn: Spatio-temporal distribution of recreational use in Ningaloo Marine Park, north-western Australia	<i>S.J. Geist</i> & W. Ekau: Food sources of early life stages of horse mackerel (<i>Trachurus trachurus capensis</i>) and anchovy (<i>Engraulis capensis</i>) from the Northern Benguela system revealed by stomach content, stable isotope and lipid analysis
11:30	<i>L. Snyman</i> , S. Elwen, M.N. Bester, T. Gridley, T. Meyer & R. Leeney: Individual variation in bottlenose dolphin ranges in Walvis Bay, Namibia. Implications for managing restricted areas	<i>D. Baird</i> : An assessment of the impact of local environmental changes on ecosystem function of selected coastal aquatic systems	<i>C.D. van der Lingen</i> & T.W. Miller: Calibrating ecosystem models of the southern Benguela with stable isotope data
11:45	<i>S. Elwen</i> , R. Leeney, T. Gridley, L. Snyman & J. Shihepo: Shrinking or emigrating? Decreasing abundance of a vulnerable population of common bottlenose dolphins (<i>Tursiops truncatus</i>) in Walvis Bay, Namibia, subject to high human impacts	<i>D. Pillay</i> , G.M. Branch, C.L. Griffiths, C. Williams & A. Prinsloo: Ecosystem change in Langebaan Lagoon (1960-2009): role of seagrass loss and anthropogenic disturbance	<i>A. Schukat</i> , H. Auel & W. Hagen: Trophic positions of calanoid copepods of the northern Benguela upwelling system identified by stable isotopes and fatty acids
12:00	<i>G.J.G. Hofmeyr</i> , M.N. Bester, S.P. Kirkman, C. Lydersen & K.M. Kovacs: Intraspecific differences in the diet of Antarctic fur seals at Bouvet Island	<i>M. Boonzaaier</i> : The effect of the thermal nest environment of hatchling sex ratios and success of loggerhead turtles (<i>Caretta caretta</i>) and the possible implications of turtle nesting in KwaZulu-Natal, South Africa	<i>L. Abram</i> , J. Sharples, G. Wolff, C. Frid & K. Kiriakoulakis: Characterising organic matter in shelf seas - clues to heterotrophic re-working and spatial and temporal variation
12:15		<i>L. Atkinson</i> , B. Newman & K. Sink Does oil mining on the Agulhas Bank affect benthic communities?	<i>A.M. de Lecea</i> , A. Omarjee, R. Cooper & A.J. Smit: The effects of preservation methods and dyes on the isotopic values ($\delta^{15}\text{N}$ and $\delta^{13}\text{C}$) of two zooplankton species from the KwaZulu-Natal Bight, South Africa
LUNCH			
	TOP PREDATORS IN MARINE ECOSYSTEMS	GLOBAL CHANGE	ECOSYSTEM STRUCTURE & FUNCTION
14:00	<i>B.S. James</i> , T. McIntyre, C.A. Tosh & M.N. Bester: Comparative dive behaviour of male southern	<i>J.G. Field</i> : Global change and the oceans around southern Africa: have we got our house in order?	<i>S.P. Weerts</i> & B. Newman: Impact of effluent discharge on the receiving environment off Durban

	elephant seals (<i>Mirounga leonina</i>) from two populations		
14:15	S.T. Ambrose, P.W. Froneman, M.J. Smale & S. Plön: Feeding ecology and diet shift of long-beaked common dolphins <i>Delphinus capensis</i> incidentally caught in shark nets off KwaZulu-Natal	H.M. Verheye & C. Reason: Long-term changes in autumn abundance, species composition and size structure of the copepod community in St Helena Bay over the past six decades	F. Porri, C. von der Meden & C.D. McQuaid: Spatial patterns of distribution of mussel larvae along the western Agulhas Bank
14:30	R.P. Koper: Indication of changes in sighting frequency, group size and behaviour of <i>Sousa chinensis</i> in Algoa Bay, South Africa since the early 1990's	L. van Niekerk, A.K. Theron, A. Meyer, N.C. James & F. Engelbrecht: Climate change and South Africa's estuaries	C. Hubas, C. Sachidhanandam, H. Rybarczyk, H. Lubarsky, A. Rigaux, T. Moens & D.M. Paterson: Bacterivorous nematodes stimulate microbial growth and exopolymer production in marine sediments microcosms
14:45	R. van Eeden, L. Pichegru & P.G. Ryan: African penguin foraging ecology in relation to fine-scale oceanographic processes in Nelson Mandela Bay, South Africa	M.H. Schleyer & P. Montoya-Maya: Effects of climate change on high-latitude coral reefs	C. Passarelli, F. Olivier, D.M. Paterson & C. Hubas: The worm and the diatom: an association of ecosystem engineers which improves sandy sediment stability
15:00	D. Reeb, M. Marais & P.B. Best: Fat and Fecund: Total lipid content in reproductively successful southern right whales (<i>Eubalaena australis</i>)	W.M. Potts, T.J. Richardson, R. Henriques, W.H.H. Sauer & P.W. Shaw: What climate-induced changes can we expect for coastal fishery species?	L. Hutchings, A. Jarre, H. Verheye, M. Worship, F. Frantz, S. Jones, H. Ismael, C. Illert & E. Wright: Ten years of seasonal shipboard transect monitoring in St Helena bay in the southern Benguela, 2000-2010
15:15		T.B. Hoareau: The role of paleoclimates in shaping the biodiversity of tropical marine species: a review	S.N. Porter, S. Kaehler, G.M. Branch & K. Sink: Trophic role of riverine particulate organic matter for inshore filter-feeder communities in the Natal Bioregion
TEA			
	INVASION BIOLOGY	GLOBAL CHANGE	
16:00	A.A. Olds, O.L.F. Weyl & M.K.S. Smith: Distribution and abundance of alien invasive fish species in a South African RAMSAR wetland, the Wilderness Lakes	J.J. Bolton, A.J. Smit, R.J. Anderson & M. Roberts: Correlation of seaweed biogeographical diversity patterns with a new dataset of coastal temperatures along the South African coast: modelling the potential effects of marine climate change on seaweed distributions	
16:15	M. Hall, F. Porri & C.D. McQuaid: Distribution of native and invasive mussels on the south coast of South Africa: competition and abiotic factors as potential causes	M. Fusi, F. Giomi, F. Porri, C.D. McQuaid & S. Cannicci: Thermal tolerance of two ecosystem engineers of East African mangroves: forecasting the effects of climate change on ecosystem functionality	
16:30	A. Terörde, B.M. Clark, K. Hutchings & K. Orr: Ballast	T. Muteveri, S. von der Heyden, R.C.K. Bowie & C. Matthee: Phylogeographic history of two endemic	

	water management technology testing	rocky shore gastropods on the South African coast: a signature of Pleistocene climatic changes and contemporary oceanography?	
16:45	<i>N.A.F. Miranda</i> & R. Perissinotto: Stable isotope analysis of gastropod diets in the coastal lakes of iSimangaliso Wetland Park, South Africa	<i>S. Golubkov</i> : Long-term dynamics of the ecosystem of the Neva Estuary (Baltic Sea): effects of climate fluctuations and invasions of alien species	
17:00-18:30	POSTER SESSION		
19.00	THEMED DINNER		

Day 3: SAMSS/ECSA Conference (WEDNESDAY 6 APRIL 2011)

Time slot	Lecture venue 1	Lecture venue 2
08:15	Plenary 3: R.J. Uncles: Physical processes in estuaries and some physical-biological interactions	
	BIOTIC RESPONSES TO ABIOTIC DRIVERS	FISHERIES MANAGEMENT
09:00	<i>C. von der Meden, F. Porri & C.D. McQuaid: Settlement intensification and the interpretation of topography-related intertidal abundance patterns</i>	<i>S. Kyle: The rise, fall and future of the Kosi Bay fishery</i>
09:15	<i>J. Tweedley, F. Valesini, S. Hoeksema & I. Potter: Relationships between fish and benthic macroinvertebrate faunas and habitat types in a seasonally-open Australian estuary</i>	<i>J.Q. Maggs, B.Q. Mann & P.D. Cowley: Rebuilding depleted line-fish stocks in the Pondoland Marine Protected Area and adjacent fisheries</i>
09:30	<i>M.C. Pfaff, G.M. Branch, J.L. Fisher, V. Hoffmann, W. Osman, A.G. Ellis & J.L. Largier: Lost in transit: a mismatch of onshore transport mechanisms limits larval delivery of intertidal invertebrates</i>	<i>J. Robey, J. Groeneveld & S. Fennessy: The abundance and biology of langoustines <i>Metanephrops mozambicus</i> and pink prawns <i>Haliporoides triarthrus</i> captured in deep-water trawls off eastern South Africa</i>
09:45	<i>R. Taylor & C. Fox: Drought at St Lucia Estuary: expected, unexpected and spectacular ecosystem responses</i>	<i>S.W. Dunlop & B.Q. Mann: An assessment of the shore-based and offshore boat-based linefisheries in KwaZulu-Natal, South Africa</i>
10:00	<i>S.C.L. Hoppe-Speer, J.B. Adams, A. Rajkaran & D. Bailey: The response of the red mangrove <i>Rhizophora mucronata</i> Lam. to salinity and inundation</i>	<i>A. Bali & C. van der Lingen: Spatio-temporal distribution of anchovy catches off South Africa</i>
10:15	<i>A. Rajkaran & J. Adams: Growth rate and population dynamics of the mangrove species at Mngazana Estuary - towards sustainable harvesting limits</i>	<i>K.E. Watermeyer, A. Jarre, L.J. Shannon & L. Hutchings: Assessing long-term distributional changes of key commercial fishes in the southern Benguela using spatialised indicators</i>
TEA		
	BIOTIC RESPONSES TO ABIOTIC DRIVERS	FISHERIES MANAGEMENT
11:00	<i>M. Lucas, M. Moore & E. Achterberg: Impact of the April 2010 Icelandic volcanic eruption on marine primary productivity in the North Atlantic.</i>	<i>J. Coetzee, C. van der Lingen & L. Hutchings: Was the sardine eastward shift an ecological experiment that failed?</i>
11:15	<i>E. Kean & M. Lucas: Nitrogen metabolism in phytoplankton as a function of light availability in the south Atlantic sector of the Southern Ocean</i>	<i>A. Foulis, J. Groeneveld & S. Dudley: Trends in shark bycatch in long-line fisheries for tuna and swordfish, and sampling of shortfin mako sharks off South Africa</i>
11:30	<i>M.J. Gibberd, S. Maxwell-Hafen & M. Lucas: Phytoplankton productivity, nitrogen metabolism and community structure in the Atlantic sector of the Southern Ocean</i>	<i>S. Lamberth & K. Hutchings: Comparison of harder <i>Liza richardsonii</i> growth under differing fishing intensities and across biogeographical regions, estuaries, islands and the nearshore</i>

11:45	<i>T. Lamont</i> & R. Barlow: Primary production and phytoplankton physiology on the KwaZulu-Natal Bight	<i>M. Gulekana</i> : Climate variability and its potential impacts on the Cape hake fisheries (<i>Merluccius paradoxus</i> and <i>Merluccius capensis</i>) in the southern Benguela Current Large Marine Ecosystem
12:00	<i>K. Tirok</i> : Light availability for primary producers in a large estuarine lake (Lake St. Lucia) experiencing highly variable water levels and turbidities	<i>A-R. Childs</i> , P.D. Cowley, T.F. Næsje, R.H. Bennett, E.B. Thorstad & A. Darnaude: Spatial and temporal movement dynamics of dusky kob <i>Argyrosomus japonicus</i>, with implications for fisheries management
12:15	<i>Y. Kisten</i> : Foraging behaviour of the anemonefish <i>Amphiprion ocellaris</i> at different light intensities	<i>R.H. Bennett</i> , P.D. Cowley, A-R. Childs, G. Gouws, P. Bloomer, K. Reid & T.F. Næsje: Movement patterns and genetic stock structure of the white steenbras <i>Lithognathus lithognathus</i>, with implications for fisheries management
LUNCH		
	GENETICS AND PHYLOGEOGRAPHY	FISHERIES MANAGEMENT
14:00	<i>M. Morallana</i> , G. Gouws & M. Mwale: Regional genetic differentiation in the dory snapper (<i>Lutjanus fulviflamma</i>) in the western Indian Ocean	<i>L. Shannon</i> , Y. Shin & A. Bundy: IndiSeas: comparing indicators across fished marine ecosystems
14:15	<i>M. Mwale</i> , G. Gouws & P.D. Cowley: Genetic stock assessment of the bronze bream (<i>Pachymetopon grande</i>), a South African endemic inshore sparid	<i>C.J. Oosthuizen</i> , B.Q. Mann & P. Bloomer: Genetic diversity of <i>Polysteganus undulosus</i> after stock collapse
14:30	<i>K. Reid</i> , T. Hoareau & P. Bloomer: Population genetic structure of the hottentot seabream <i>Pachymetopon blochii</i> (Valenciennes, 1830) along the coast of South Africa based on newly developed microsatellite markers	<i>H. Winker</i> , S. Kerwath, A. Götz, C. Attwood & A.J. Booth: Evaluation of delta-models for the standardization of CPUE time series: evidence for spill-over effect from a South African MPA?
14:45	<i>L.K. Mmonwa</i> , C.D. McQuaid & N.P. Barker: Investigating evolution of foraging behaviour amongst five sympatric intertidal limpets (Patellidae) along the coast of South Africa	<i>T.S. Murray</i> , M.K.S. Smith & P.D. Cowley: An evaluation of the illegal coastal fishing effort in the Tsitsikamma National Park Marine Protected Area, South Africa
15:00	<i>A. McLachlan</i> , C. Mathee & S. von der Heyden: Comparative phylogeography of the catshark, <i>Haploblepharus pictus</i> and its nematode parasite, <i>Proleptus obtusus</i>	<i>W. Osman</i> , L. Shannon & A. Jarre: Trophic model-generated indicators of the southern Benguela ecosystem for communicating with fisheries managers
15:15	<i>N. Springbok</i> , M. Mwale, G. Gouws & O. Gon: Regional connectivity and differentiation of three goatfishes (<i>Parupeneus</i> spp.) within the Western Indian Ocean	
TEA		
	GLOBAL CHANGE	FISHERIES MANAGEMENT
16:00	<i>K. Tunley</i> , B.M. Clark, K. Hutchings, A. Angel, K. Orr, N. Steffani & J. Turpie: Long-term environmental monitoring in Saldanha Bay and Langebaan Lagoon	<i>L. Pichegru</i> , P.G. Ryan, R. van Eeden, T. Reid, D. Grémillet & R. Wanless: Industrial fishing, no-take zones and endangered penguins

16:15	<i>R. Mussgnug</i> & C. Attwood: Trends of Chondrichthyan bycatch in the inshore trawl fishery from 1898 to 2010	<i>K. Prochazka</i> , J. Augustyn & A.C. Cockcroft: Making a difference - working with and influencing fisheries management
16:30	<i>H. Cawthra</i> & R. Uken: The geology and continental shelf evolution of the Durban Bluff and adjacent Blood Reef, related to Quaternary sea-level fluctuations	<i>S. Mbande</i> : Co-Management - the future of small scale fisheries management
16:45	<i>A. Green</i> & L. Garlick: Buried river courses from the Durban Bight continental shelf: implications for lowstand fluvial behaviour and palaeo-drainage	
17:00-18:00	POSTER SESSION	
19:00	FORMAL DINNER	

Day 4: SAMSS/ECSA conference (THURSDAY 7 APRIL 2011)

Time slot	Lecture venue 1	Lecture venue 2
08.15	Plenary 4: C. Griffiths, A. Mead, J. Carlton & M. Ruis: Revealing the diversity and distribution of marine invasive species in South Africa	
	BIODIVERSITY & BIOGEOGRAPHY	MARICULTURE
09:00	<i>V.J. Cole & C.D. McQuaid: Effects of biogeography, upwelling and habitat structure on the fauna associated with bioengineers</i>	<i>R. Field; H. Kaiser & C.L.W. Jones: Fish physiology; the effect of diet on the excretion of ammonia-nitrogen in juvenile dusky kob, <i>Argyrosomus japonicus</i></i>
09:15	<i>M. Montefalcone, P. Vassallo, V. Parravicini, C. Paoli, G. Gatti, C. Morri, M. Fabiano, G. Albertelli & C.N. Bianchi: The exergy of a phase shift: ecosystem degradation in <i>Posidonia oceanica</i> meadows of the Ligurian Sea (NW Mediterranean)</i>	<i>B.M. Macey, K.W. Christison & M.R. Greeff: Development, optimization and evaluation of a real-time pcr assay for detecting <i>Halioticida noduliformans</i> in South African abalone, <i>Haliotis midae</i></i>
09:30	<i>S. von der Heyden: How many species of southern African marine fishes?</i>	<i>R. Scholtz, J.J. Bolton & B.M. Macey: The effect of different micro algal feeds on development and settlement of <i>Tripneustes gratilla</i> (L) larvae and the prospect of echinoculture in South Africa</i>
9:45	<i>D. Yemane & R.W. Leslie: Demersal fish biodiversity pattern: West coast vs. South coast</i>	<i>N. Molnar, D. Welsh, T. Meziane, J. Deborde & C. Marchand: Benthic metabolism and N-dynamics in mangrove sediments subject to shrimp farm effluents (New Caledonia)</i>
10:00	<i>K.J. Sink, S. Holness, L. Harris, A. Lombard, T. Wolf et al.: The status of coastal and marine biodiversity in South Africa</i>	<i>A. Johnson: WWF and aquaculture: moving towards a sustainable future</i>
10:15	<i>G. Gouws, M. Mwale, J. Bourjea, D. Muths, J. Mwaluma, A. Mwandya & O. Gon: Many fish and many genes: providing insight into Western Indian Ocean connectivity and biogeography</i>	<i>M. Cyrus, J.J. Bolton, B.M. Macey & L. de Wet: The potential for echinoculture in South Africa: development of a formulated feed</i>
TEA		
	BIODIVERSITY & BIOGEOGRAPHY	
11:00	<i>C.M. Browne, J.J. Bolton, R.J. Anderson & C.J. Ward: Algal epiphytes on the seagrass, <i>Thalassodendron ciliatum</i> (Cymodoceaceae), on rocky shores in South Africa: a biogeographic and ecological investigation</i>	
11:15	<i>R.J. Anderson, J.J. Bolton, A.J.Smit & D. da Silva Neto: Biogeographic affinities of the marine macroalgae of Angola</i>	
11:30	<i>L. Gersun, J.J. Bolton & R.J. Anderson: Subtidal pioneers: abundance and diversity patterns of seaweed communities on dead corals at Sodwana bay, South Africa</i>	

11:45	<i>S. Fennessy</i> , D. Hayes & C. Wilkinson: From coast to canyon - the nature of soft-sediment demersal communities off central KwaZulu-Natal, South Africa	
12:00	<i>J. Bourjea</i> , D. Muths, J. Garnier, J. Mortimer, G. Okemwa, B.J. Godley, G. Hughes & S. Ciccione: Evidences of a more complex green turtle genetic stock structure in the South West Indian Ocean - implication for regional conservation	
12:15	<i>V. Parravicini</i> , M. Montefalcone, E. Villa, G. Albertelli, C. Morri & C.N. Bianchi: Are we losing historical marine habitats? Scales of homogenization and differentiation of rocky reef habitats across a decadal period	
CLOSING CEREMONY		

PLENARY TALKS

Biotic responses to human pressures: moving from research to management issues

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Through implementing environmental legislation, Europe and other countries (USA, Canada, Australia, South Africa), are moving towards coordinated and integrated catchment-to-coast management, following the most novel legislation on ecosystem-based approaches. This legislation includes human activities as part of the ecosystem, trying to promote sustainable uses of marine waters. However, human pressures are degrading ecosystems and need management plans to reduce impacts and provide restoration programmes. These management plans need adequate scientific information, obtained from monitoring programmes, and using the best available methods to assess adequately the health of marine systems. In recent times, the number of methods to assess the status of different physico-chemical and biological elements (i.e. phytoplankton, benthos, fishes) has increased exponentially. However, few of them are using adequate reference conditions to assess the status and only some of them are testing the assessment together with human pressure intensity. Hence, in this presentation I will present some examples of different biological elements and their responses to human pressures. Moreover, I will show the integrative assessment, using multiple components and the response to actions taken to remove pressures. Finally, the integrative assessment done for the European Marine Strategy Framework Directive will be presented. All this information will serve to extract conclusions on how to move from research to management in marine waters.

Revealing the diversity and distribution of marine invasive species in South Africa

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As recently as 2009 the number of introduced species recorded for South Africa was considered to be 22. This paper reports on a recent study which reassesses the diversity and scale of introduced marine and

estuarine species in the region, based on both reviews of taxonomic literature and historical records and new sampling surveys across selected marine habitats. These revealed a total of 85 introduced and 40 cryptogenic species, representing a dramatic increase over previous published lists. Additional species were revealed within the historic literature (74%), from surveys conducted post-2005 (13%) and following taxonomic resolutions (12%). We present analyses of this invasive fauna based on taxonomic composition, distribution pattern, origin, vector and date of introduction. The most diverse introduced groups are Crustacea, with 22 species, and Cnidaria and Mollusca, each with 13. Spatial analyses revealed patterns of bioinvasion to be significantly higher on the west coast, compared to other coastal regions. Overall, 53% of introductions were concentrated within harbour areas, with few open coast invaders detected. Introduced species on the cool and warm-temperate provinces of the west and south coasts mainly originated from the northern hemisphere (30%). In contrast, introductions located in the sub-tropical and tropical provinces of the east coast mainly originated from the southern hemisphere (14%). Ballast water and ship fouling were the dominant vector pathways, accounting for 38 and 48% of introductions respectively. A few significant introductions and their impacts will be highlighted. Although the current assessment is far from comprehensive, the research described has contributed massively toward revealing the true scale and patterns of bioinvasions for a developing region within a relatively short period of time.

Time, space and generality in marine ecosystems

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The aim of ecology is to understand the distribution and abundances of organisms. Because it is impossible to make all measurements at all places, this requires us to seek generality, in other words, 'laws' or patterns to which 'all' organisms conform. In effect such laws do not exist and I believe probably cannot exist. Ecosystems vary in time and in space and a common approach is a reductionist one based on the premise that if we can make sufficient measurements of enough factors at all appropriate scales, then we can make accurate predictions. I believe this is incorrect and that we should instead take a synthetic approach. Ultimately ecosystems respond in the first instance to the interaction of multiple drivers that are themselves set by physical conditions that vary across space and alter in time. Consequently, the patterns we observe in nature reflect the physical and temporal scales at which environmental gradients are strong or show clear variability. Generally predictability diminishes with

physical scale, partially as a result of the blurring or disappearance of environmental gradients. Using examples from work done by postgraduate students and post-doctoral researchers at Rhodes University, I illustrate: that ecosystems can show dramatic and unpredictable variability in time; that while we can observe large scale generality in space, this generality is not perfect; that at small-scales we can improve predictability through the creation of small-scale gradients in physical factors; that natural systems can show small-scale spatial determinism and that interactions are key to understanding ecosystem structure and function. Finally I use an example from a collaboration on high shore littorinids to show that biology can perhaps challenge even the rules of physics.

turbulent kinetic energy and bed shear stress. Flow structure, in general, is greatly affected near aquatic plants.

Physical processes in estuaries and some physical-biological interactions

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An account is given of estuarine circulation, stratification and frontal behaviour, together with some aspects of their importance to biological processes, e.g. the potential enhancement of macrozooplankton concentrations at plume fronts. A general methodology is described for the estimation of tidal current speeds, residence (or flushing) times and the magnitude of the estuarine turbidity maximum (ETM) and its associated suspended particulate matter (SPM). The natural robustness of a river-estuary-coastal system is partly dependent on the residence time of its waters, solutes and suspended sediments. Longer residence times reduce robustness because, e.g., greater nutrient concentrations can occur for a given rate of nutrient input to the system, leading to the possible occurrence of harmful algal blooms. In very turbid estuaries where vertical mixing is strong, phytoplankton cells experience high light conditions for only very short periods, so that system robustness is increased. Fluid mud estuaries can exhibit pronounced dissolved oxygen (DO) sags, partly caused by free-living and particle-attached bacteria that exert a strong DO demand. Biological activity tends to increase the aggregation of SPM, e.g. by secretion of carbohydrates that increase its stickiness or directly through the production of faecal pellets and pseudo-faeces. In muddy estuaries the erosion properties of cohesive, intertidal mudflats depend on a balance between the physical and biological processes of stabilisation and destabilisation. Bio-stabilisation of intertidal sediments can be affected by e.g. microphytobenthos, whereas bio-destabilisation results from e.g. the bioturbation caused by burrowing and deposit-feeding animals, such as bivalves. Flume and field studies of saltmarsh dynamics show that flow attenuation with increasing *Spartina* stem density is accompanied by an increase in

RESEARCH TALKS

Characterising organic matter in shelf seas - clues to heterotrophic re-working and spatial and temporal variation

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Shelf seas account for 7% of the world's oceans but are responsible for up to 20% of total ocean primary production. Critically they link the draw down and fix carbon through autochthonous production and this together with terrestrially-derived material is in part exported to the open ocean. The fate of material at the base of the food web (phytoplankton and detritus) in the open ocean as it passes through the twilight zone (100-1000m) has been well documented (e.g. Martin *et al*, 1987; Buesseler *et al*, 2007). Similar studies on particulate organic matter (POM) in shelf seas are lacking. Here, we report the first developments in characterising organic matter through the shallow water columns of shelf seas. Suspended POM (sPOM) was collected at discrete depth horizons from Liverpool Bay, the Irish Sea and the Celtic Sea using large volume stand-alone pumps (SAPs). These fractionated sPOM into two particle size groups (0.7-50µm and >50µm). Analysis of the lipid component of sPOM shows a great deal of variability spatially and with depth. Nevertheless, cholesterol and unsaturated alcohols, which are biomarkers often associated with zooplankton suggest that heterotrophic re-working of sPOM is an important process. In the Irish Sea and the Celtic Sea this signal increases with water depth. In the Irish Sea a storm event may have led to resuspension and then resettling of benthic detrital material. Samples collected from Liverpool Bay show spatial and temporal (tide related) variations from these it is possible to distinguish estuarine and open marine sources of sPOM in the Bay.

Regional variations in the diets of the benthic community around the Prince Edward Islands: Fatty acid signatures

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The sub-Antarctic Prince Edward Islands (PEI) comprises of two islands separated by a shallow inter-island shelf which consists of a diverse and biomass-rich benthic community. The waters surrounding the islands have been shown to exhibit increased phytoplankton concentrations ("island mass effect"), which provides an important carbon source for the benthos. The extensive kelp beds near the islands may represent an additional carbon source for these organisms. Fatty acid analysis was used to assess the spatial patterns in the diets of the benthic community in the vicinity of the islands. Benthic samples were collected in April 2009 from the inter-island shelf (seven stations divided into upstream, between and downstream of the islands) and nearshore regions (three stations). Data indicated that kelp detritus contributed more to the diets of organism near the kelp beds than those from the inter-island region. Overall, however, pelagic primary production was the dominant food source in the diets of all organisms, even for those living near the kelp beds. Notable exceptions were the sponges and bryozoans, in which kelp and phytoplankton contributed similar proportions to their diets, most likely resulting from a size-restricted feeding mode. Consequently, there were no distinct spatial differences in the importance of the various food sources. There was, however, strong evidence for increased food quality between and within the lee of the islands compared to upstream. The organisms collected from upstream of the PEI had substantially lower quantities of total fatty acids than the same species collected from nearshore, open shelf or downstream stations, thus indicating an increased food quality between and within the lee of the islands, likely a result of the "island mass effect" observed at the PEI. Global climate change may therefore have a considerable impact on the feeding ecology of the benthic organisms in the vicinity of the PEI.

Feeding ecology and diet shift of long-beaked common dolphins *Delphinus capensis* incidentally caught in shark nets off KwaZulu-Natal

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In recent years, unpredictable inter-annual variations in the timing, spatial extent, and intensity of the sardine run have been documented, possibly resulting in changes in the suite of prey available to the predators feeding in the run, like the long-beaked common dolphin *Delphinus capensis*. To examine temporal

changes in diet and prey availability in this species over the last four decades, stomach contents of animals incidentally caught in the shark nets off KwaZulu-Natal between 2000 and 2009 were examined and compared to previous data gathered between 1974 and 1992. Stomach contents from 95 animals (55 females, 40 males) were analysed and compared to historical data. Twenty eight different prey species were represented in diet. The most important in terms of % frequency, % number and % mass were chub mackerel (*Scomber japonicus*) (65.2%, 21.8%, 64.1%, respectively), sardine (*Sardinops sagax*) (30.3%, 11.1%, 5.3%), elf (*Pomatomus saltatrix*) (15.2%, 2.7%, 6.0%), and maasbanker (*Trachurus delagoa*) (25.8%, 12.1%, 3.7%). A shift in the principal prey species consumed by the dolphins was found: prior to 1992, sardine comprised 49% of the total prey by mass, whereas chub mackerel dominated prey (64% by mass) between 2000 and 2009. This shift appeared to correspond to fluctuations in the availability of the two principal prey species. However, stable isotope analyses conducted on the teeth of *D. capensis* representative of the life time diet of the animals indicated that there has been no significant shift in the trophic position ($\delta^{15}\text{N}$) and principal prey consumed ($\delta^{13}\text{C}$) over the corresponding period. These data suggest that the long-beaked common dolphins can be considered opportunistic predators, generally consuming the most abundant prey species available locally. Thus the dietary shift found over the last four decades appears to indicate changes in the shoaling characteristics of the most abundant fish prey in KwaZulu-Natal during winter.

Biogeographic affinities of the marine macroalgae of Angola

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The seaweed flora of Angola is relatively poorly known. Most of the 132 records listed on AlgaeBase.org come from a 1974 British Natural History Museum expedition to the central and southern parts of that country. In 2006 the Benguela Current Large Marine Ecosystem project funded two expeditions to Angola to carry out coastal biodiversity surveys. Seaweeds were collected at five sites in the north of Angola and five sites in the south. We report on the results of these collections, and the

biogeographic affinities of the Angolan seaweed flora. Multivariate analyses of our data, based on species presence/absence, show some distinction in species composition between the northern and the southern sites. These patterns are discussed in relation to 4 km resolution Advanced Very High Resolution Radiometer (AVHRR, Pathfinder version 5 reprocessed) sea surface temperature (SST) monthly data that were processed for the region. The Angolan flora is compared to the cool-temperate flora of Namibia and the Tropical flora of Ghana, and shown to be essentially Tropical West African, with a few transitional cool-water elements in the south. This sudden transition between tropical and cool-temperate marine floras, with little evidence of an intervening warm temperate flora, is unusual. Our collections add about 48 species to the Angolan seaweed flora, raising the total number of species to around 180. This total approaches that of Ghana which, with about 200 species, is considered to have the richest seaweed flora in Tropical West Africa.

Does oil mining on the Agulhas Bank affect benthic communities?

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This study assesses the potential benthic pollution impacts from petroleum activities for the first time in South Africa. Benthic invertebrate fauna play important ecological roles in both structuring habitat and as prey for commercially valuable species. Benthic assemblages effectively integrate historical environmental conditions and provide useful indices to evaluate the status of marine ecosystems in monitoring for long-term responses and site-specific impacts. The physical attributes of the sediment are equally important in assessing potential factors contributing to any changes observed. The effects of petroleum extraction activities on benthic infauna were assessed by sampling the area around a wellhead active on the Agulhas Bank since 1993, at geometrically increasing distances, along four radiating transects up to 4 km from the wellhead. Only water-based drilling fluids have been used at the wellhead sampled, at depths of ~ 118 m. Two sites considered to represent reference conditions were sampled 10 km south-east of the wellhead. Enforcement of a petroleum exclusion zone around the active wellhead prevents demersal trawling and other fishing activities at 57% of the sites around the wellhead. Sediment attributes from each sample were assessed for particle size, percent total organic carbon, trace metal and hydrocarbon content. Multivariate analyses showed that infaunal assemblages closest to the wellhead were significantly

different to those greater than 250 m away while sediment properties measured showed no significant differences among any of the sites. No significant differences were detected among infauna at any remaining sites sampled, whether they were within or outside of the petroleum exclusion zone. Trawling and petroleum activities appear to have similar effects on benthic infaunal assemblages. Recommendations from this study include the continued use of water-based drilling fluids, expanding such studies to other areas and implementing long-term environmental monitoring of petroleum activities in South Africa's offshore environment.

(Poster 1) The physiology of overwintering Antarctic krill

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Antarctic krill, *Euphausia superba*, occurs in vast quantities in the Southern Ocean. Because of its abundance and its position in the food web, the species is regarded as a key organism in the Antarctic marine ecosystem. Krill can reach a life span of up to six years which makes it necessary for juveniles and adults to survive several Antarctic winters. Overwintering success is regarded as a major factor that dictates physiological condition, survival, recruitment, and population size of krill in the Southern Ocean. The answer to probably the most important question, however, as to what biological mechanisms facilitate the overwintering of krill, remains still unanswered. Two categories of overwintering mechanisms for adult krill were previously proposed: 1) non-feeding mechanisms and 2) switching from algae in the water column to alternative food sources.

In the present study, we present data collected during different seasons in the field as well as from short- and long-term experiments in the laboratory.

Our results revealed the following: 1) A dramatic reduction of feeding activity by up to 85%. 2) A shift from herbivorous feeding in summer to omnivorous feeding during winter. 3) A strong reduction in respiration rates by up to 70%. 4) Lower growth during winter but no shrinkage. 5) In addition to the low feeding activity, body lipids accumulated during summer were consumed for energy provision during winter. In addition, during short-term starvation at the end of winter, lipid concentration falls from low to critically low levels, despite quick reduction of respiration. This provides a possible explanation why some year-classes successfully recruit while others fail.

Comparative ecosystem analysis of a data-limited marine ecosystem - the KwaZulu-Natal Bight, South Africa

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Ecosystem modelling allows for an understanding of the structure and functioning of data-limited ecosystems provided that models undergo extensive sensitivity analyses to explore how realistically they represent the system. We explored one such data-limited system, the KwaZulu-Natal (KZN) Bight, a river-influenced bight on the east coast of South Africa. Comparative ecosystem analysis was conducted, along with sensitivity analyses, to explore the possibility of constructing plausible mass-balanced trophic models of the Bight. Firstly, nine different representations of the KZN Bight were constructed as multiple models in Ecopath with Ecosim, using various biomass values from the literature available. Sensitivity analyses and outputs of the nine models were compared to determine how the models reacted to changes in input data. Large variability in outputs with changes in input data would indicate unrealistic models. This comparison demonstrated that the models produced similar results for most outputs and showed small variability in outputs with changes in input data. Thus the models represented plausible configurations of the KZN Bight ecosystem. Secondly, the model outputs were compared to similar ecosystems by determining whether they fitted within the ranges of outputs from Ecopath models of a number of bays and bights. Outputs from the KZN Bight models fell within the ranges of many outputs from other bays and bights with the exception of net primary production and net system production. A comparison of the nutrient-poor KZN Bight to the nutrient-rich Southern Benguela on the west coast of South Africa was conducted. The models were able to reproduce known differences between the two systems indicating that the KZN Bight models were able to produce plausible differences between shelf systems influenced by upwelling (Southern Benguela) and oligotrophic currents (Agulhas). The KZN Bight was detritus-driven and considerably smaller in biomass, productivity and fisheries landings than the plankton-driven Southern Benguela but had higher cycling through the system and longer path lengths.

(Poster 2) Documenting change on two young artificial reefs in sub-tropical South Africa

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Artificial reefs provide a complex mosaic of habitats for the establishment of invertebrate and fish assemblages. Two ocean going barges, 128m in length, were scuttled in the near-shore region off Cape Vidal in November and December 2008, creating two new artificial reefs. Annual dive surveys have been conducted on both artificial reefs since May 2009 to assess the colonisation and succession of fish and invertebrate communities. Major habitats surveyed on the barges were decks, holds and hulls. Colonisation of these artificial reefs has been rapid, as within six months a diverse fish community was documented. Several species of serranids, lutjanids, chaetodontids and labrids were recorded in high abundance, with serranids (mainly *Pseudanthias cooperi* and *Pseudanthias squamipinnis*) dominating. The invertebrate community on both barges was dominated by pearl oysters (*Pictada* sp.), a pioneering bivalve. Over time the abundance of pioneering species should decrease as more competitive species become established. Both fish and invertebrate communities showed differences between the major habitats.

An assessment of the impact of local environmental changes on ecosystem function of selected coastal aquatic systems.

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The functioning of coastal ecosystems is greatly dependent on a wide variety of external pulses (e.g. tides, freshwater influx, seasonal trends in temperature, nutrient input, etc.). Assessments of the effect of a selection of environmental characteristics driven by natural and/or anthropogenic forces on ecosystem function are discussed using selected ecosystem properties, such as total system throughput, system organization, productivity, recycling, and trophic efficiency, derived from ecological network analysis (ENA) of several coastal ecosystems on monthly, intra-seasonal, seasonal, and interdecadal scales. Each ecosystem was modelled depicting data of standing stocks, the flows between the constituent living and non-living components in the system, exports, and imports. Results from ENA revealed considerable differences of the same system property (or properties) resulting from changes in the environment (e.g. in temperature, salinity, oxygen, rate of freshwater inflow) over time. Results from several example ecosystems are presented to illustrate the response of ecosystems to environmental variability. For example, the development of hypoxia during summer in the Neuse River estuary resulted in a state change of the

estuary, a diversion of energy flow pathways from pelagic and benthic consumers to microbes, and variability in ecosystem properties. A small temperature increase in a Florida sea grass bed resulted in increases in system throughput, the P/B ratio, and in the rate of carbon recycling, but also in a significant decrease in system organization. The effect of seasonal increases in water temperature and of measured decrease/increase in river run-off to a few selected estuaries is discussed using ENA.

(Poster 3) Biogeography and population structure of three sandhopper species (Amphipoda Talitridae), *Talorchestia capensis*, *T. quadrispinosa* and *T. australis*, along the South African coast

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Three sandhopper species were investigated to examine relationships among population structure, biogeography and environmental variability. Twenty-five sandy beaches were sampled along 3000 km of the South African coast, encompassing three biogeographic regions: the cool-temperate west, warm-temperate south and sub-tropical east coasts.

Animals were collected using pitfall traps during winter in a once-off survey. The following traits were recorded: total abundance, length, sex ratio, number of adults (female, male, intersex female) and number of juveniles. Environmental data recorded were: sand temperature, water temperature, salinity, percentage cover of detritus, beach morphodynamic state.

Talorchestia quadrispinosa showed high abundances and large individual lengths on the west coast, with the eastern limit situated on the south coast (Knysna) and no individuals on the east coast. *T. australis* ranged between Port Edward (northern limit) and Jeffreys Bay (southern limit) with low abundances and small individual sizes. A few animals were collected at Richards Bay but no adults (required for species confirmation) were found. No individuals were collected on the west coast. *T. capensis* showed very patchy distribution; individuals were collected all along the coast, with the highest abundances and sizes at a site on the west coast (Hondeklipbaai).

The presence of upwelling appears to influence the population structure of *T. quadrispinosa* and *T. capensis* on the northern west coast, where the highest abundances and largest sizes were found. This can be also related to the generally high detritus cover at west coast sites. Upwelling on the south and east coasts did not have this effect. Beaches on the east coast were mostly reflective with coarse grain size and supported low abundances of *T. australis*. The data are preliminary, but suggest that these populations of

Talorchestia do not conform to the abundant center model, which predicts maximum abundances of organisms at the centre of their distribution.

Spatio-temporal distribution of anchovy catches off South Africa

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Anchovy (*Engraulis encrasicolus*) is the mainstay of South Africa's fishery for small pelagic fish and has dominated purse-seine landings since the mid-1960s, with average annual catches during this period of around 230 000 t. We describe the spatio-temporal distribution of anchovy catches over the period 1987-2010, using vessel logbooks that report catch location per 10 n.mile by 10 n.mile pelagic fishing block (PFB) at a daily temporal resolution. Whilst anchovy are distributed around South Africa's coast from the Orange River mouth to Port Alfred, catches of this species are taken almost entirely from the inshore region off the west coast, particularly between Lambert's Bay and Cape Town. Small-scale (10s of kms) interannual variability in the centre of gravity of anchovy catches has been observed, but there does not appear to be a unidirectional change through time that could be indicative of distribution changes. Catches in the west coast region comprise primarily recruits (young-of-the-year), which are reduced to fish meal and fish oil in industrial-scale factories. Most of the anchovy catch is taken over winter, with July being the peak month and reflecting the temporal pattern in recruitment of this species. Small quantities of adult anchovy are taken on the western Agulhas Bank in the region of Gans Bay. Spatio-temporal patterns in anchovy catches between 1987 and 2010 are compared to those observed during the 1970s, and the utility of catch data in informing on ecological questions pertaining to breeding success of African penguins is discussed.

(Poster 4) Spatial, seasonal and interannual variability in the lipid content of anchovy in the Southern Benguela

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The lipid content of clupeoid fish generally shows a seasonal cycle, being highest immediately before spawning and declining thereafter, indicating that gonad maturation in these species is dependent to some degree on stored energy. Hence lipid reserves will influence spawning success, and possibly also recruitment success. Additionally, variability in lipid content is related prevailing environmental conditions, particularly productivity, and possibly also to population size. A "Fat Staging" technique to estimate the lipid content of small pelagic fish based on the amount of visible mesenteric fat present has been applied during bi-annual surveys of pelagic fish around the South African coast since 1995. The lipid content of >75 000 anchovy collected from approximately 1 300 trawls conducted during these surveys has been estimated using this method, and analyses of these data to assess spatial, seasonal, and inter-annual variability in anchovy lipid content are presented. Anchovy lipid content data collected during spawner biomass surveys are compared to egg abundance data to examine whether the two are related, and density-dependent effects are assessed by comparing the mean lipid content of recruits with annual recruitment strength. These results will help to elucidate the role of lipid reserves in spawning success of pelagic fish and may allow testing of the hypothesis that recruitment success is partly dependent on parental condition, as has been suggested for other pelagic fish species.

Introducing electronic data logging to the South African and International commercial fishing industry

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The poor state of critical data on fishing operations is a fundamental setback to fisheries management. The fishing industry, partially due to its operating environment, has not embraced the technology revolution with as much enthusiasm as other sectors. A culture of protectiveness and suspicion between fishers, managers, scientists and government is also to blame. However, computers are now commonly found on many fishing vessels and with the advent of satellite communication systems and broadband on vessels, the recording of data and transmission of reports from sea has proved manageable and a technological approach to at-sea data collection and reporting must be taken for the industry to develop. In response, OLRAC, a South African company, developed an electronic logbook, Olfish, aimed at overcoming both the technical and political obstacles facing the introduction of such technology. Olfish can collect, analyse, plot, map, report, trace and transmit all data related to fishing operations. Data can be compressed, encrypted and

digitally authenticated before transmission to company or authorities. Olfish is designed for skippers, managers, scientists and compliance inspectors and authorities. Olfish consists of an onboard version (Olfish Dynamic Data Logger: Olfish-DDL), which includes a dynamic report generator, a shore version, and a web-based data management hub (Olfish Reports Management System: Olfish-RMS). Olfish-DDL captures data in real-time and/or in post-event mode, reads GPS input and incorporates GIS capabilities for viewing of vessel movements and other operational data. Users can collect any type of data in any form, (images, video, numerical/alphanumeric fields, free-text, date, time, location, etc). Olfish-DDL is installed on numerous vessels worldwide, including 12 South African vessels. The South Coast Rock Lobster Industry in South Africa implements an Olfish-DDL solution, allowing it to complement/replace many data collection tasks normally executed by the Fishing Management Authorities. Olfish-DDL can thus convert the entire national fishing fleet into a large-scale survey tool capable of dramatically improving fishery management in South Africa.

Phytoplankton absorption and pigment photoadaptation on the Natal Bight

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The absorption characteristics of phytoplankton were investigated during process studies at selected focus sites on the Natal Bight during February 2010. Measured absorption spectra from various depths were compared to spectra reconstructed from pigment concentrations and individual weight-specific absorption coefficients. Measured and reconstructed spectra were similar at the Tugela Mouth (TM) and Mid-Shelf (MS) sites where biomass levels were more elevated and diatoms tended to be the dominant component of the community. Reconstructed spectra were lower than measured spectra at the Durban Eddy (DE), Richards Bay North (RN) and Richards Bay South (RS) sites where biomass was low and flagellates and/or prokaryotes were the main algal groups. These observations suggested that there were light-absorbing compounds other than pigments that contributed to particulate absorption. This has implications for the application of *in vivo* absorption in the development of satellite ocean colour algorithms to monitor phytoplankton in Natal Bight waters.

Pigment spectra indicated that maximum chlorophyll *a* absorption occurred at 440 and 676 nm, chlorophylls *b* and *c* at 462 nm, photosynthetic carotenoids (PSC) at 490 and 510 nm, and photoprotective pigments (PPC) at 462 and 490 nm. The total absorption over the PAR range of 400-700 nm showed that chlorophyll *a* and

PSC accounted for 60-70% of the pigment absorption at the TM, MS and DE sites, with chlorophyll *c* absorbing 12-20% at TM and DE, but 20-26% at MS. PPC absorption was only significant near the surface (10-15% at TM and MS; 18-26% at DE) and decreased with depth under low light conditions. At the RN and RS sites, absorption was dominated by PPC and chlorophyll *a*. Chlorophyll *a* accounted for approximately 35% of absorption at RN and PPC for 23-30% in a shallow water column, while PSC plus chlorophyll *c* were <40%. PPC absorbed 40-50% of the light in the upper water column at RS, chlorophyll *a* 40% and PSC <10%. At depth, PPC declined to <10%, while PSC and chlorophyll *a* absorbed 70% of the irradiance. The results indicated that significant pigment photoadaptation occurred in the different phytoplankton communities at the various focus sites.

Is our seafood sustainable? The considerations behind how WWF SASSI helps consumers make more sustainable seafood choices

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A quarter of fisheries are classified as overfished or depleted. It is estimated that approximately 25% of what is caught is thrown back and, because no fishing gear is completely selective, many non-target and endangered species are accidentally caught. This situation has been exacerbated by a 165% increase in the global consumption of seafood since the 1960s. Today, the demand for seafood outstrips the supply. As fishing is central to the livelihood and food security of ca. 200 million people worldwide, this is a socio-economic dilemma with extensive implications. However, with the market driven strongly by consumer demand, one solution to the crisis is to provide mechanisms to encourage the shift of demand from overexploited species to sustainable options. We demonstrate how tools provided by the Southern African Sustainable Seafood Initiative (SASSI) assists consumers to make more informed seafood choices, towards reducing pressure on overexploited and unsustainable species. We present details on the research methodology and implementation of the SASSI 'traffic light' system, where seafood is categorised according to conservation status: Green denotes the most sustainable options; Orange species have associated ecological reasons for concern; Red species are either illegal to sell or from unsustainable populations. After many rigorous assessments following international best practice, the updated list takes a number of additional considerations into

account. This information is available via a range of tools, including website, cell phone and pocket card. We have observed that the new list has both gained significant traction in the media and motivated a select few individual consumers to drive marked changes in the practices of prominent South African retailers. However, the list's revision resulted in mixed reactions amongst seafood consumers and industry. Despite this, the evidence we present here demonstrates that SASSI has become an important facilitator of positive change within the seafood market.

Use of a dual frequency identification sonar (DIDSON) to examine the size structure and distribution of fish within a small closed estuary

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Small temporarily open/closed estuaries represent important habitats for fish and act as nursery grounds along many temperate coastlines, especially in the southern hemisphere. Understanding the size structure and distribution of fish within these estuaries is fundamental in establishing how the ichthyofauna utilises these systems. The fish population within the East Kleinemonde Estuary was studied using a dual frequency identification sonar (DIDSON) during March 2010 which allowed for direct comparisons in the abundance, distribution and behaviour of a wide size range of fish along the length of the system. Small shoaling fish less than 100 mm in length were most abundant while larger size classes 100-300 mm and 300-500 mm were less abundant but evenly distributed longitudinally within the estuary. Fish >500 mm, as well as fish <100 mm, were most abundant within the mouth region which may reflect the feeding ecology of species that fall into these size classes. Differential behaviour was observed among the longitudinal sections, with small fish forming schools in areas of low turbidity and particularly in the presence of large predatory fish. Results from this study present a snapshot of the composition, distribution and behaviour of the ichthyofauna within a small temporarily closed estuary and highlight the potential of the DIDSON in future ecological research within these systems.

(Poster 5) Cross-shelf patterns in the pelagic ecosystem of the Kimberley region, northern Australia: preliminary findings

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The Kimberley is a remote region of Northern Australia where the marine environment is characterized by massive tides and seasonal fluvial discharge from large river systems, but little is known about the pelagic ecosystem. A multidisciplinary research voyage in April/May 2010 enabled the phytoplankton, zooplankton and larval fishes to be examined in conjunction with the physical oceanography along five cross-shelf transects (20-2000 m depth). Though surface waters were isothermal across the study area, strong stratification was evident and warm, high salinity surface waters overlaid a cooler, less saline water mass. There was no evidence of frontal features over the shelf or at the shelf break. Phytoplankton at the shelf break and further offshore was dominated by tiny picoplankton whilst, inshore, the concentration of phytoplankton rose dramatically with an unexpected diversity and abundance of medium to large diatoms. Significant cross-shelf structuring was evident in the bio-volume of macro-zooplankton and the concentrations of larval fishes with higher values recorded for inshore waters. Zooplankton assemblages included the pelagic larval stages of many benthic invertebrate species as well as larvae of krill and squid. Larval fish assemblages, which also displayed significant cross-shelf structuring, were diverse (>100 teleost families) and dominated by the larvae of neritic fishes. The natural variability of macro-zooplankton and larval fishes was found to be driven largely by isobath. This study provides a baseline which can be used to evaluate anthropogenic disturbance to the Kimberley pelagic ecosystem.

Spatio-temporal distribution of recreational use in Ningaloo Marine Park, north-western Australia

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Understanding where, when, and how many people use coastal environments is imperative for conservation of

marine biodiversity, management of natural coastal assets and location of appropriate infrastructure. This study determined the spatial and temporal distribution of recreational activities within the coral reef lagoon system at Ningaloo Marine Park in north-western Australia. Geo-referenced aerial surveys, coastal surveys and interviews with recreational participants conducted along the entire 300 km length of Ningaloo Marine Park, throughout 2007, allowed assessment of patterns in boating and coastal recreational activities. The use of the park is markedly seasonal with a clear increase in the number of users, and expansion of their spatial extent to cover most of the park, during the cooler months from April to October. In the off-season (November to March), people conducting activities in the park are fewer and concentrated in Coral Bay and around North West Cape. A wide range of extractive activities (e.g. recreational fishing) and non-extractive activities (e.g. whale shark and manta ray interactions, snorkelling, surfing, sailing sports, relaxing on the beach and walking) is undertaken in the Ningaloo Marine Park. While some activities are ubiquitous, others are highly dependent on the current zoning plan, the biophysical attributes of sites, road/track access, accommodation opportunities and tenure of the land adjacent to the park. The results of this study provide a robust benchmark of recreational use as a basis for enhanced management, readily measurable indicators for monitoring and are well-suited to systematic conservation planning for the next iteration of the Ningaloo Marine Park Management Plan.

Movement patterns and genetic stock structure of the white steenbras *Lithognathus lithognathus*, with implications for fisheries management

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White steenbras *Lithognathus lithognathus* is one of South Africa's most sought after and threatened endemic coastal fishery species. Dependence on estuarine nursery habitats and residency within the inshore marine environment make white steenbras highly vulnerable to localised overexploitation, and are factors contributing to stock collapse. This study aimed to determine estuarine residency and space use patterns, coastal movement patterns and genetic stock structure of white steenbras in South Africa, to provide recommendations for corrective management. Acoustic

telemetry studies showed that juvenile white steenbras (<35cm) are highly resident within estuaries, with little tendency to undertake excursions to sea. These early juveniles also exhibit distinct diel movement, utilising the shallow littoral zone at night and deeper channel areas during the day. Acoustic telemetry and conventional dart tagging showed that late juveniles and sub-adults are resident within the coastal zone, while larger individuals undertake larger-scale movements and have lost their dependence on estuaries. Preliminary analyses of nuclear (microsatellite) and mitochondrial DNA indicate little spatial genetic structure, providing evidence of a single, well-mixed adult population. The multi-method approach provides an improved scientific basis for the management of white steenbras and a platform for research on other estuarine-associated coastal fishery species.

FIN: The development of a volunteer based long-term monitoring programme for subtidal reefs around the Cape Peninsula

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Reliable information regarding the extent and cause of ecosystem change is essential if coastal biodiversity and resources are to be conserved efficiently. Long term monitoring (LTM) is advocated as one of the best means by which to collect the required information. However, without sufficient planning, coordination and support, LTM programmes often don't achieve their goals and are abandoned before their full value is realized. This can be attributed to poor planning and inefficient selection of monitoring methods during the conceptual stages, as well as insufficient and insecure long-term funding. In an effort to overcome these hurdles, pilot studies that optimise programme design are recommended, while volunteer based LTM programmes are gaining recognition as a financially viable option.

In the development of the Fish and Invertebrate (FIN) LTM programme a detailed pilot study was used to determine the feasibility of a volunteer based monitoring programme, develop a training course based on underwater visual census (UVC) techniques, assess the ability of the volunteers to identify and count different target fish and invertebrates and assess the level of variability in count data between volunteers and researchers. The results indicate strong public support for a volunteer programme, while the training course improved divers' ability to identify the selected target species. Similarly, field trials suggested a learning period associated with diver experience, and

showed little difference between the precision of count data collected by researchers and trained volunteers. Furthermore, the field trials were able to shed light onto biases and sources of variability associated with UVC techniques.

Monitoring the recovery of the southern right whale in South African waters

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After depletion from uncontrolled whaling in the 19th and early 20th centuries, southern right whales *Eubalaena australis* received international protection in 1935, but not before the population had sunk to possibly less than 1% of its original numbers. Aerial counts of right whale cow-calf pairs on the south coast of South Africa since 1971 indicate an annual instantaneous population increase rate of 0.069 a year (95% CI 0.064, 0.074). Annual photographic surveys since 1979 have resulted in 1 968 resightings of 954 cows with calves, individually recognised from their unique callosity patterns. Observed calving intervals ranged from 2 to 23 years, with a principal mode at 3 years and secondary modes at 6 and 9 years, but these make no allowance for missed calvings. Using a maximum likelihood model, a maximum calving interval of 5 years produces the most appropriate fit to the data, giving a mean calving interval of 3.16 years (95 % CI 3.13, 3.19). The same model produces an estimate for adult female survival rate of 0.990 (0.985, 0.996). The model is extended to incorporate information on the observed ages of first reproduction of grey-blazed calves, which are known to be female. This allows the estimation of first parturition (median 7.74 years, 95% CI 7.15, 8.33). First year survival rate was estimated as 0.713 (0.529, 0.896) and the instantaneous population increase rate as 0.070 (0.065, 0.075). Detection probabilities on surveys are generally high (>70%), and after an initial slight decline seem to have stabilised between 1990 and 2006. The current (2006) population visiting South Africa is estimated as some 4 100 animals, or about 20% of initial population size: the last parameter needs re-consideration. There are no signs as yet of a density dependent response in vital parameters.

(Poster 6) Systematics, taxonomy and Biogeography of South African Barnacles

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The last systematic and taxonomic review of the Cirripedia in South Africa was that of K. H. Barnard (1924). He added 48 new species added to the previously known 26 species documented by Stubbings (1910). To date, this study has added five new species to the list, including an entire family - the *Pyrgomatidae*. Most of the species introduced to South Africa were found to be well known fouling species. The existing key, produced by Barnard, is unclear and largely unusable, lacking illustrations and images for almost all species. Extensive revision of the taxonomy and biogeography for each species has been undertaken and a new illustrated dichotomous key compiled. Distribution ranges for several species have been extended, the most notable of which is a 300km southerly extension of *Tetraclita squamosa rufotincta* into the Natal Bioregion¹. High morphological plasticity is noted in species belonging to the *Lepas* genus - in particular *Lepas testudinata*. Phylogenetic analyses using two mitochondrial loci (COI and 16S) and one nuclear locus (18S) have been conducted in order to resolve whether new species may be present or not. Up until now it seems this may be the case using the 16S mitochondrial locus. Results incorporating the 18S and COI markers shall be presented and compared to a morphological treatment.

¹As defined by Lombard *et al* (2004).

Developing ecosystem indicators for the southern Benguela inshore region

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The overexploitation of target fish species worldwide, combined with other anthropogenic and climatic effects have resulted in complex changes in ecosystem structure. Fisheries management have had to re-think their strategies and many fishing nations now strive towards an ecosystem approach to fisheries management (EAF). The development of ecosystem indicators is helping to facilitate this EAF. Over the last two decades, the southern Benguela has experienced ecosystem shifts both offshore and inshore. However, research on ecosystem indicators has largely been limited to the offshore fisheries and associated ecosystems. In an initial attempt to develop indicators for the inshore region, possible physical and

biological indicators were identified. A method known as sequential t-test algorithm for analysing regime shifts (STARS) was then applied to these variables. Preliminary results of the STARS analysis identified shifts in two of the identified physical variables: wind and upwelling. Shifts in the mean east/west and north/south winds at Cape Point were detected during the early 1980s and early 1990s at both the 5% and 10% significance level. And a shift in upwelling variation was detected at various locations along the west and south-west coast during the late 1980s/early 1990s and early 2000s, at both the 5% and 10% significance level. These results correspond with an eastward shift in the West Coast rock lobster resource during the early 1990s. They provide an initial attempt at identifying regime shifts in the southern Benguela inshore ecosystem and will help to identify indicators that can be used to monitor ecosystem change.

Correlation of seaweed biogeographical diversity patterns with a new dataset of coastal temperatures along the South African coast: modelling the potential effects of marine climate change on seaweed distributions

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A detailed dataset of presence/absence of South Africa seaweed species, from the literature and collections, in 58 x 50km coastal sections has been developed and continually updated over many years. The distributions of around 850 species are interpolated between their extremes of reported occurrence along the coast. In the past, efforts to link seaweed biogeographic distribution patterns with inshore coastal temperature regime have been limited by the lack of detail in available sea temperature datasets. A detailed, high-resolution coastal alongshore seawater temperature climatology has now been produced for the South African coast. The monthly climatology is based on time-averaged, multi-annual continuous seawater temperature records obtained at 37 coastal localities, which have been subsequently interpolated to fill data-sparse regions. Cluster analyses of the separate seaweed and temperature datasets reveal remarkable congruence in pattern between the two. A reduced dataset of large and/or ecologically important species was produced, which contains around 30% of total species numbers.

Various scenarios for inshore seawater climate change were used to modify the temperature data, and models of their potential effects on biogeographical patterns of ecologically important seaweed species will be presented.

(Poster 7) Transverse, longitudinal & vertical growth of shoreface-connected ridges from the Aliwal Shoal, KZN, SA

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Shoreface-connected ridges (SCRs) are present on the Aliwal Shelf, in the vicinity of Aliwal Shoal. They are 3 to > 8km long, 1 to 6m high, spaced between 0.5 to 1.4km apart and open into the prevailing northerly directed, shore-parallel shelf current. These massive bedforms are generally ascribed to storm-current formation and have been linked to coastal retreat and sea-level rise, although no consensus on the exact process has been reached. They occur in groups with their crests usually parallel to the regional wave propagation direction. The Aliwal SCRS emerge from the shoreface at about -13m and dominate the inner-shelf to a depth of -30m, and persist to depths of about -60m. Aspects of the Aliwal SCRs indicate both a transverse (sand movement across the SCR) and a longitudinal phase (sand movement parallel to the SCR crest). Inshore SCR asymmetry is directed northwards (-13 and -20m) but further offshore (-22 to -30m) a bi-directionality is noted. This geometry supports a northerly unidirectional coast-parallel current inshore and a bi-directional coast-parallel current offshore currents measured in the vicinity confirm this. Existing seismic evidence confirms the transverse phase. In addition evidence from both SCR morphological change (thinning and offshore extension) as well as the sea-bed sediment distribution indicates a longitudinal mode of SCR growth. Evidence indicates that this phase is driven by offshore-directed storm-return flows. The association of these SCRs with shelf (non-storm) currents indicates that storm currents are not necessary for transverse growth, but this work confirms that storm currents are required for longitudinal growth. These SCRs have constructed a clinof orm which represents a Holocene condensed sequence.

Evidences of a more complex green turtle genetic stock structure in the South West Indian Ocean - implication for regional conservation

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The South West Indian Ocean (SWIO) hosts some of the most important nesting and feeding grounds for green turtles. This region includes major green turtle nesting areas, especially isolated islands such as on Europa and Tromelin Islands, Aldabra Atoll, Mayotte and Mohéli, where each island regularly hosts thousands of annual nesters.

Patterns of mitochondrial DNA (mtDNA) variation were used to reassess the population genetic structure based on new SWIO nesting green turtle (*Chelonia mydas*) populations (north of Mozambique, Kenya and the outer and inner Seychelles islands). Analysis of sequence variation over 396 bp of the mtDNA control region revealed 11 haplotypes among 84 individuals from 13 new sampled nesting sites in the Southwest Indian Ocean. Data set was gathered with previous analysed samples for this region comprising 288 samples from 10 other nesting sites, for a total of 23 sites and 372 samples. Global analysis confirms that green turtles nesting at the rookeries of the South Mozambique Channel (SMC) and those nesting in the North Mozambique Channel (NMC) belong to separate genetic stocks, the first one being related to the Atlantic, and the second one to the Indo Pacific. Even if the east African sites (Kenya and Mozambique) seems clearly related to the NMC stock, this study also found compelling genetic evidence that green turtles nesting at the rookeries of the Seychelles archipelago (Granitics, Amirantes and Farquar groups) are not part of the NMC stock, but belong to a separated new genetic stock. Such a result indicates that the SWIO needs to be considered for a regional management not anymore as two Management Units but as three.

Governance challenges facing African fisheries

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It is increasingly recognised that the failure to manage fisheries and ecosystems in a sustainable way is usually caused by institutional issues, rather than a shortage of data or a lack of understanding of stock dynamics. The paradigm shift to an ecosystem approach to fisheries (EAF) creates a framework for integrating the biophysical, social and economic aspects of fishery management. While African governments have largely been willing to buy into the EAF at a political and policy level, it has profound implications for the organisation of government, as fisheries and environmental management is now framed as a governance issue - as opposed to the traditional science based single species resource assessment with advise to managers who operate within a well defined set of protocols. We examine the realities of selected African fisheries, and assess the extent to which the existing governance assumptions and management arrangements are appropriate. Fisheries management in sub-Saharan Africa is largely derived from a "target resource management" paradigm, with interventions largely focussed on limiting fishing effort for single stocks. Our experience to date and examples in our presentation will show that when it comes to implementation of EAF, bureaucrats, government scientists and resource managers are uncomfortable with, and often resistant to, initiating and facilitating processes which address governance issues, or are often powerless to implement measures they know are necessary. We conclude with the need for the mainstreaming of programmes which address the governance arrangements of African fisheries through comprehensive processes such as the large marine ecosystem programmes.

Algal epiphytes on the seagrass, *Thalassodendron ciliatum* (Cymodoceaceae), on rocky shores in South Africa: a biogeographic and ecological investigation

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This study of *Thalassodendron ciliatum* and its epiphytic macroalgae is part of a project on marine biodiversity of the Sodwana area (African Coelacanth

Ecosystem Programme, ACEP). Sodwana Point (27°32'23"S 32°40'49"E) lies near the southern extremity of the Indo-Pacific biogeographic region. Knowledge of southern seagrass populations and their algal epiphytes, as well as their biogeographic extent and ecological functioning, is limited. *Thalassodendron ciliatum* is a dominant seagrass in eastern Africa, with a widespread distribution in the tropical Indo-Pacific. A single population of *T. ciliatum* is to be found at Maphelane, 100 km south of Sodwana, and fairly well-developed populations from Sodwana Point northwards. Seagrass populations were sampled in different habitats (different shore heights and open rock versus rock pools) at Sodwana Point and Maphelane. The biogeography of algal epiphytes associated with *T. ciliatum*, together with their biomass and diversity, is described. Coralline red algae (particularly *Pneophyllum amplexifrons*) which dominate at Sodwana Point were much less abundant at Maphelane. Seaweed epiphytes corresponded to 42% of the seagrass total biomass at Sodwana Point but 59% at Maphelane. The number of seaweed epiphyte species increased with increasing seagrass height and the bulk occurred on the upper quarter of stems. Differences in species composition and abundance were observed between different parts of the stems and leaf tufts, as well as between habitat types. Total numbers of epiphytic macroalgal taxa were 42 (Sodwana Point: March 2010), 43 (Sodwana Point: September 2010), and 42 (Maphelane: October 2010). Rhodophyta formed the largest fraction, always exceeding the numbers of taxa of Chlorophyta and Phaeophyta put together. Information on the distribution of this seagrass and its epiphytes can help to understand the effects of climate change, since species with their limits at biogeographic boundaries will be those primarily affected.

The comparative diet of the dominant zooplankton species in the St Lucia Estuary, South Africa

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The copepods *Pseudodiaptomus stuhlmanni*, *Acartia natalensis* and the mysid *Mesopodopsis africana* are the three dominant zooplankton taxa in the St Lucia Estuary, Africa's largest estuarine lake. This system is currently undergoing severe desiccation, owing to freshwater deprivation. Carbon and nitrogen stable isotopes of the main primary and secondary producers were analysed temporally at two contrasting habitats, Charters Creek, heavily affected by desiccation, and the Mouth, virtually under unchanged conditions. This study aimed to compare the diet composition of these species under different environmental conditions. The

mixed model SIAR (Stable Isotope Analysis in R) v 4.0 was used to determine the contribution of each food item to the diet of these taxa. Copepods made a substantial contribution to the diet of *M. africana* in the Mouth region, while those at Charters Creek utilised an even mixture of the available sources. At the Mouth, *P. stuhlmanni* utilised mostly particulate organic matter (POM), while feeding on an even mixture of available sources at Charters Creek. Limited data were available for *A. natalensis*, due to its short seasonal occurrence. Results do, however, indicate that this species feeds primarily on POM at the Mouth. Overall, results indicate that diet composition of all three species is more selective at the Mouth. This can be attributed either to the harsh environmental conditions prevailing at Charters Creek, or the poor separation of $\delta^{13}\text{C}$ signatures of primary producers in this region. The food partitioning abilities shown by these species may facilitate the utilisation of resources available in the estuary.

The geology and continental shelf evolution of the Durban Bluff and adjacent Blood Reef, related to Quaternary sea-level fluctuations

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The Bluff Ridge lies on the eastern seaboard of South Africa and forms a prominent feature rising 110m above MSL. Geology of the Bluff Ridge and adjoining Blood Reef consists of upper Pleistocene aeolianites and beachrocks deposited on a marine Cretaceous sequence, recording east coast sea-level fluctuations from the Last Interglacial (LIG) to the present. Despite several studies of the continental shelf fringing the central KwaZulu-Natal coastline, the evolution and age of these features have remained a subject of debate. Geological mapping of Blood Reef was carried out by SCUBA diving and the collection of boomer seismics, side-scan sonar and multibeam bathymetry. This enabled subdivision of the Quaternary deposits into three aeolianite units and thirteen beachrock units. Correlation to regional events and calcareous nannofossils suggest that Units 1 and 2 Aeolianite were deposited ~200 000 (MIS 7b) and ~132 000 (MIS 5e) years before present respectively. Unit 3, the youngest cordon, lies between 30 and 22m below MSL and provided a new feldspar Infrared Stimulated Luminescence age of 60 000-70 000 years (MIS 4). Palaeowind vectors indicate shifting pressure belts associated with palaeoclimate, and foreset orientation of Unit 1 Aeolianite indicates that during MIS 7b prevailing winds in the area were comparable to modern conditions. Unit 2 Aeolianite of the LIG is

characterised by a palaeowind more akin to the east-southeasterlies of warmer latitudes such as experienced in Beira. Unit 3 Aeolianite is comparable to cooler latitudes and matches those of the Cape. The beachrocks reflect both a regressive sea-level cycle from the peak of the LIG and sea-level rise from the middle of the Holocene Transgression. Diagenetic history indicates a succession of carbonate cements precipitated in the marine phreatic zone and a modern beachrock, cemented by aragonite and iron oxide, contains whaling and World War II artifacts. Unconsolidated shoreface-attached ridges characterise the Holocene sediment wedge on the shelf, bounded on the landward margins by Blood Reef. These are interpreted to be relict features associated with lowered sea-levels, but a northward-flowing eddy of the Agulhas Current influences their modern morphology. A bioclastic ravinement surface underlying migrating sand waves and shoreface-attached ridges reflects gravel lag deposits remnant of the Holocene Transgression.

(Poster 8) Managing marine animal strandings on the KwaZulu-Natal coast

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A stranded animal by definition is an animal that comes ashore either dead or alive. Marine animals have stranded throughout human history, with the earliest being documented from the 14th century. Cetaceans are the most common to strand, either alone or in large numbers, known as mass strandings. Other animals that also strand include turtles, whales, seals, whale sharks and sea birds. Scientists have hypothesised several causes for this behaviour, such as navigational errors and weakness through injury, sickness or old age. The real reason for stranding is unknown therefore records of standing events assist scientists in finding the true cause of this behaviour. South African scientists also support the notion and for that reason the Ecological Advice Marine Team has been tasked with managing and keeping record of stranding events that occur on the KwaZulu-Natal coast with the assistance of the EKZNW marine managers. Ezemvelo collaborate with a number of other institutions such as Sea World and the Natal Sharks Board often with the assistance by volunteers, i.e. members of the public, South African Navy, the National Sea Rescue Institute, SAPS and local veterinarians. Various response and rescue approaches are applied, these are dependent on the type of incident and the species involved, and is therefore dealt with on a case by case basis. Data is collected at each stranding event and later databased. Dead animals are either removed for storage until such time an autopsy can be performed, or is disposed of. Live animals are assessed, and either removed for rehabilitation, refloated/released or euthanized.

Currently, a national response plan for strandings is being developed in order to coordinate efforts for a more effective way of dealing with strandings in South Africa.

Spatial and temporal movement dynamics of dusky kob *Argyrosomus japonicus*, with implications for fisheries management

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Dusky kob *Argyrosomus japonicus* is one of South Africa's most sought-after coastal fishery species. High levels of juvenile exploitation in estuaries have led to stock collapse in South Africa, highlighting the need to understand the spatial and temporal aspects of estuarine-dependency and multiple habitat use. With current management regulations failing to arrest a decline in exploitation pressure, the need for alternative management strategies is required. This study uses a multi-faceted approach to acquire empirical data on the movement behaviour of dusky kob and to use this information to develop alternative fisheries management procedures. An acoustic array comprising 49 data-logging receivers spanning 300 km of the South African coastline was used to monitor the movements of 94 acoustically-tagged dusky kob (237-1130 mm TL) over three years. Sixteen receivers were deployed in the Sundays Estuary to determine habitat use and fine-scale estuarine movements. Additionally, a minimum of two receivers were deployed in the mouths of seven adjacent estuaries and the Port Elizabeth and Coega harbours to assess estuarine connectivity. Ten receivers were also deployed in the coastal zone to assess dispersal patterns. Micro-chemical composition of dusky kob otoliths was investigated to identify estuary-specific signatures for evaluation of the role of the Sundays Estuary in the production and export of juveniles to the coastal fishery. The quantification of estuarine residency periods, low levels of connectivity between estuaries and high exploitation rates of juveniles in estuarine fisheries, have provided new insights into the value of estuarine nursery habitats and pertinent information for the corrective management of this species.

The Pangani and Rovuma - a tale of two east African estuaries

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Assessments of the health and flow requirements have recently been conducted for two large, mangrove-dominated East African estuaries - the Pangani and the Rovuma systems. The Pangani estuary is situated in northern Tanzania, is approximately 22 km in length and receives an MAR of $1.2 \times 10^3 \text{ Mm}^3/\text{A}$ from a catchment of 43 600 km² in extent, while the Rovuma system is situated further south on the Tanzania/Mozambique border, is approximately 10 km in length, has a much larger catchment (152 200) but receives a considerably smaller MAR (15 Mm³/A). In their present state, these two systems appear markedly different from one another. It is hypothesised, however, that these two systems were much more similar in the past, in spite of some marked differences in the geomorphological and climatological characteristics of their catchments. The Pangani system is severely degraded in its present state, a function of changes to its geomorphological characteristics (caused by disruption in sediment supply), reductions in water quality (due to waste water discharges), and changes in MAR (due to agricultural abstraction and hydropower developments), while the Rovuma system is largely pristine, without significant change in runoff (MAR = 99% of natural), geomorphological characteristics that are largely natural, and water quality that shows only minor impairment.

(Poster 9) Changes in the spatial distribution of West Coast Rock lobster in the area East of Cape Hangklip

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A general southward shift in the spatial distribution of West Coast rock lobster (*Jasus lalandii*) and a specific influx of lobster into an area previously not associated with high lobster abundance was observed between Cape Hangklip and Danger Point lighthouses during the late 1990's. The social, economic, ecological and management implications of a shift in lobster distribution, particularly to the nearshore component of the fishery, are far reaching. All available information was therefore reviewed to answer the following pertinent questions: 1) are the changes in spatial

distribution limited to the nearshore region only or have they also occurred in deeper water? 2) Is the eastward shift still occurring? 3) What are the possible causes and implications of such a shift? The contribution of the West Coast region to total lobster landings declined from about 60% to <10%, whereas that of the southern region increased from around 18% to around 60% over that period. The early 1990s was also the start of a major influx of lobsters into the nearshore zone (shallow water (<30M) region of the area East of Cape Hangklip (EOCH), an area not previously associated with high lobster abundance. The absence of West Coast Rock Lobster in dedicated longline trap surveys for lobster in deepwater areas (50 - 100M) EOCH over a three year period clearly demonstrates that the eastward shift of lobster is limited to the shallow nearshore region. The underlying causes of the eastward shift in lobster are poorly understood but are thought to be linked to changes in the physical environment.

Was the sardine eastward shift an ecological experiment that failed?

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Sardine *Sardinops sagax* have historically mainly been found off the West and South West Coasts of South Africa where they contributed largely to the diets of top predators, including seabirds, and were an important target of the pelagic purse-seine fishery. A gradual eastward shift in their distribution during the late 1990s and early 2000s eventually resulted in more than 90% of the sardine biomass being distributed to the east of Cape Agulhas in 2005. The eastward shift also coincided with an abrupt shift in the main spawning location of this species, from predominantly west of Cape Agulhas during 1994-2000 to predominantly east of Cape Agulhas in 2001 - a situation that remained until 2007. The biomass of sardine, which had also gradually been increasing reached a peak of 4.2 million tonnes in 2002 following record levels of recruitment in 2001 and 2002. Six consecutive years of poor recruitment between 2004 and 2009, however, resulted in the adult biomass declining to <500 thousand tonnes. This poor recruitment occurred despite prolific but patchy spawning of sardine off the East Coast. Subsequently, an increase in the number of eggs found to the west of Cape Agulhas and their occurrence further north off the west coast during the 2009 annual acoustic biomass survey may have contributed to above-average west coast recruitment of sardine in 2010 and an increased presence of sardine in the area west of Cape Agulhas by November 2010. It therefore

appears plausible that successful sardine recruitment, and subsequent growth in the biomass of the adult population, is dependent on adequate spawning west of Cape Agulhas. In the light of this, it becomes increasingly important to ensure that fishing effort on potential spawning adults in the area west of Cape Agulhas is carefully managed. Additionally, the return of sardine to the west has important ecosystem implications particularly for endangered seabirds.

Effects of biogeography, upwelling and habitat structure on the fauna associated with bioengineers

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Temperature and primary production (often linked to nutrient supply) are two of the few factors influencing species diversity and abundances across mesoscale gradients, while at smaller scales the habitat complexity offered by bioengineers is important. We examined the habitat structure offered by two species of mussels (*Perna perna* and *Mytilus galloprovincialis*) and their associated fauna in five regions across 3000 km and three biogeographic provinces of the South African coast, replicating upwelling and non-upwelling areas within each region. Upwelling and region influenced the size-frequency structure of mussel beds. Mussel bed fauna were strongly correlated with the structure of the habitats created by mussels. We investigated the relationship between this structure and the assemblages of associated fauna by experimentally manipulating mussel bed structure. We worked in two of the upwelling regions in the south coast biogeographic province. On two shores in each region, we created mussel beds with structures typical of the two regions and as a control sampled undisturbed mussel beds. We found strong differences in the associated fauna between shores within regions, and the effect of habitat structure often differed between shores. In general, shores within each region showed similar differences among the three structures. This study highlights the fact that relationships between bioengineers and their associated fauna are often complex, and that understanding the underlying processes influencing patterns of biodiversity requires recognising the contingency of these relationships on spatial scale.

The Comoros Gyre: a numerical modelling approach

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The oceanographic processes of the Comoros Basin (815° S and 4050° E) are poorly understood. A number of observational and modelling studies have reported an anticyclonic eddy (“Comoros Gyre”) in the northern Mozambique Channel, however to date this feature has received little attention. The Comoros Gyre is generally located from 10°S to 15°S between the northeast coast of Mozambique and the northwest coast of Madagascar. This gyre may play an important role in Agulhas Current dynamics since it has been noted that Mozambique Channel eddies affect the dynamics of the Agulhas Current and contribute to the upstream source region of the Agulhas Current. It is also possible that the Comoros Gyre plays an important role in sustaining the biomass and diversity in the Mozambique Channel through dispersal of larvae. Thus a better understanding of the dynamics and processes of the Gyre is warranted. In order to study the dynamics and processes of the Comoros Gyre, the Regional Ocean Modelling System (ROMS) was employed to simulate a realistic representation of the Comoros Gyre. A good agreement was found between satellite derived and model sea surface temperature (SST) patterns, however the model SST in the Mozambique Channel are slightly higher than the satellite SST. The sea surface height (SSH) and geostrophic currents of the model simulation agrees well with satellite derived SSH and geostrophic currents as well as with results obtained from other modelling studies. In the model simulation three anticyclonic vortices are formed in the Mozambique Channel which propagate southward. The model results show that the Comoros Gyre is not a stationary or permanent feature. This validated simulation will allow for higher resolution studies of the Comoros Gyre as well as experimental model simulations to improve our knowledge of the dynamics of the gyre and the processes involved in its formation.

(Poster 10) Resource partitioning among albatrosses breeding on Marion Island: insights from three complementary methods

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Due to their geographic isolation, sub-Antarctic islands are among the best places to investigate the concept of differential niche exploitation. We combined direct and indirect approaches to examine resource partitioning among three albatross species breeding on Marion Island in the Prince Edward archipelago (Southern

Ocean) during April and May 2009: the Grey-headed *Thalassarche chrysostoma* (GHA), Light-mantled *Phoebastria palpebrata* (LMA), and Sooty *Phoebastria fusca* (SA) albatrosses. Three complementary techniques with different temporal resolutions allowed us to investigate their diets across time scales: conventional stomach analysis (last meal), fatty acids of stomach oils (last foraging trip), carbon and nitrogen stable isotope ratios as indicators of foraging areas and trophic level respectively (analysed for adult and chick blood: breeding season; adult feathers: moulting period). The combination of these approaches provided information on food and feeding during both breeding and moulting seasons for adults and chicks of all three species. The three species exhibited spatial segregation in foraging. During both seasons the SA foraged further north (in sub-Antarctic/subtropical areas), as shown by significantly higher $\delta^{13}\text{C}$ in SA blood and feathers, than the two other species (sub-Antarctic/Antarctic waters). $\delta^{15}\text{N}$ and stomach content analyses also revealed trophic segregation, with GHA preying mainly upon fish while LMA and SA foraged mainly on squid. Lipid class analyses of stomach oils confirmed this result with diacylglycerols-ethers being recovered in LMA stomach oils with few diacylglycerols-ethers, but huge quantities of triacylglycerols, detected in GHA stomach oils. This work demonstrates how sympatric species share resources through spatial segregation (SA foraging at lower latitudes) as well as prey specialization (fish for GHA and squid for LMA). The results highlight the need to combine approaches to determine accurately the trophic relationships of top predators.

(Poster 11) When seabirds touch the bottom. Progress in bio-logging enables submesoscale discrimination of underwater foraging strategies in small flighted divers

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The technological revolution of the compass sensor, GLS, ARGOS-PTT, and GPS tags has produced exciting discoveries in the spatial monitoring of breeding seabirds, and become a key asset to conservation. However, to date, many studies have focused on large bodied species, like albatrosses, penguins, or gannets, which move over large distances and are thought to respond to rather large-scale

oceanographic physical processes. Tracking of smaller species has been delayed, not only due to the size of data-loggers, but also because of their resolution and/or sampling interval. Indeed, many small seabirds have short foraging ranges and should therefore respond to submesoscale oceanographic cues. Fine-scale temporal (<10s) and spatial (<10m) resolution is therefore essential when studying these species. In addition, precise spatial positioning has proved difficult to obtain in divers, because animals' surface periods - when communication with satellites is possible - are sometimes very short, and waterproofing loggers is decisive. We used state-of-the-art GPS and time-depth recorders for studying the submesoscale, three-dimensional foraging behaviour of an inshore small (~1000g) flighted diving seabird: the Cape Cormorant (*Phalacrocorax capensis*). By intersecting our results with precise inshore bathymetric data, we show how these birds, which feed on shoaling fish, explore and exploit the coastal zone horizontally and vertically, and how differences in dive category (benthic or pelagic) can relate to dive shape and foraging strategy. Such techniques will become important tools for the conservation of the smaller species of seabirds, guiding the conception of Marine Protected Areas.

(Poster 12) An experimental test of the interactive effects of nutrients and sandprawn, *Callichirus kraussi* Stebbing, bioturbation on macrofaunal communities

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Disturbance and productivity are two important factors shaping community structure and diversity, alone or interactively. The interactive effects of nutrient enrichment, as a means of enhancing productivity, and bioturbation by *Callichirus kraussi*, as a disturbance, on macrofaunal communities were examined through a field caging experiment in the intertidal sandflats in Langebaan Lagoon. Three levels of nutrients, background (0 g), 250 g and 500 g Plantacote-Plus™ 8M (Aglukon) controlled-release fertilizer per bag, and four levels of bioturbation, 0, half (125 m⁻²), normal (250 m⁻²) and double (500 m⁻²) sandprawn density were applied. Nitrate with nitrite, ammonia and orthophosphate levels were significantly enhanced by enrichment, but microphytobenthic biomass and bacterial (extra-polymeric substance) levels were not. *C. kraussi* bioturbation had significant effects on macrofaunal communities, enhancing burrowing infauna, but also promoting the surface grazer, *Assimineia globulus*, contrary to expectations. *C. kraussi* bioturbation significantly affected diversity and abundance of macrofauna, producing peaked or positive (logarithmic or power) relationships in

enriched treatments. Nutrients had no significant effects or interactive effects with bioturbation on either macrofaunal community structure or diversity. However, it is suggested that background nutrient levels were naturally high due to upwelling and are raised to even greater levels by enrichment. Positive or peaked relationships of diversity and abundance with bioturbation are thought to occur because bioturbation muted the negative effects of high nutrient levels on diversity.

The trouble with estuarine fisheries in South Africa, illustrated by a case study on the Sundays Estuary

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A detailed 12-month survey conducted on the Sundays Estuary revealed that this system is an important recreational destination for local and nearby residents who use it primarily for fishery resource utilisation. Empirical data collected on species and size composition, catch retention rates, effort and catch per unit effort (cpue), as well as additional information gleaned from social questionnaires, indicated that the sustainability of the Sundays estuarine fishery is questionable. The main areas of concern are (i) high targeting of vulnerable catadromous species (e.g. dusky kob), (ii) low capture success rates for targeted species, (iii) high capture rates of juvenile (undersized) individuals, (iv) high retention rates of captured fish, (v) ill informed users, (vi) limited law enforcement, (vii) no fishery monitoring, and (viii) no public awareness campaigns. These threats to fishery resource sustainability are not unique to this system and a comparison of findings from similar studies suggests that the management of estuarine fisheries in South Africa is currently inadequate.

(Poster 13) Influence of coastal upwelling on the biodiversity and ecosystem function of sandy beaches in South Africa

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It has been predicted that alterations to established upwelling systems will occur under conditions created by global climate change. The allochthonous nature of sandy beach systems makes them vulnerable to changes in nutrients, and previous works have

indicated food availability can alter the structure of their macrofaunal communities. The presence of upwelling cells around South Africa, in different biogeographical provinces, creates the perfect opportunity to test upwelling effects on coastal communities irrespective of temperature and latitude. Four regions were identified; two on the west coast and two on the south coast, and upwelling and non-upwelling sites were replicated in each, during austral winter. Much debate surrounds the techniques for sampling sandy beaches, and it heavily depends on the aims of the investigation. The method adopted here was a stratified sampling plan, with 14 samples (20cm diameter cores) taken from each of nine sections of equal breadth, encompassing the entire intertidal (bore collapse to drift line) within a defined alongshore area (50m). This method enabled representative coverage of the shore, whilst maintaining haphazard sampling and avoiding autocorrelation. Complementary physical measurements were taken to compare beach types. Preliminary analysis of the physical characteristics indicates consistent beach slope among sites within each region allowing reliable comparisons. Low abundances of macrofauna were found at all south coast sites, however assemblage composition varied. Completion of summer sampling will complement these data and help to further elucidate any upwelling effects.

Lake St Lucia in crisis status after eight years of mouth closure, impacts on the meta system and options for recovery

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The Lake St Lucia Estuarine System, on the East Coast of southern Africa, is a major nursery area for juvenile marine fish and prawns and comprises some 80% of the total estuarine area of KwaZulu-Natal. The mouth of the system closed in June 2002 due to a major drought event in the catchment. Apart from a breach in March 2007 due to high seas resulting from Cyclone Gamede passing offshore, which connected the system to the sea for six months, the system has been closed for almost eight years. During this period reduced river flow coupled with high annual summer evaporation rates at one point resulted in the lake contracting to <25% of its 325km² area. It also caused hypersaline conditions with a maximum salinity of 200 being recorded. Despite the lake almost being filled, by inflowing sea water during the breach, water from the catchment has been insufficient to restore the connection to the marine environment. The St Lucia Crisis situation is further exacerbated by the fact that 50 years ago some 60% of the annual runoff to the system was excluded when a separate mouth was

created for the Mfolozi estuary. This paper reviews the impacts of the eight year closure on the major faunal components of the lake, the adjacent marine zone and nearby Mfolozi estuary. The current Ezemvelo KZN Wildlife management policy relating to the mouth closures is reviewed and options to reduce further impacts both in St Lucia and the offshore marine environment are considered. Issues and implications relating to the reconnection of the Mfolozi to St Lucia are considered in relation to the long term survival of the Lake St Lucia Estuarine System which is both a RAMSAR and World Heritage Site.

The potential for echinoculture in South Africa: development of a formulated feed

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The South African marine aquaculture industry is growing rapidly and is investigating the culture potential of a number of indigenous marine invertebrate species in intensive land-based recirculation systems. One such species under investigation is the echinoid *Tripneustes gratilla*. Since nutrition is one of the major factors governing the success of most aquaculture initiatives, the development of a formulated feed that is nutritionally consistent and capable of producing a high quality product is essential prerequisite for the development of South African echinoculture. In this study, we investigated whether formulated feeds could promote maximal growth and improve the market acceptability of gonads from cultured *Tripneustes gratilla*. Five protein rich artificial diets, supplemented with varying amounts (0, 5, 15 & 20% (DW)) of the macroalga *Ulva*, were developed and fed to adult *T. gratilla* over a 12 week feeding trial. A control group was fed only with fresh *Ulva*. Urchin growth, gonad growth and number of gonad quality factors, such as colour, texture and sexual maturity, were assessed on a monthly basis. Our results indicated that urchins fed artificial diets had a significantly ($p \leq 0.05$) higher gonad somatic index (GSI) by the end of the feeding trial when compared to urchins fed only with fresh *Ulva*. In fact, the 20% *Ulva* inclusion diet increased GSI by 205% in just nine weeks (7.6 to 23.3%), compared to a 57% increase in GSI for the control group. Gonad lightness (L*), redness (a*) and yellowness (b*) were also quantified using a spectrophotometer. While L* and a* values did not differ significantly between treatments, b* values of gonads obtained from urchins fed the artificial feed supplemented with 20% *Ulva* were significantly ($p \leq 0.05$) higher when compared to all other artificial dietary treatments, but did not differ significantly from the control group. *Ulva* also effected the density of nutritive phagocytes (NP's) within the gonad. Fresh

Ulva and the artificial feeds supplemented with 15 and 20% *Ulva* produced gonads with significantly ($p \leq 0.01$) more NP's compared to the other treatment groups. Food consumption rates were also significantly higher ($p \leq 0.01$) for animals fed the artificial diets supplemented with *Ulva*. These results suggest that urchins fed artificial feeds supplemented with 20% *Ulva* can produce gonads of high market quality in terms of size, texture and colour, indicating the potential for this artificial feed in commercial echinoculture.

(Poster 14) A note on the first documented southern transatlantic migration of a blue shark (*Prionace glauca*) tagged off South Africa

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The first documented recapture of a South-African-tagged, juvenile blue shark *Prionace glauca* off Uruguay lends weight to the hypothesis of a single blue shark population in the Southern Atlantic. The presence of neonate blue sharks with umbilical-scars and females with post-parturition scars as well as the high frequency of small juveniles in research longline catches confirm the existence of a parturition and nursery area off South Africa. The final positions of three tagged sharks suggest that large-scale movement patterns in the South Atlantic are a mirror image of movements in the North Atlantic with sharks using the northwesterly Benguela Drift to migrate into the tropics and ultimately across into South American waters. The confirmed existence of a parturition and nursery area off the Cape and the movement of sharks into both adjacent ocean basins suggest the possibility that the southern African blue sharks are part of a single stock which straddles the South Atlantic and Indian Ocean and possibly the entire Southern Hemisphere.

(Poster 15) The influence of grazing by the starfish *Parvulastra exigua* on microalgal assemblages in intertidal soft-sediments

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In this paper we report on field experiments undertaken to quantify the effects of grazing by the starfish *Parvulastra* (= *Patiriella*) *exigua* on microalgal communities in Langebaan Lagoon, South Africa. This starfish commonly occurs on rocky shores in South Africa and Australia, but rarely occurs in soft-sediments. Whilst grazing is generally known to be important in structuring marine systems, the influence of grazing starfish are poorly documented. Our results indicate that at naturally occurring densities, *P. exigua* plays an important role in structuring soft-sediment microalgal assemblages. *P. exigua* had no significant effect on microalgal biomass, but linearly reduced microalgal density through consumption. Interestingly, increasing *P. exigua* densities resulted in a linear increase in extracellular polymeric substances (EPS), which is indicative of an enhancement of carbohydrate levels in the sediment either through mucus addition or stimulation of bacteria. Taxonomic richness and diversity of microalgae showed classical hump-shaped responses to increasing starfish density. The findings of this experiment are discussed in the context of the intermediate disturbance hypothesis (IDH), which proposes that disturbance acts to promote diversity at intermediate levels by eliminating dominant species thus allowing poor competitors to establish. We also present evidence for a non-competitive mechanism by which this starfish may promote microalgal diversity in marine sediment habitats, arising from its promotive effects on sediment EPS levels. We conclude with a model to show how grazers may structure communities through the combined effects of the Intermediate Disturbance Hypothesis (IDH) and EPS mechanism. Collectively, our results indicate that *P. exigua* plays an important role in regulating diversity and richness of microalgal assemblages and concur with previous assertions that this starfish plays an under-estimated role as a structuring agent of intertidal systems.

Bridging fundamental science, policy making and management in practice

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Current biological indicators are not well suited to judge the quality of entire ecosystems. An alternative could be the use of series of nested tools like habitat chance maps based on physical factors, the assessment of their availability including the species assemblages and the subsequent calculation of holistic ecosystem indicators (e.g. by Ecological Network Analysis/ ENA) to assess status and quality. This then could be confronted with the 'goods and services' these systems provide to human society. Against this background we proposed for the European Wadden Sea a challenging 'cost-effective' modification of current monitoring in

such a way that collected data can be used to feed simulation models and food web analyses. Simple automated recording of basic water quality data on board a ship is an attractive possibility while moving from the one to the other sampling station. Such an approach is not only cost-effective but also offers a solution for the fact that results of our conservative monitoring programs increasingly need to be used for assessing increasingly complex EU Directive related goal-oriented functions, a phenomenon that happens everywhere. Among these goals is the judgement of the quality of the 'integral system' covering the combination of ecological, socio-economic and cultural heritage aspects. Application of combinations of e.g. the 'ecosystem approach', 'habitat mapping', 'DPSIR approach' and 'ENA food web analyses' very well fit this EU context. A 'cost-effective' development of the above described approach may form a challenging future direction which can be applied everywhere.

(Poster 16) The effects of freeze-thaw preservation events and desiccation by oven- and freeze-drying on isotopic and elemental carbon and nitrogen values of marine organisms

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Stable isotopes are an increasingly important tool in trophic linkage ecological studies. For the preservation of isotopic tissue samples, freezing and freeze-drying are considered ideal. In studies of large marine animals, isotopic sampling is often given secondary priority to sampling for diversity and biomass aspects. Consequently, isotopic samples are frequently collected subsequent to repeated freezing and thawing, and results of these studies are often based on the assumption that this does not affect isotopic values. Our study tested this assumption and also examined the difference between oven- and freeze-drying on isotopic values and elemental carbon:nitrogen (C:N) ratios. Nitrogen and carbon isotopic values were determined from tissues of five marine species as fresh material, and from samples that had been thawed once and thawed twice; elemental values for nitrogen (N) and carbon (C) and the C:N ratios were determined as a by-product. Freeze-drying had no significant effect on ¹²C/¹³C or ¹⁴N/¹⁵N ratios, and oven-drying only affected ¹⁴N/¹⁵N of *Veledona togata*. Oven-drying significantly decreased elemental N in the fishes *Squalus megalops* and *Otolithes ruber* and C in *Chaunax pictus*, *S. megalops* and *O. ruber*, but did not affect C or N levels in invertebrates. It also altered C:N ratios in *Squalus megalops* and *Penaeus japonicus*. Freeze-drying significantly decreased N and C in all

species, but C:N ratios were unaffected. We recommend using samples as fresh as possible and freeze-drying as a means of sample desiccation in isotopic and elemental studies.

The effects of preservation methods and dyes on the isotopic values ($\delta^{15}\text{N}$ and $\delta^{13}\text{C}$) of two zooplankton species from the KwaZulu-Natal Bight, South Africa

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Stable isotopes are an important tool for ecosystem trophic linkage studies. It is ideal to use fresh samples for isotopic analysis, but in many cases organisms must be preserved and analysed later. In some cases dyes must be used to help distinguish organisms from detritus. Since preservatives and dyes are carbon-based their addition could influence isotopic readings. This study aims to improve understanding of the effects of sample storage method, dye addition and the effects of acidification on $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ of zooplankton (*Euphasia frigida* and *Undinula vulgaris*). Zooplankton was collected and preserved by freezing, the addition of 5% formalin, 70% ethanol, or 5% formalin with added Phloxine B or Rose Bengal and stored for one month before processing. Samples in 5% formalin and 70% ethanol were also kept and processed after three and nine months to study changes over time. Formalin caused the largest enrichment for $\delta^{13}\text{C}$ and a slight enrichment for $\delta^{15}\text{N}$, while ethanol produced a slight depletion for $\delta^{13}\text{C}$, while $\delta^{15}\text{N}$ caused different effects depending on the species. In formalin, dyes depleted $\delta^{13}\text{C}$ values, but had variable effects on $\delta^{15}\text{N}$, relative to formalin alone. Acidification had no significant effect on $\delta^{15}\text{N}$ or $\delta^{13}\text{C}$ for either species. Long term storage showed that the effects of the preservatives were species-dependent. Although effects on $\delta^{15}\text{N}$ varied, a relative enrichment in carbon of samples occurred with time. This can have important consequences for the understanding of the organic flow within a food web and for trophic studies.

(Poster 17) An investigation of the ichthyofauna in the Port of Ngqura, South Africa

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This study represents one of the first quantitative assessments of a fish community within a pre-operational deep-water port system. Between September 2006 and September 2007 a total of 4,559 fish, representing 47 species and 27 different families were caught within the port of Ngqura in 1,713 hours of shore (2.3 fish angler⁻¹ h⁻¹) and 239 hours of boat based angling (2.8 fish angler⁻¹ h⁻¹). Catches included species representative of both estuarine and shore fisheries. The majority (83.0%) of species caught were marine and less than size-at-50% maturity (71.4%). The most abundantly caught species were *Argyrosomus japonicus* (25.5%), *Pomatomus saltatrix* (24.9%), *Lichia amia* (17.7%) and *Carcharhinus obscurus* (10.7%). Using a Jolly-Seber open population model the abundance of neonate and juvenile *Carcharhinus obscurus* within the Port was estimated at 552 (95% CI: 422 - 765). Annual apparent survival probability was 0.38 (95% CI: 0.30 - 0.46), with an average annual recapture probability of 0.28 (95% CI: 0.19 - 0.39). This study demonstrates that the Port of Ngqura is functioning as an important habitat for both juvenile and adult fish. In particular, it is acting as an important summer nursery and core activity zone for both neonate and juvenile *Carcharhinus obscurus*.

How useful are monitoring derived data for ecological risk assessment?

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Monitoring of benthic communities in the Murray River estuary, South Australia, has resulted in a comprehensive data set documenting the deteriorating ecological health of the system over the past seven years. Drought and over-allocation of water, together with a series of barrages separating the estuary into a marine and freshwater component had led to serious environmental conditions, with hypersalinity in the Coorong lagoon and receding water levels in the Lower Lakes. Ecological Risk Assessment (ERA) was undertaken in 2010 to evaluate consequences of several management scenarios to prevent acidification from acid sulphate soil exposure, including the proposal to flood the lakes with seawater. The long-term data series on the distribution and abundance of macrobenthos provided valuable knowledge on salinity preferences of key species in the system and allowed to evaluate their possible response to the management actions in both the lakes and remaining estuary. While site-specific data were available with regards to species specific response to salinity, consideration for other aspects of the ERA had to be based on a literature review of related species or general expert knowledge. I will discuss benefits and challenges of monitoring

derived data for usage beyond the original monitoring objectives.

(Poster 18) *Ficopomatus enigmaticus* (Polychaeta, Serpulidae) in the Coorong, Lower Lakes and Murray Mouth, South Australia: distribution and ecological relevance

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Biogenic reefs of the tubeworm *Ficopomatus enigmaticus* are prominent structures in parts of the Murray River Estuary and Coorong Lagoon. Manipulative field experiments in the estuary revealed that even without live tubeworms, these biogenic structures are harbouring a higher biodiversity than adjacent sediments. The size and extent of these reefs has fluctuated subject to prevailing environmental conditions, with concurrent decline and spread in different parts of the system. Seawater seepage through barrages allowed colonisation of previous freshwater lakes, where the tubeworm thrived for several years, colonising man-made structures as well as freshwater turtle and bivalve shells. These negative effects of tubeworm colonisation contrast the positive effect of their reef structures in the estuary. The ability of *F. enigmaticus* to occur and grow in a wide range of salinities will contribute to its persistence under changing environmental conditions, and continue to pose a management challenge in the estuary.

(Poster 19) Gillnet fishery catches and bycatch in Langebaan Lagoon MPA

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Gillnets/driftnets are non-selective by design for all fish species not smaller than the mesh size, and many of the non-target species are immature and/or below the legal size limit. To effectively manage bycatch requires reliable and/or *in situ* data, which is lacking. The temporal coverage of the *in situ* data was four - five conservative days in a month since July 2010, but all daily catch returns data has been collected since

September 2010. Data collected for *in situ* observations include the GPS position of all net throws and catches, catch, date, start and end time. While daily catch returns data only included date, catch, time out and back. To date, a total of 24 *in situ* observation data collection trips have been made, and 700 catch returns recorded. The total catch and length size (from 26 to 29 cm) over the months has generally increased in the summer season compared to spring. The number of bycatch species and the frequency of capture for these have also increased in the summer season into ± 10 species compared to ± 3 species in winter and spring. The spatial distribution of bycatch species is closely associated with deep channels mainly on the western side of the Lagoon. The most commonly caught bycatch species was white stumpnose *Rhabdosargus globiceps*, elf *Pomatomus saltatrix* and steentjie *Spondylisoma emarginatum* with an average length size of 33 (SD= ± 9.5), 34 (SD= ± 4.9) and 17 (SD= ± 0.8) cm, respectively. A noteworthy observation made during this study is that the length size of harders in Zone A and B was substantially different, and this may suggest either different species or populations harvested within the Lagoon.

(Poster 20) Marine resource utilisation patterns in Table Mountain National Park MPA

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Marine resources are difficult to manage due to uncertainty regarding population sizes, recruitment variability, and most important due to shortfalls in data (i.e. monitoring). To elucidate this, we established a marine resource monitoring program to assess resource use patterns within the Table Mountain National Park marine protected area. The spatial coverage of the program was limited to selected areas due to logistical and financial constraints. Roving creel survey method was used to collect catch and effort data. In addition, catches landed at slipways also recorded. A total of 3 220 and 1 254 shore and slipway patrols were conducted, respectively over the period May 2005 until March 2008. Most commonly collected invertebrates were limpets *Patellidae*, white mussel *Donax serra*, black mussel *Choromytilus meridionalis* or Mediterranean mussel *Mytilus meridionalis*, polychaet worms and periwinkles. Most of these were caught on the Atlantic. 27 different line fish species, smoothhound shark *Mustelus mustelus* and a group of different shark species were recorded. Boat-based angling catches were dominated by snoek *Thyrsites atun*, hottentot *Pachymetopon blochii* and red roman *Chrysoblephus laticeps*, while shore-based angling catches were dominated by yellowtail *Seriola lalandii*,

galjoen *Dichtus*, maasbanker *Trachurus trachurus*, hottentot and strepie *Spondylisoma emarginatum*. Most catches for both boat- and shore-based angling were recorded on the False Bay side. The overall shore angling catches per unit effort have declined from 3 fish per 10 angler days (2005-2006) to 1 fish per 10 angler days (2007-2008). A noteworthy observation made during this study is that invertebrate collectors often did not have a fishing permit compared to recreational anglers, and this suggests a need for greater outreach education program and increased level of compliance surveillances.

(Poster 21) Existence of deeper spawning grounds for the South African chokka squid *Loligo reynaudii*

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Originally it was thought that regardless of the sub-optimal benthic conditions, spawning in deep water may provide a buffer against the high levels of fishing pressure exerted on inshore spawning aggregations. However the use of “parachute” sea drogues and lights has enabled fishermen to target possible deep spawners. The extent, viability and contribution of deep spawning to recruitment are as yet unassessed. The aim of this work is to determine the extent, depth range and importance of the deep spawning grounds in comparison to those inshore. Demersal survey data used in this study were collected by DAFF over the period 1985-2008. In total data from 61 demersal surveys covering the west and south coasts, separately, were examined for squid eggs. The majority of spawning occurred on the eastern Agulhas Bank between Knysna and Port Alfred. In the inshore spawning area the greatest percentage of positive trawls was found in the 21-30m and 41-50m depth categories. The high percentage of positive trawls in the 61-70m depth category indicated “inshore” spawning activity to occur to a maximum depth range of 70m. Thereafter there was a general increase in offshore spawning from 71-100m, peaking at 101-110m, and a decrease from 111-130m. Very little spawning occurred at depths 131-270m. It appears the majority of eggs were spawned in the 41-50m depth zone, with biomass increasing from inshore (57kg.km^{-2}) to 50m (140kg.km^{-2}). Between 51 and 70m, biomass decreased to 42kg.km^{-2} . In comparison, offshore spawning was not substantial, with the highest biomass, 6.3kg.km^{-2} , spawned in the 101-110m depth zone. As expected, the largest egg biomass was found on the inshore spawning grounds with offshore spawning contributing 18% to total estimated egg biomass.

The hydrology and biogeochemistry across the Subtropical Convergence Zone in the Southwest Indian Ocean region

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The Subtropical Convergence Zone (STCZ) is one of the major frontal zones of the world's oceans and is considered to be the northern boundary of the Southern Ocean separating warm, oligotrophic, well-stratified subtropical waters in the north from colder, nutrient rich but less stratified subantarctic waters to the south. It has been proposed to be an important biogeochemical boundary due to the physical, chemical and biological changes across the zone. It has been proposed that mixing across the frontal zone is responsible for the high primary productivity associated with the STCZ suggesting that this is an important region for the drawdown of carbon. The STCZ and neighbouring regions may therefore play a significant role in today's changing climate. Results collected during cruise 410 of the *RV Dr. Fridtjof Nansen* in the late austral spring-early summer of 2009 in the South West Indian Ocean across the STCZ south of Africa will be presented. Hydrological and biological data was collected along two transect lines, with 11 and 15 hydrographic stations occupied in the southward and northward leg, respectively. In this presentation we will highlight the biological, chemical and physical characteristic of the STCZ at the time of the survey to show the correlation between nutrient concentrations, mixed layer depths in determining chlorophyll-a concentrations. In the southbound transect the Subtropical Convergence was located at $40^{\circ}30'$ S, while in the northbound transect it was located at 41° S. The temperature change across the front was $15-7.5^{\circ}\text{C}$ over a distance of approximately 110km. While SiO_4 was depleted in the surface layer NO_3 and PO_4 concentrations were higher in the subantarctic surface waters than the subtropical surface waters. A better understanding of the processes across the STCZ will undoubtedly improve our understanding the role played by the STCZ in shaping the primary productivity and local production in the South-West Indian Ocean region.

(Poster 22) The effect of fish oil substitution level with soya oil in fish feed on the growth, health and carcass composition of dusky kob, *Argyrosomus japonicus* (Pisces: Sciaenidae) Temminck & Schlegel 1843

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The recent trend in marine finfish feed production has been to produce high lipid, energy- dense diets that allow for the protein sparing effect. Increasing lipid levels in fish feed through fish oil sources is undesirable as fish oil is expensive and from an unsustainable source. The partial substitution of fish oil with vegetable oil can lead to less expensive diets with the same amount of digestible energy as a 100% fish oil diet but may reduce fish growth and health. The growth trial was conducted in twelve recirculating tanks and repeated twice. Fish were fed three diets containing various levels of soya oil substitution. Diet 1 = 100% fish oil, diet 2 = 14% soya oil and 86% fish oil, diet 3 = 28% soya oil and 72% fish oil. Fish were weighed and measured at the beginning and end of each experiment and growth and feed utilisation variables were calculated. At the end of the second experiment hepatosomatic indices and haematocrit levels were determined. Carcass composition proximate analysis and glycogen levels still need to be quantified. In both experiments specific growth rates were significantly better in diets containing soya oil substitutions than the control, diet 1 (one way ANOVA: $p = 0.007$ for experiment 2 and Kruskal-Wallis ANOVA: $p = 0.03$ for experiment 2). In experiment two, protein efficiency ratios and food conversion ratios were significantly higher for diet 2 than for diet 1 or 3 (one way ANOVA: $p = 0.01$ for FCR and $p = 0.01$ for PER). The results suggest that *A. japonicus* grew and utilise their food better when part of the fish oil lipid source was substituted with soya oil in the short term.

An assessment of the shore-based and offshore boat-based linefisheries in KwaZulu-Natal, South Africa

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In order to evaluate the management effectiveness of the KwaZulu-Natal linefishery, surveys of the shore-based and offshore boat-based linefisheries were undertaken between February 2009 and April 2010.

Methods used included a stratified-random creel sampling technique for the shore-based linefishery and a random access-point sampling technique for the offshore boat-based linefishery. Overall, excluding an increase in the number of charter vessels and associated fishers, it appears that there have been relatively few new entrants into the KZN linefishery since the last national linefish assessment conducted in 1994-1996. In contrast, total angler effort in both the shore and offshore linefisheries has decreased substantially in the past 12 years. This is as a result of changes in management, as well as biological and socio-economic factors influencing these fishery sectors. Analysis of overall catch per unit effort (CPUE), catch composition and total catch in both these linefisheries suggested that they are currently in a relatively stable condition (i.e. little change in the past 12 years). However, further analysis of CPUE for several important linefish species suggests that stocks may have been fished down to low levels. Recommendations such as improved management of the charter fishery and ongoing establishment of an effective MPA network are discussed.

(Poster 23) Spatio-temporal variation in the early life history characteristics and recruitment dynamics of greenback flounder (*Rhombosolea tapirina*) in the Murray Mouth and Coorong, South Australia

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Recruitment of newly-settled fish can vary spatially and temporally and it can be beneficial to develop some understanding of the casual factors of this variability. This study examined the recruitment and early life history characteristics of greenback flounder, *Rhombosolea tapirina* in the ecologically degraded environment of the Murray Mouth and Coorong, South Australia, between April 2009 and March 2010. The aims were to: (i) describe the spatial and temporal patterns in recruitment; (ii) determine the duration of the settlement season and the timing of settlement of successful recruits using otolith microstructure; and (iii) to determine seasonal variation in post-settlement growth rates for juveniles. Recruits were sampled regularly at five sites of increasing distance from the Murray Mouth using a beach seine net. Young-of-the-year were captured at all sites between April and November. Small post-larval recruits were most abundant at sites near the Murray Mouth (<5 km), while mainly larger juveniles were captured at the more distant sites. Back calculation using post-settlement

daily increment counts indicated that settlement occurred between April and November. This long settlement season was corroborated by observations of spawning activity from April to October. However, almost 70% of the recruits settled between May and June. Instantaneous growth rates were determined from the relationship between fish size and age and were significantly higher during autumn compared to winter and spring when temperatures were lower. The prolonged pre-settlement duration when water temperatures were lowest, may have resulted in higher mortality of eggs and larvae, and ultimately lower settlement rates. Based on settlement dates, successful recruitment resulted from periods when growth rates were highest. Ongoing studies of the early life history characteristics of *R. tapirina* will further explore the influence that water temperature has on recruitment success.

Variation in the diet of greenback flounder (*Rhombosolea tapirina*) affected by freshwater inflows in Australia's largest temperate estuary

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Estuarine fish live in a dynamic environment subject to salinity-regulating freshwater inflows. Climatic changes, combined with the over-exploitation of freshwater resources can have a major influence on the foraging capabilities of estuarine fish. The aims of this study were to examine the diet and ontogenetic trophic traits of greenback flounder, *Rhombosolea tapirina*, before and after, drought-breaking freshwater inflows in the Murray River estuary. Samples of *R. tapirina* were collected using haul and seine nets and assigned to one of three size classes: juveniles (>100 mm); sub-adults (101-200 mm); and mature adults (>200 mm). The dietary composition and feeding patterns were determined from gut content analysis. Overall, 21 prey items were identified in the diet. The main food items were polychaetes (Nereididae), bivalves, crustaceans (mainly amphipods) and chironomid larvae. Juvenile grapsid crabs and small bodied fish were also consumed. A clear ontogenetic shift was evident between juveniles and adults: both adults and sub-adults consumed large volumes of nereidid polychaetes, whilst amphipods dominated the diet of juveniles. The predation of siphons of the bivalve *Tellina* was evident in the guts of adults and sub-adults. These ontogenetic differences in diet were evident before and after the freshwater inflows commenced into the estuary, however greater volumes of amphipods were consumed following the flows. The

consumption of bivalves and grapsid crabs decreased significantly after the introduction of freshwater into the system, presumably due to rapid drop in salinity within the estuary. *R. tapirina* is an opportunistic carnivore that has a strong association with the benthic invertebrate communities, which may account for the high abundance of this species where invertebrate diversity and abundance is highest in the Murray River Estuary and Coorong lagoons. Knowledge of this strong association facilitates well-informed, ecological sustainable management of the population.

Challenging paradigms in estuarine ecology

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For many years, estuarine science was the poor relation in aquatic research - freshwater scientists ignored estuaries as they get confused by salt and tides, and marine scientists were more preoccupied by open systems. Estuaries were merely regarded by either group as either river mouths or sea inlets. However, for the past four decades, estuaries (and other transitional waters) have been regarded as being ecosystems in their own right and as such several paradigms have been proposed as summarising their structure and functioning and which relate to both the natural science and management of the systems. This paper details, comments, challenges and/or affirms these paradigms. The paradigms can be grouped into those covering firstly the science (definitions, scales, linkages, productivity, tolerances and variability) and secondly the management (pressures, value/valuation, health and services). As such the examination of the paradigms covers the development and types of ecotones, the nature of stressed and variable systems (and relevance to resilience and redundancy), the relationship between generalists and specialists produced by environmental tolerance, the relevance of scale in relation to functioning and connectivity, the sources of production and degree of productivity, the biodiversity-ecosystem functioning and the stress-subsidy debates, the development and effects of exogenic unmanaged pressures and endogenic managed pressures, the perception of health and ability to manage related to internal and external influences, and the influence of all of these on the production of ecosystem services and societal benefits.

Shrinking or emigrating? Decreasing abundance of a vulnerable population of common bottlenose dolphins (*Tursiops truncatus*) in Walvis Bay, Namibia, subject to high human impacts

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An isolated population of bottlenose dolphins inhabit the nearshore waters of the central Namibian coastline, including Walvis Bay. Within the bay, the population is subject to considerable human pressure including aquaculture, port activities and a large and currently uncontrolled marine tourism industry of >25 boats. Much lower levels of boat activity have been associated with temporary and permanent emigration of sensitive individuals from similar populations elsewhere and the tourism industry is currently regarded as the main threat to the population. Five seasons of photographic mark-recapture data are available from Walvis Bay since winter 2008. Closed-population abundance estimates indicate large seasonal variation in abundance (40-60%) possibly associated with prey availability, but a longer term trend of a 6-8% decrease. This decrease could be due to emigration or a real population decline. Here we analyse available data on sightings history, strandings and human impacts to assess the conservation status of this population. A large proportion of animals identified in 2008 (27%, 19 of 70) were never seen again, but a similar number have entered the population. The sighting frequency of a group of known mothers has decreased dramatically since a traumatic live stranding event in early 2009. Combined with a sighting well outside of the known range of the population and increased opportunistic sightings 50km south of Walvis Bay, these results suggest the population decline is due to range shift or emigration. However, an apparently low birth rate (two since 2008) and high mortality (two calves, four adults) are concerning. Strong social bonds within this population mean individuals are not resighted at random, and most sightings are of only a few individuals, creating a misleading impression of abundance which could undermine conservation efforts. We investigate the interplay between these factors to assess the real and perceived conservation status of this population.

From coast to canyon - the nature of soft-sediment demersal communities off central KwaZulu-Natal, South Africa

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Other than on the crustacean trawl grounds, little is known of the biodiversity of demersal fauna of soft sediments in the east coast province of KwaZulu-Natal, South Africa. The African Coelacanth Ecosystem Programme provided an opportunity to investigate these communities, as part of a multi-disciplinary study on the ecosystem functioning of the KwaZulu-Natal Bight. During 2010, demersal research trawls were undertaken along a transect from ~30m to ~560m water depths, during the wet/warm and dry/cool seasons, off the Thukela River (29°S) in central KwaZulu-Natal. Trawl station localities were determined based on a combination of depth strata, shelf width and trawlability. Catches were generally small, implying low biomass, with higher catches in shallower depths (on the shelf). There was a broad trend of increasing numbers of species and greater numbers of higher taxonomic categories with depth. Catches were dominated by demersal taxa, mainly fishes and crustaceans, with the former more dominant in shallower depths; crustaceans assumed more importance in depths > 400m; in trawls around 300m depth, porifera and echinoderms were much more common. Amongst the fishes, sciaenids and soles predominated in shallower trawls, while chlorophthalmids and macrourids dominated deeper trawls; the crustaceans were mainly comprised of crabs and prawns at all depths. Gear problems, exacerbated by high current speeds and a lack of replicates preclude more quantitative interpretation, but the biodiversity information gained is invaluable. It remains to be seen whether there were substantial changes in environmental parameters which could explain differences in the species composition from the two seasons.

Global change and the oceans around southern Africa: have we got our house in order?

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This talk examines the marine issues involved in Global Change, including both climate change and exploitation of marine resources. What is involved in projecting climate change scenarios into the future and linking marine ecosystem models to these? It also examines our research needs in order to tackle global

change issues and the structures in place to carry out global change research. What are our main limitations and how are we addressing these? How do marine and atmospheric scientists interact in southern Africa and how should they interact? It concludes with some explicit proposals to promote such research and meet national needs.

Fish physiology; the effect of diet on the excretion of ammonia-nitrogen in juvenile dusky kob, *Argyrosomus japonicus*

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In the past decade dusky kob have become an increasingly popular aquaculture species; in order to develop this industry and reduce the running costs associated with it, it is essential that optimal diet formulations be developed. This research project investigates the effects of protein to energy (P:E) ratio in formulated diets on water quality in relation to the excretion of ammonia-nitrogen. The aims of this study were to determine whether the excretion of ammonia-nitrogen in juvenile dusky kob is affected by dietary protein levels and to analyse the effect of diet on water quality. Ninety juvenile dusky kob in a recirculation system comprised of 16 80L tanks were used. Water samples were taken at feeding and at two-hour-intervals after feeding for twelve hours. The ammonia concentration was measured using a double beam spectrophotometer. The concentrations of ammonia were converted to NH_3 as a function of salinity, pH and temperature and compared statistically using repeated measures analysis of variance. Results suggest that the production of ammonia-nitrogen is independent of diet, as there were no statistical differences between treatments. The excretion of ammonia-nitrogen increased rapidly for two hours after feeding, following which the rate of excretion decreased. The combined results were plotted as polynomials to illicit general trends. It is thus hypothesised that the production of ammonia-nitrogen in kob was not related to the diet in this study, but rather is a process of protein metabolism. Since the production of ammonia-nitrogen is greatest in the first two hours after feeding, increasing the flow rates during this time could improve general water quality, which may have implications on growth and feeding efficiency and should be the focus of future studies.

(Poster 24) Aspects of the movement behaviour of sicklefin lemon sharks, *Negaprion acutidens*, in the St. Joseph's Atoll, Seychelles using acoustic telemetry

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The sicklefin lemon shark, *Negaprion acutidens*, is a poorly studied, large bodied, coastal shark species occurring in tropical and subtropical areas of the Indo-Pacific region. Juveniles typically utilise shallow coastal embayments and atolls as nursery areas. Through the use of a passive acoustic array, the movement patterns of large juveniles of this species were assessed in the St. Joseph's Atoll in the Amirantes island group, Seychelles. Twenty one individuals were equipped with acoustic tags and monitored for a year. Long term use of the Atoll, as well as fine scale movements between different habitats within the Atoll, were investigated. The majority of individuals showed regular daily use of the Atoll over the year. Core area use was found to be largely consistent throughout the year, but also differed between individuals. Movements within the Atoll were found to be strongly influenced by tidal height. The limited area use highlights the need to conserve such atoll environments for the effective protection of this inherently vulnerable species.

Biogeochemical dynamics of the Benguela Upwelling with emphasis on the carbonate system

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The influences of central water masses and their carbon imprint on the biogeochemical condition of the Benguela Upwelling System (BUS) were studied to assess the importance of the BUS for carbon sequestration.

During four expeditions the BUS was surveyed on a latitudinal extent of 17°S - 34°S. Vertical profiles of nutrients, $\delta^{13}\text{C}$ DIC, alkalinity (AT) and DIC (dissolved inorganic carbon) were taken along cross shelf transects and underway measurements of surface pCO_2 were performed along the cruise tracks. Sediment traps were deployed off Walvis Bay.

Preliminary results support the view that the BUS splits into a northern and a southern subsystem, which differ in regard to their biogeochemical characteristics. The northern subsystem is strongly influenced by preconditions set by the inflow of suboxic, CO_2 and

nutrient rich South Atlantic Central Water (SACW) from the Angola Dome, whereas the southern subsystem is affected by Eastern South Atlantic Central Water (ESACW). CO₂ emissions show a pronounced seasonality for the northern system and more stable conditions for the southern system. In contrast to the northern subsystem, the southern one is on average under saturated in CO₂ with respect to atmospheric concentrations. Preliminary results reveal strong gradients of aragonite and calcite saturation states from the coast to the open ocean, suggesting a limiting effect for calcifying organisms towards the coast. Data obtained from sediment traps in the northern subsystem show that matter export seems to follow the seasonality in upwelling activities with enhanced fluxes in the austral summer and lower fluxes in the austral winter.

Fish as indicators of diving and fishing pressure on South African coral reefs

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Differences in coral reef fish assemblages were investigated on six South African and one southern Mozambican reef under varying management regimes. All of the South African reefs fall within marine protected areas (MPA) but are zoned to include multiple-use and no-take sanctuary areas. The reef in southern Mozambique was not situated within an MPA at the time of data collection and was thus zoned as open. The aim of this study was to assess the impact of human activities on coral reef fish communities using 25 fish indicator species. These species were selected *a priori* based on their ecological importance and sensitivity to human activity (fishing and diving). The objective was to use these species as indicators of recreational diving and fishing pressure in the different protection zones. Randomly stratified underwater visual censuses (UVC) were used to collect the fish data. An average of 62 point counts were conducted per reef. Various environmental variables and habitat characteristics were recorded during the UVCs. Fish density, biomass, trophic structure and size frequency analyses comprised the primary metrics in this assessment. The total abundance and biomass of the indicator species were significantly higher in Sanctuary zones and lowest in the Open zone. In addition, Sanctuary zones were characterised by high numbers of large predators, while non-Sanctuary zones were characterised by a higher abundance of prey species. Target species were also larger and more abundant in Sanctuary zones. The data revealed that recreational fishing and diving intensity may be significantly influencing the fish community structure on southern African coral reefs, which was confirmed by GLM regression analysis. Long-term monitoring of these fish

communities is recommended to confirm the trends observed in the data.

Trends in shark bycatch in long-line fisheries for tuna and swordfish, and sampling of shortfin mako sharks off South Africa

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Declining bycatch of pelagic sharks in long-line fisheries for tunas and swordfish has raised concerns that shark populations may be under pressure from these fisheries in some areas of the South West Indian Ocean (SWIO) region. Historical data collected by fisheries observers on commercial long-liners over the past 10 years, and official landing statistics of sharks have been sourced from the Department of Agriculture, Forestry and Fisheries (DAFF). These data have been analysed to investigate trends in fishing effort, catch and catch rate over time, relative to fishing area, season, and nationality of fishing fleet. In addition to the analysis of general shark bycatch data, an analysis of catch rate and length-frequency distribution of shortfin mako sharks *Isurus oxyrinchus* in the SWIO region has been undertaken. Mako sharks were sampled for length, sex, body weight, vertebrae for ageing studies and genetic tissue during a three-week sampling trip on a shark-directed long-liner operating on the Agulhas Bank during November 2010. The above analyses form part of a longer term MSc project funded by SWIOFP, which will include not only an assessment of shark bycatch in long-line fisheries but also a detailed biological study of shortfin mako sharks in the SWIO region. The study is in an early stage, and the presentation shows some of the most interesting preliminary results.

(Poster 25) Molecular analysis reveals potential new genera & species for South Africa in red seaweeds of the Laurencia complex (Rhodomelaceae)

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Laurencia Lamouroux is an ecologically important genus on the coastlines of South Africa, which has been little studied locally. The genus also contains suites of potentially useful chemical compounds which

are under investigation. Correct taxonomy is, thus, essential. Stegenga *et al.* (1997) and De Clerck *et al.* (2005) reviewed taxa on the South African west and east coasts respectively and recognised nine species in genus *Laurencia* on the basis of morphological and anatomical features. Following recent molecular taxonomic studies elsewhere, the genus has expanded into a complex now comprising five distinct genera. Results from Parsimony and Bayesian phylogenetic inferences based on plastid DNA sequence characters (*rbcL* gene, 1467bp) have increased the number of putative taxa in South Africa from nine to fifteen *Laurencia* entities. The well-known South African species *Laurencia flexuosa* comprises two distinct entities, which are supported by a difference in the number of *corps en cerise* present in members of each group. Other South African samples exhibit a strong affinity to *L. marilzae*, a species recently described from Brazil. This species exhibits significant sequence divergence and morphological and anatomical differences from *Laurencia sensu stricto*, and this may lead to the formation of a sixth genus in the complex. Phylogenetic analyses have also revealed the first molecular evidence for the presence of the genera *Chondrophyucus* and *Palisada* in South Africa.

Thermal tolerance of two ecosystem engineers of East African mangroves: forecasting the effects of climate change on ecosystem functionality

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Rapid climate change has a strong impact on marine ecosystems, through warming, acidification, hypoxia and salinisation of sea water. Marine ectotherms are mostly affected by changes in temperature, which directly influence oxygen availability and their ability to utilise oxygen and so can have potential cascading effects on their overall fitness. As a consequence, understanding the thermal response of organisms, particularly ecosystem engineers, is crucial to forecasting the effects of climate warming on ecosystem functionality. Here we focus on the thermal tolerance of two mangrove ecosystem engineers inhabiting the eulittoral of East African and South African mangrove forests, the crabs *Perisesarma guttatum* (Sesarmidae) and *Uca urvillei* (Ocypodidae). In order to assess their sensitivity to acute temperature fluctuations across a wide latitudinal gradient, we

studied the thermal window of a Kenyan and a South African population of each species using intermittent flow-through respirometry. Metabolic rate was measured in the laboratory along a temperature ramp procedure of 1°C × h⁻¹ between 17-27°C in water and in air, as these species experience both conditions. The results showed a stenothermic response for both species in water, with a pronounced latitudinal effect, the South African populations being adapted to lower temperatures than the Kenyan ones. Both species showed a different response in air, where the thermal window was wider, highlighting a better tolerance to temperature change in air than in water. This suggests that oxygen limitation is the driving parameter in determining the limits of thermal tolerance. These results suggest that these subtropical mangrove populations are vulnerable to long-term increases in temperature, particularly because of reduced oxygen content in water as it warms. This is likely to lead to a loss of fitness with serious consequences for overall mangrove ecosystem functioning.

(Poster 26) The influence of size of the mussel *Mytilus galloprovincialis* on the uptake of trace metals

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The trace metals, Al, Cr, Mn, Fe, Co, Ni, Cu, Zn, Cd and Pb, were measured in mussel, *Mytilus galloprovincialis*, water and sediment. The samples were collected at two locations along the West coast of South Africa, Milnerton Lagoon and Scarborough which present different levels of trace metal concentrations and sources of anthropogenic influences. Analysis of *M. galloprovincialis*, water and sediment have shown Milnerton Lagoon as having high Al, Cr, Mn, Cu, Fe, Ni, Pb and Cd concentrations while Scarborough had high Co, Zn and Cd concentrations. Two size classes of *M. galloprovincialis* were used, 50 - 75 mm (size class 1) and 30 - 45 mm (size class 2). The smaller size class of mussels accumulated higher trace metal concentrations than the larger mussels. This could be an indication that smaller mussels accumulate more trace metals in their tissues as larger mussels consist of mainly gonads. This study indicates that smaller juvenile *M. galloprovincialis* should be used in biomonitoring rather than the larger reproductive mussels.

Food sources of early life stages of horse mackerel (*Trachurus trachurus capensis*) and anchovy (*Engraulis capensis*) from the Northern Benguela System revealed by stomach content, stable isotope and lipid analysis

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Pelagic fish such as horse mackerel (HMC) and anchovy (ANC) are or once were important fisheries resources in the Northern Benguela Current System. Hence a sustainable management of their stocks is of great importance and in this regard a successful recruitment of early life stages into the adult stock is crucial and widely accepted to be a major bottleneck.

Eggs and larvae are planktonic and thus exposed to the environmental conditions of the surrounding water mass without a chance to escape from poor conditions. Despite of abiotic factors such as water temperature and oxygen saturation, the availability of sufficient and appropriate food organisms is highly important for their growth and survival. Species could have different dietary needs, which in turn might help to explain different recruitment success.

Trophic ecology of early life stages of commercially important fish species of the Benguela Upwelling System only came into the focus of research recently. Here we present results of the first study conducted in the Northern Benguela in this context. Stomach content analysis of larval HMC from 4-30 mm standard length revealed that ingested items were mainly copepods. Cyclopoid species of the genera *Oithona* and *Oncaea* dominated in terms of abundance. In terms of volume, as a measure of biomass calculated by the size of prey items, additionally calanoid copepods were important. ANC larvae were almost exclusively caught at night with empty stomachs, which limits a comparison of both species to tracers of assimilated food revealed by the stable isotope (SI; $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) and fatty acid approaches. Preliminary results of fatty acid composition hint to a dinoflagellate based diet in larvae of both species. SI and stomach content data of HMC did not show an ontogenetic shift in diet composition within the investigated length range.

(Poster 27) Spatio-temporal distribution of catches of redeye roundherring (*Etrumeus whiteheadi*) by the small pelagic fishery off South Africa's Coast

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Redeye round herring (*Etrumeus whiteheadi*) is endemic to southern Africa waters and occurs over the continental shelf between Namibia and the east coast of South Africa. This species is targeted by the South African fishery for small pelagics and is used to produce fish meal and oil, and was first caught in 1958. Annual landings since then have ranged between <1 000 tonnes and 92 000 tonnes, with an average of around 35 000 tonnes. The fishery for redeye is currently managed via a precautionary upper catch limit (PUCL) of 100 000 tonnes, but industry has seldom come close to reaching this limit. Redeye is presently considered underexploited because its estimated biomass has ranged between 1 and 2 million tonnes over the past decade. Little is known about the life history of *E. whiteheadi*, and information gleaned from commercial catches will be useful for the assessment and management of this species. In this presentation we describe the spatio-temporal distribution of purse-seine catches of redeye using commercial catch data recorded during the period 1987-2010. Catches are limited both spatially and temporally, the majority of redeye being taken from March to May over the continental shelf between Cape Columbine and Cape Point. Almost no catches are taken during the remainder of the year or elsewhere along South Africa's coastline, although catches of redeye off Mossel Bay to provide fish for a newly-built canning factory there have been made in recent years. We discuss the reasons for these catch patterns, and also present some results from exploratory midwater trawling for redeye and other small pelagic species that was undertaken in 2010.

(Poster 28) Examination of redeye roundherring (*Etrumeus whiteheadi*) size and age data - towards developing a growth curve for the redeye stock assessment

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Redeye roundherring (*Etrumeus whiteheadi*) has been caught as bycatch in the South African pelagic fishery since the early 1950s, and is converted to fish meal, fish oil and fish paste. It is caught mainly by the pelagic purse seine fishery, which primarily targets anchovy (*Engraulis encrasicolus*) and sardine (*Sardinops sagax*). Redeye adult biomass fluctuates around an average of 1.3 million tons. Catches are restricted by an annual Precautionary Upper Catch Limit of 100 000 ton that is set each year, but catches

have generally been low, averaging 50 000 tons per annum over the last 10 years. The resource is therefore considered to be underexploited. In view of this, and the possibility of expanding the fishery, work has been directed at assessing the status of the redeye to support the management of the resource. Implicit in such an assessment is the requirement for information on the age and growth of the species. An examination of the size structure of the population observed during the routine pelagic surveys from the period 2000-2009, coupled to the application of available daily age data was conducted in order to improve the growth modeling for stock assessment purposes. The examination of redeye age and size distribution data has revealed the likelihood of the existence of three sub-cohorts each calendar year, an (early) summer (January-March) sub-cohort, a (peak) winter (May-July) sub-cohort and a (late) spring (August-November) sub-cohort. A von Bertalanffy growth model was fitted to daily ageing data for young fish and length-at-age data for older fish. These two key sources of information will be used to model redeye population dynamics.

Subtidal pioneers: abundance and diversity patterns of seaweed communities on dead corals at Sodwana bay, South Africa

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The reef coral communities of the Maputaland coastline in northern KwaZulu-Natal (KZN), South Africa, are one of the southernmost tropical coral communities in the world. Subtidal seaweed communities in northern KZN have been poorly studied. The only ecological report on seaweeds in the region is a study on subtidal turf-forming communities at Sodwana Bay. The present study investigates the abundance and diversity of the subtidal macroalgae colonising dead coral at Two Mile Reef (TMR), Sodwana Bay. Samples were collected (using SCUBA) from reefs ('sites') at depths of 10-19m. Each sample comprised all macroscopic seaweeds within a 10cm x 10cm quadrat at each site (a total of 43 quadrats). Components of the reef substrata were estimated using line-point intercept (LPI) methods combined with phototranssects along 10m transect lines at each site. A total of 39 seaweed taxa were recorded (excluding encrusting coralline algae), the most abundant genera being *Lobophora*, *Dictyota*, *Dictyopteris* and *Herposiphonia*. A second component of the study investigates the macroalgal species colonising new/empty substrata (artificial settlement tiles) which were placed on TMR over a six month period by the Oceanographic Research Institute (ORI). These

communities are compared to those found on the dead coral on TMR. 27 taxa were identified from 145 tiles and *Lobophora*, *Dictyota* and *Sphacelaria* were most abundant. *Lobophora variegata* was the dominant species from both the reef and tile samples (39.1% and 33.1% respectively). Dead coral cover of the reef was 15.2% while living coral cover ranged from 6.7% (*Acropora*) to 22.9% (plate corals). Results are discussed in relation to possible substrate preferences of the seaweeds and death (bleaching) of corals at Sodwana Bay.

Phytoplankton productivity, nitrogen metabolism and community structure in the Atlantic sector of the Southern Ocean

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During summer 2008/2009 and 2009/2010 *MV SA Agulhas* resupply voyages to Antarctica, phytoplankton productivity studies were conducted using stable ¹³C and ¹⁵N stable isotope tracers in the Atlantic sector of the Southern Ocean, including along a transect between SANAE and South Georgia. Phytoplankton biomass and daily productivity decrease throughout the season, likely the result of depletion of the winter dissolved iron reserve. For both cruises, stations to the north east of South Georgia exhibited the highest biomass and productivity (08/09: 2.9ug.l⁻¹ and 2.91 mgC m⁻³ h⁻¹; 09/10: 64.43mg.m⁻² and 313.17mgC.m⁻².d⁻¹) suggesting that the input of iron into the euphotic zone enhanced productivity relative to iron deficient regions further afield in the ACC. Elevated productivity and nitrogen uptake was also found near frontal regions for similar reasons. Community structure was determined by CHEMTAX analysis of pigments. Nanoplankton (2-20µm) dominated productivity and NH₄ was the preferred source of nitrogen. Algal assemblages were dominated by diatoms with considerable contributions to biomass by haptophytes, notably *P. antarctica*. The role of phytoplankton new production is also discussed.

(Poster 29) Benefits of bimodal respiration: intertidal crabs rise above the oxygen limitation of thermal tolerance

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The principle of oxygen limitation of thermal tolerance in ectotherms (OLTT) theorises that the higher limits of an organisms' thermal niche is directly linked to its capability of maintaining adequate provision of oxygen to its tissues. Initially inferred for marine ectotherms, the decline of thermal resistance due to inefficient tissue oxygenation, as expected by the OLTT, was also shown in terrestrial species. Air-breathing ectotherms, however, showed wide thermal tolerances, since they could take advantage of the higher oxygen availability in air than in water. Here we tested the educated guess that bimodal species, such as intertidal invertebrates, could better cope with acute thermal stresses with respect to truly marine species, by taking advantage of air-breathing. Using intermittent flow-through respirometry, we measured the metabolic rate of the rocky intertidal crab *P. marmoratus* along a temperature ramp procedure of $1^{\circ}\text{C} \times \text{h}^{-1}$ between 17-27°C. We demonstrated that the oxygen consumption rates of *P. marmoratus* in aquatic and aerial conditions show typical temperature-dependant exponential rise in water, while in air the aerobic metabolism remains unaltered. Our results demonstrate the ability of bimodal intertidal ectotherms to exploit both the aquatic and the aerial phases. This ability has to be taken into account in climate warming scenarios and predictions about their present and future distribution and biology.

(Poster 30) Thermal tolerance of key-note macrofaunal species: a method to forecast the impact of climate change on African Mangrove systems

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World climate change is leading biologists to investigate the thermal biology of key species inhabiting particularly vulnerable ecosystems. The study of thermal tolerance of ectotherms, in particular, offers a reliable model to understand how these organisms face temperature changes and, how these changes can ultimately affect ecosystem functioning. Importantly, it is not always obvious which stage of the life cycle is most vulnerable to long term change and most studies focus on a single life stage, generally the adult stage. Here, we present an ongoing project aimed at evaluating the thermal biology of several crab

species inhabiting East African and South African mangrove forests. The project is part of the wider Marie Curie EU Project "Coastal Research Network on Environmental Changes" (CREC). We focus on understanding the different thermal windows that key species show across different life stages, from embryo, to larva and adult. Since thermal tolerance is primarily determined by oxygen availability, the assessment of the temperature-dependent aerobic range is crucial to forecasting the effect of climate change on macrofaunal intertidal species. The need for highly reproducible non-invasive methodologies, suitable for species exposed to a wide range of temperatures, has led us to implement different respirometric tools: a laboratory temperature increment of 1°C per hour and an instrumental setup appropriate for aquatic and aerial measurements. We adopted fiber optic oxygen mini- and micro-sensors (PreSens, Germany) connected to 0.5l respirometric chambers and to Hamilton syringes as controlled volume micro-chambers for measurements on adults and eggs and larvae respectively. Giving some preliminary examples of our data, we describe the innovative aspects of this approach, which allows us to address all ontogenetic stages of species that facultatively breathe in both air and in water, allowing a more complete estimation of thermal tolerance of marine ectotherms than has been possible so far.

(Poster 31) So what makes it too dark for squid to spawn? The constituents of the nepheloid layers occurring across the Agulhas Bank, southern Africa

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High Pressure Liquid Chromatography (HPLC), ocean colour and hydrographic data were used to characterise and determine the constituents of nepheloid layers across the Agulhas Bank off the southern coast of Africa - a first for this region. Water column measurements were assessed simultaneously and near-surface and near-bottom samples collected for pigment analysis. Phytoplankton biomass was two-fold (max 8.3 mg m^{-3}) higher in spring compared to autumn (max 3.3 mg m^{-3}) and mean biomass was highest in the eastern and western Agulhas Bank in autumn and of decreasing importance over the central Bank. Mean diagnostic indices revealed seasonal differences in surface nepheloid layer (SNL) phytoplankton community structure. SNLs in autumn showed mixed diatom-flagellate communities dominating over small flagellates and prokaryotes. Diatoms were of decreasing importance westward and flagellates of increasing importance over the eastern Agulhas Bank. In spring, this pattern was somewhat different. The analysis showed mixed diatom-flagellate-dinoflagellate

communities dominating over small flagellates and prokaryotes, and diatoms were of increasing importance over the western Agulhas Bank. Bottom samples had high breakdown products below detection limits. However, data from autumn showed that well-developed benthic nepheloid layers (BNLs) associated with increased temperatures, salinity, low oxygen had elevated chlorophyll *a* characterised by mixed diatom-flagellate communities with diatoms dominating over small flagellates in the western Agulhas Bank.

(Poster 32) On currents, upwelling and coastal trapped waves between Algoa Bay and Port Alfred

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In October 2008, SAEON began measuring physical oceanographic variables in and around Algoa Bay as part of the Algoa Bay Long Term Monitoring and Research Programme. This paper presents some of the main results obtained from the first year of measurements. Analysis of data from an ADCP deployed off the east side of Bird Island, and wind measured on Bird Island, showed a high coherency between winds and currents. Moreover, a small amount of lag between wind and currents was evident, implying that currents were forced directly by local wind stress. In addition, the currents were predominantly barotropic, with the strength in current speed decreasing with depth. The average longshore currents were about 20cm/s on the surface (10m) and about 8cm/s on the bottom (30m), with the net currents towards the south-southwest. The M₂ tidal constituent was a strong component of currents, although less linearly polarized with depth. Inertial currents were evident, but not strongly so. On occasion, it was evident that Agulhas Current influences overrode wind-driven effects. Another overriding force was coastal trapped waves (CTWs). Analysis of underwater pressure sensor data showed that large disturbances (>50cm) in sea level were occasionally recorded at all moorings, although clearly more evident in the exposed regions such as the capes of Algoa Bay and Port Alfred. Further investigation of the currents, during the large disturbances, showed that a northeastward longshore current was associated with the sea-level peak, and that the current reversed direction as the wave trough propagated past the site toward the northeast; this is the signature of CTWs. As part of an upwelling experiment, five underwater temperature

recorders (UTRs) were deployed in gullies between Woody Cape and Port Alfred. These results showed that cold bottom water upwelled almost simultaneously at all sites during a northeasterly wind (and often penetrated to the surface at the deeper moorings). From these measurements, it was evident that nearshore water responds rapidly to wind forcing along this stretch of coastline. Sea temperatures ranged from about 12°C to 24°C during the summer upwelling months, while during the winter the range decreased to between 15°C and 18°C.

An alternative method for estimating the status of resident reef fish stocks, based on differential fishing effort across a marine reserve boundary

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The stock status of roman, *Chrysoblephus laticeps*, was estimated in the 'Goukamma', a temperate South African marine protected area (MPA). Standardized catch-per-unit-effort (CPUE) from a controlled angling survey on both sides of the MPA border was employed to extrapolate the CPUE at zero fishing mortality. Converted into biomass, the estimate (61% of unexploited biomass) lay midway between those of two biomass-per-recruit (B/R) models for the same population based on angling and diving surveys (i.e. 52% and 69% of unexploited biomass). The extrapolated CPUE at zero fishing mortality (4.4 fish per hour) in this study compared well with the mean CPUE of 4.6 fish h⁻¹ determined during a concomitant survey in the core area of the nearby Tsitsikamma MPA - the oldest, and one of the largest, MPAs in Africa. CPUE extrapolations have the potential to deliver reliable and consistent estimates of stock status and could offer a practical alternative to conventional B/R models.

Many fish and many genes: providing insight into Western Indian Ocean connectivity and biogeography

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Both dominant biogeographical paradigms - dispersal and vicariance - have been invoked to account for the establishment of the endemic faunas characterizing the various regions of the Western Indian Ocean (WIO). However, the extent to which these processes, known biogeographic breaks and the physical complexity of the WIO influenced the contemporary distribution of intraspecific genetic diversity remains largely unexplored. Here, the coarse phylogeographic structure of a variety of reef-associated fish species are compared, with a view to understanding patterns of contemporary and historical connectivity. Target species - primarily two damselfish (*Abudefduf vaigiensis* and *Dascyllus trimaculatus*) and a parrotfish (*Scarus rubroviolaceus*), but also including representatives of the cardinalfish and triggerfish - were sampled from numerous WIO localities. Sequence data were generated from two mitochondrial gene fragments and one nuclear locus. Conventional analyses of population differentiation and phylogeographic structure were performed. Most species were characterised by widely distributed haplotypes, indicating little differentiation among vastly separated localities. While some species (*Dascyllus trimaculatus* and the triggerfish *Sufflamen fraenatum*) provided no evidence of geographic structure, others (*Abudefduf vaigiensis* and *Scarus rubroviolaceus*) revealed the separation of Kenya and Seychelles from the remaining localities. This can perhaps be attributed to the influence of the dominant current patterns and gyre systems in the region. Some species also provided evidence of historically unique lineages with contemporarily overlapping distributions. These results are discussed in terms of patterns emerging from studies across the wider Indo-Pacific and in parallel studies of additional WIO reef-fish species.

Buried river courses from the Durban Bight continental shelf: implications for lowstand fluvial behaviour and palaeo-drainage

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High resolution seismic data from the Durban Bight continental shelf reveal a series of incised valley networks and associated sedimentary fills. Three major episodes of cross shelf fluvial incision are documented, occurring in the Mid-Late Cretaceous, Late Pliocene/Early Pleistocene and the Latest Pleistocene periods. Mid-Late Cretaceous incised valleys are characteristically stacked as compound valleys; the result of several episodes of minor base-level fall superimposed on an overall phase of 1st order sea-level rise. Late Pliocene incised valleys are isolated in form,

do not create an interlinked network of valleys and appear to have been extensively eroded by wave ravinement processes during sea-level rises of the Pleistocene. Latest Pleistocene incised valleys are the product of sea-level fall towards the Last Glacial Maximum shoreline of -120m ~ 18ka BP. These most recent valley incisions do not reflect the present position of the contemporary onland Mgeni River incised valley. Rather, data indicate that some 10km south of the modern river, incised valleys of Late Pleistocene age occur offshore the Durban Harbour inlet. Pronounced meandering of the lowstand course is apparent, the channel trending northeast-southwest behind the contemporary barrier of the Durban Beachfront and seaward through the harbour area. Such constraint of meander belts during sea-level fall indicates either: 1) a strong structural control on fluvial patterns; or 2) the inheritance of antecedent highstand channel morphology by more recent erosional processes. The fact that: 1) shelf-hosted incised valleys of all ages exist as stacked compound features; 2) there is no evidence of faulting from seismic records; and 3) the strong cross shelf Agulhas Current existed throughout the period of valley formation suggests that topographic inheritance, spurred on by limited infilling and current scouring, is the dominant process in influencing palaeo-drainage networks on the shelf and outer coastal plain.

Lipids and fatty acids as indicators of condition and maternal effects in *Merluccius paradoxus* and *M. capensis* early life stages

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Larval mortality in marine fishes is strongly linked to individual life history traits such as early life condition or growth. The factors influencing the variability in these traits are poorly understood for a number of species. During the transition to exogenous feeding, endogenous lipid reserves are the major energy source for larvae, determining their condition. The aim of this study was to elucidate the condition and changes in the fitness of *Merluccius paradoxus* and *M. capensis* early life stages. Cape hakes, *M. paradoxus* and *M. capensis*, are key predator species in the Benguela Current ecosystem. Eggs and larvae were sampled in September 2007 and 2008 off the west coast of South Africa. Biochemical analyses of individual egg and

larva included total lipid content and fatty acid (FA) profiles to compare the condition among different early developmental stages. *M. paradoxus* eggs and larvae occurred in consistently higher abundances compared to *M. capensis*. In both species, eggs had significantly higher lipid content per dry mass (%DM) than larvae. The total lipid content was 3.5-17.0%DM per early-stage egg and 6.8-12.5%DM per late-stage egg of *M. paradoxus* and 9.2-11.9%DM per early-stage egg of *M. capensis*. During the yolk-sac stage, total lipid content was 3.5-10.3%DM for *M. paradoxus* and 6.3-7.9%DM for *M. capensis*. Lipid levels as well as FA profiles of larvae changed with the developmental stage. Quantities of essential fatty acid (EFA), which are critical for larval development, increased after feeding due to dietary lipid incorporation. Interestingly, yolk-sac larvae contained significantly lower total lipid levels in 2007 than in 2008. Since amount and quality of the yolk is a direct result of the reserves the spawning female is able to provide during vitellogenesis, our findings indicate the importance of maternal effects in controlling the condition of hake larvae. Thus, maternal effects may influence early stage survival and subsequent recruitment.

Dynamics and role of the Durban cyclonic eddy in the KwaZulu-Natal Bight ecosystem

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The Durban eddy is a semi-permanent cyclonic eddy circulation that exists off the coast of KwaZulu-Natal (KZN) in the lee of the southern end of the KZN Bight between approximately Durban in the north and Sezela in the south. Little understanding of this feature exists - particularly with regards to its dynamics, the driving force, and importance to shelf circulation and the KZN Bight ecosystem. To address this, a study in the ACEPII KZN Bight research programme involved the deployment of a line of Acoustic Doppler Current Profilers (ADCP's) and a thermistor array across the eddy for a period of 18 months. These first quantitative measurements indicate high velocities in the eddy attaining 1.4 m s^{-1} in the inshore region and 1.9 m s^{-1} in the offshore region. They also indicate that the cyclonic spin lasts about 14 days. Ship-borne ADCP data illustrate the eddy to be approximately 60 km in diameter with the centre above the receding shelf edge (100 m). This lends credence to the notion that the Durban eddy is a lee-trapped feature driven by the Agulhas Current leaving the shelf edge near Durban.

CTD data collected during dedicated research surveys show upward doming of the thermal structure in the centre of the cyclone. This is important for moving nutrients higher in the water column and the stimulation of primary production. Satellite-tracked surface drifters released in the eddy show that inshore eddy water with associated biota can penetrate along the inshore regions of the KZN Bight as far north as the Thukela River whilst eddy waters at the offshore portion can be swept offshore and downstream into the Agulhas Current and are lost from the Bight. The Durban cyclonic eddy thus acts as a nutrient pump to feed the KZN Bight and the Agulhas current ecosystems.

Climate variability and its potential impacts on the Cape hake fisheries (*Merluccius paradoxus* and *Merluccius capensis*) in the southern Benguela Current Large Marine Ecosystem

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The Benguela Upwelling System (BUS) is one of the major upwelling and most productive systems in the World Oceans. It is an eastern boundary current (EBC) of the South Atlantic Ocean and borders the west coast of southern African countries, namely, Angola, Namibia and South Africa, from north to south, respectively. It is the only boundary current that is bordered to the north and south by warm-water regimes. The northern region is characterised by tropical to subtropical Atlantic waters, whereas the southern region is characterised by water from the Agulhas Current system at the tip of the African continent. The BUS is also host to a variety of marine living resources ranging from benthic to top predator species including plankton, pelagic and demersal species in general. Fish species such as the Cape hakes (*M. capensis* and *M. paradoxus*, shallow-water and deep-water hakes, respectively) are a typical example of some of the marine living resources harvested in the BUS that will be impacted by the long-term and short-term variability in the physico-chemical dynamics of this marine environment, which forms their habitat. Cape hakes account for the majority of the landings in the demersal fishing industry. The objectives of this study are thus to investigate the long-term (inter-annual and inter-decadal) variability of the oceanographic dynamics of the southern Benguela Current system over the last 50 years and its effects on the behaviour, migration (which are poorly understood at present), abundance and the spatial distribution of the Cape hake fisheries (*M. paradoxus* and *M. capensis*) in the southern BUS.

Towards developing the first South African National Coastal and Marine Atlas

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For the first time in South Africa, an initiative to develop a national coastal and marine atlas was conceived. The main objectives of the atlas, called the South African National Coastal and Marine Atlas (SANCOMA) are to develop a “one-stop shop” product that will support the management and planning of coastal and marine resources and features of the entire maritime region under the jurisdiction of South Africa. The aim is to create a product that will be freely accessible and able to be used by any individual for purposes of tourism, management, research, leisure, planning, etc. Although it is envisaged that the data/products may reside at the originator’s database, the system will be able to make all the information accessible to the users and providers online. The product will be an automated geographical information system (GIS) with specific locations of a variety of features (habitat, bathymetry, mariculture sites, tourism landmarks, harbours, estuaries, offshore platforms, roads, etc.) and other products/datasets (remotely-sensed data, satellite imagery, photography, etc) that are widely available from various sources. SANCOMA will be made possible by contribution from all academic institutions, research agencies, public and private organisations, and any individuals that can contribute with data.

Distribution of native and invasive mussels on the south coast of South Africa: competition and abiotic factors as potential causes

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Worldwide trade and tourism have provided an opportunity for the inadvertent transfer of invasive species between regions, and the rate of establishment of foreign marine species in ports has increased dramatically. Invasive exotic species severely affect many communities and ecosystems, and the rate of marine invasion is expected to continue to increase in coastal areas, making the study of invasion biology critical. Two species of mussels dominate the southern coast of Africa, the indigenous *Perna perna* and the invasive *Mytilus galloprovincialis*. Recent evidence has shown two distinct genetic lineages of *P. perna* exist along the South African coast and experimental evidence suggests the lineages are maintained by a combination of selection and dispersal limitation. The

western *P. perna* lineage occurs on the south coast from Haga Haga to the Cape of Good Hope, and also extends northwards from Luderitz, in southern Namibia. The eastern *P. perna* lineage overlaps with the western lineage for 200 km on the south coast from Kenton-on-Sea to Haga Haga, where it continues eastward up the South African coast. Currently, *M. galloprovincialis* occurs from Luderitz to East London. The experiment was designed to examine the effects of competition and abiotic factors on the distribution of *Mytilus* and the two lineages of *Perna*. Mussels of both species were transplanted in varying densities to cages at four sites on the South African coast (two on the eastern and two on the western boundaries respectively) where they were monitored monthly for mortality for one year. Preliminary results suggest that abiotic factors are not playing a significant role in preventing the spread of *M. galloprovincialis*, but that interspecific competition between the Eastern *Perna* lineage and *M. galloprovincialis* may limit the eastward spread of *M. galloprovincialis*.

(Poster 33) Investigating stock structure in *Sardinops sagax* in the southern Benguela region using microsatellites

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Small pelagic fish are characterised by large population size and an extended larval duration, and are found over wide geographical distances that have limited barriers to gene flow. Whilst one would presume that this would result in limited genetic differentiation it is still important to investigate, as several studies have shown genetic structuring in small pelagic species around the world. The level of genetic structuring in southern Benguela sardine (*Sardinops sagax*) is currently under investigation, following recent changes in its distribution patterns that raised the question of whether more than one stock exists off the South African coast. We report here on preliminary results of a population genetics study of this commercially and ecologically important species that was conducted by analysing microsatellite DNA of fish from the west, south and east coasts of South Africa, as well as of fish from the northern Benguela off Namibia. Microsatellites are selectively neutral and highly polymorphic and are thus useful for high resolution population genetics research and stock identification. Our initial results suggest genetic differentiation between Namibian and South African sardine stocks,

which will be further investigated with increased sample sizes. The results of analyses within the southern Benguela are as yet inconclusive, but should stock differentiation be found, it will be important to maintain inherent genetic variability. This may mean that putative regional stocks will have to be managed separately to prevent the complete collapse of one stock and the genetic variability associated with it. Such a loss would undermine the capacity of the population to buffer change.

(Poster 34) Coccolithophore and nanoplankton community composition in the Scotia and Weddell Seas (Southern Ocean)

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Polar Oceans are the front-line in climate change, and hence understanding both the current dynamics and possible future changes in marine ecosystems in these areas is a high priority for oceanographic research. The Southern Ocean (SO) is an important area of deep water formation, and much of it is thought of as a High-Nutrient-Low-Chlorophyll (HNLC) desert in terms of marine productivity. Small nanoplankton, with cell diameters between 2 and 20 µm, are poorly resolved using traditional light microscopy techniques of phytoplankton enumeration and it is becoming increasingly recognised that unknown diversity and ecosystem functionality may be contained in this size class. For example, small diatoms (~5 µm) of the genus *Fragilariopsis* appear to be widespread in the SO and may have a significant role in the silica-cycle, and also in carbon export. Furthermore, the origin of significant reflectance and calcite signals detected in the SO remain to be ground-truthed, tackling the question of just how far south coccolithophores are present? To address these issues we have collected and analysed (using Scanning Electron Microscopy) filtered water samples from transects between Antarctica and South Georgia (2008-'09; 2009-'10) as part of the South African National Antarctic Expedition (SANAE). Preliminary results indicate that coccolithophores are indeed found surprisingly far south and that the nanoplankton has a significant role in SO biogeochemistry. In addition this study has revealed only the 2nd ever record of a tropical coccolithophore in this region, raising interesting questions regarding ocean circulation linkages between the tropics and the Southern Ocean in this region.

Sandy beach conservation: getting around MPAs for amphipods...

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Although sandy beaches rank as one of the most popular recreational destinations, they continue to be disregarded as ecosystems by scientists, managers and the public alike. Beaches consequently have a history of being misunderstood and mismanaged. This, coupled with their multiple sources of stressors from both the land and sea, leaves sandy shores under tremendous threat - particularly in the face of global climate change. Conserving an ecosystem without resident charismatic fauna, and with a buried biota where the most economically valuable species are microbes thus proves challenging. It is perhaps not surprising then that sandy beaches are conspicuously absent in conservation plans. Systematic conservation planning (SCP) is an efficient method of selecting sites with high conservation priority. However, this tool relies heavily on GIS shapefiles of biodiversity, for example, of which we simply do not have enough field data to construct national maps. Sandy beach ecological theory teaches of the strong role the physical environment (beach morphodynamic type) plays in determining faunal communities. Habitat type is thus a particularly good surrogate for beach biodiversity. Here we present a novel methodology for mapping beach morphodynamics, and the first sandy beach habitat map for South Africa. Once overlaid with shapefiles of threats and ecosystem services, taking cognizance of key coastal processes, sandy shores can be interrogated with SCP techniques. The objectives will not be to proclaim marine protected areas for amphipods, or zone activities on beaches to prevent trampling of interstitial microbial communities. Rather, identifying beaches of high ecological priority can aid proclamation of generous setback lines, for example, to ensure conservation of sandy shores into the future. Beaches can largely take care of themselves, provided we give them the space to do so.

(Poster 35) Coral recruitment on a high-latitude reef at Sodwana Bay, South Africa: study methods and dynamics

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Despite being marginal for coral growth, reefs at Sodwana Bay attain high biodiversity and cover. The resulting coral assemblages are dependent on a

combination of typical coral reef processes, including coral recruitment. This has been the focus of numerous studies worldwide in an attempt to ensure the effective management of reef systems. Scientists have used a variety of settlement surfaces and techniques to detect coral recruitment. However, little attention has been paid to the implications associated with the different techniques. This study aimed to determine the dynamics of coral recruitment on Two-mile Reef (TMR) at Sodwana Bay using different settlement surfaces and detection techniques. Coral recruitment was compared on ceramic, marble, coralline algae-conditioned tiles and the surrounding natural substratum. Two batches of 135 tiles (45 tiles/treatment) were fixed on TMR over two consecutive six-month sampling periods. During this time, the tiles and the surrounding natural substratum were monitored using *in situ* fluorescent photography. After retrieval, the tiles were analysed microscopically to determine the density, diversity, size and settlement location of recruits. This enabled comparison of the surface treatments at multiple spatial scales. The preliminary results suggest no settlement preferences were elicited by the artificial substrata but recruitment levels on the natural substratum were lower. Significant spatial variation was evident in settlement on the tiles with the majority of corals settling on their sides. Comparison of the two detection methods revealed that fluorescent photography is extremely effective at detecting recruits on the upper surface of tiles, but not on their sides. The results provide further insights on coral recruitment dynamics within the core community at Sodwana Bay as well as methodological considerations in the study of this process.

(Poster 36) A first look at cross shelf macrobenthic diversity of the Natal Bight

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The east coast subtropical waters of South Africa are oligotrophic with limited nutrient resources to sustain a large, diverse ecosystem. The question thus is, how is biodiversity maintained? As part of an interdisciplinary African Coelacanth Ecosystem Program (ACEP) to understand Natal Bight ecosystem functioning, our study aims to investigate and describe the community dynamics of soft sediment macrobenthos relative to the possible main process drivers of the physical environment. Macrobenthos play an important role in these ecosystems by contributing to biological cycles and structural diversity, and are important secondary producers of the shelf habitat. Nonetheless, these animals are still poorly known from the Natal Bight. Sampling was undertaken during a subtropical wet

season (February) and dry season (August). The Bight was divided into coast parallel and perpendicular transects relative to suspected and known direct and indirect process drivers. Quantitative data were collected from 106, replicated stations. Abundance data (m^{-2}) per lowest attainable taxonomic level were used in a combination of diversity indices including those focussing on species dominance, richness, diversity and evenness. Preliminary results show the change in biodiversity relative to the physical environment across the shelf along the 60m isobath (middle shelf), for the wet season only. This depth was chosen as it is below the influence of fair weather wavebase in the area, thus reducing confounding variability of distribution parameters. Results indicate that particular areas along the coast (off Durban, Thukela River, Richards Bay) have distinct and diverse combinations of Phyla (Crustacea, Echinodermata, Annelida, Mollusca). Also, the macrobenthos are distributed according to differences in the physical environment that are primarily sediment habitat driven. Ultimately, we hope to fully investigate the spatial and temporal biodiversity characteristics in terms of the relative importance of the main nutrient inputs (Agulhas Current, Thukela River) in maintaining these biodiversity patterns across the Bight.

(Poster 37) Fish sampling during pelagic biomass surveys. It's not just counting fish!

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Twice a year the Branch: Fisheries, of the Department of Agriculture, Forestry and Fisheries (DAFF), undertakes research surveys to determine the biomass of commercially important pelagic fish species, namely anchovy *Engraulis encrasicolus*, redeye round herring *Etrumeus whiteheadi*, and sardine *Sardinops sagax*. These surveys range from five weeks during the winter Pelagic Recruit Survey to seven weeks during the summer Pelagic Spawner Biomass Survey. Recruit surveys cover the inshore to mid-shelf region between the Orange River and Port Alfred, whereas Spawner Biomass surveys start from Hondeklop Bay on the west coast to Port St John's on the east coast, and extend from inshore to the continental shelf edge. Pelagic fish biomass is estimated using hydroacoustics, and midwater trawling is done to collect samples for biological analysis. This poster describes fish and fish egg sampling procedures used during these surveys. Fish biological data on size frequency distributions, length-weight relationships, sex and gonad maturity stage distributions, and fat stage distributions are collected and recorded at sea in an Access database. Additional samples to determine age structure, stock structure, and to address the objectives of a variety of subsidiary projects are also collected. Continuous sampling for ichthyoplankton of the three species and

determinations of egg abundance and distribution permit near-real time mapping of spawning habitat. Collected data are used as inputs to stock assessment models for these species that are used in management of the fishery for small pelagics.

(Poster 38) Spatial and temporal patterns in the hyperbenthic community structure in a warm temperate southern African permanently open estuary

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The spatial and temporal patterns in the hyperbenthic community structure (>500µm) in the warm temperate, permanently open Kariega Estuary situated along the south-eastern coastline of South Africa was investigated over a period of a year. Data was collected monthly using a modified hyperbenthic sledge at six stations along the length of the estuary. Physico-chemical data indicate the virtual absence of a horizontal salinity gradient along the length of the estuary, although strong seasonal patterns in temperature and dissolved oxygen were evident. A strong seasonal pattern in the chlorophyll-a concentration was evident with the lowest concentrations recorded in winter (0.4 mg chl.m⁻³; ±0.7) and the highest values in summer (1.8 mg chl.m⁻³; ± 2.4). Total average hyperbenthic abundance ranged between 54.7 and 412.5 ind.m⁻³ in the lower net and between 23.8 and 245.1 ind.m⁻³ in the upper net. There were no significant spatial and temporal patterns in the total hyperbenthic community abundances evident during the study (P < 0.05). Both the lower and upper nets were numerically dominated by decapods (mainly crab zoae) with the exception of June and July 2008 when mysids (mainly *Mesopodopsis wooldridgei*) dominated, comprising up to 69% of the total abundance in the lower net and 35% in the upper net. A canonical correspondence analysis indicates that 80.69% of the variance in the hyperbenthic community structure could be related to organic content and turbidity during winter and temperature and dissolved oxygen concentrations (mainly during summer).

The role of paleoclimates in shaping the biodiversity of tropical marine species: a review

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The effect of Pleistocene climatic cycles on the distribution and biodiversity of temperate species is well known both in terrestrial and marine environments. Phylogeographers have proposed a model of population expansion/contraction to explain the evolutionary history of these species linked to climate: (1) contraction of relictual populations into different refuges during the glacial maxima and (2) demographic expansion during the interglacial periods favouring colonization of new habitats. Faunas in tropical environments are supposed to be less affected by climatic cycles than those present in temperate environments, though some studies showed some possible effects of Pleistocene sea-level changes. Here, I review phylogeographic studies involving marine tropical organisms in order to understand the role of recent paleoclimatic changes on their biodiversity. Data from about 50 studies were recovered allowing identification of the effect of Pleistocene climate changes on both connectivity and diversification of widespread species. Several species consisted of different well supported lineages and most of them experienced a recent demographic expansion. All these data are compared to the recent sea-level changes during the Pleistocene period in an attempt to identify the major events that have shaped the tropical marine biodiversity.

Intraspecific differences in the diet of Antarctic fur seals at Bouvet Island

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Intraspecific differences in the diets of pinnipeds are expected in view of substantial differences between the sexes of many species in morphology, life history and foraging behaviour. We examined the diet of the Antarctic fur seal *Arctocephalus gazella* population at Bouvet Island in the Southern Ocean, to assess intersexual differences through the analysis of prey remains extracted from scats and regurgitations collected in areas used predominantly by one or the other sex. Both sexes feed primarily on Antarctic krill *Euphausia superba* with several species of fish and squid taken, likely opportunistically given their low prevalence. Significant differences were identified in the frequency of occurrence of otoliths in scats and the abundance of the major fish prey species in the diet. Adult males ate a smaller quantity of fish overall, but ate significantly more of the larger species. The greater diving capabilities of males and the fact that they are

not limited in the extent of their foraging area by having to return regularly to feed dependant offspring might play a role in the differences observed between the diets of males and females. Furthermore, females might be more selective, favouring myctophids because they are richer in energy than krill. The absence of major differences in the diet between the sexes at this location is likely due to a high overall abundance of prey. The possible intraspecific differences in diet highlighted by this study indicate that researchers should be wary of using data from a single or unassessed component of a population as a means of determining changes in the diet of an entire population. This is especially relevant since Antarctic fur seals are one of a number of indicator species monitored as part of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) Ecosystem Monitoring Programme.

The response of the red mangrove *Rhizophora mucronata* Lam. to salinity and inundation

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Salinity and water level fluctuations are important factors that influence mangrove species distribution, zonation patterns and succession. Increases in salinity and prolonged inundation are predicted impacts associated with sea level rise due to climate change and therefore an understanding of the response of mangroves to these environmental factors is important. This study investigated the response of red mangrove seedlings (*Rhizophora mucronata* Lam.) to these factors in controlled laboratory experiments. Seedlings were exposed to five salinity treatments (0, 8, 18, 35 and 45 ppt) and a semi-diurnal tidal cycle in an experimental tank set-up. In a separate experiment the effects of different inundation treatments: no inundation, 3, 6, 9 hour tidal cycles and continuous inundation (24 h) were investigated. Both morphological and physiological responses of *R. mucronata* seedlings were measured. There was a decrease in growth (plant height, biomass and leaf production) with increasing salinity. Seedlings in the seawater, hypersaline and no inundation treatments showed symptoms of stress such as increased leaf necrosis ('burn marks'). The highest seedling growth occurred in the low salinity (8 ppt) treatment, but the highest photosynthetic performance and stomatal conductance occurred in the freshwater treatment (0 ppt). The typical response of stem elongation with increasing inundation was observed in the 24 h

inundation treatment. Seedlings in the no inundation treatment had significantly lower seedling height compared to the other treatments.

Bacterivorous nematodes stimulate microbial growth and exopolymer production in marine sediments microcosms

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The cohesive strength of intertidal soft sediments depends on a large range of physicochemical parameters, but the production of exopolymers by the inhabiting organisms is increasingly recognised as a major stabilising factor. It is likely that the vast majority of these polymers are produced by microorganisms but very few studies have addressed the impact of benthic meiofauna on this microbial production.

The major aim of this study was thus to estimate the impact of nematodes (often the main contributor to meiofauna abundance and biomass in temperate intertidal habitats) on the EPS (extracellular polymeric substances) production of marine sediments. Bacterivorous nematodes *Diplolaimelloides meylli* Timm, 1961 and *D. oschei* Meyl, 1954, bacteria and diatoms were grown in laboratory experiments both separately and together to estimate their respective influence. Our experiment revealed a positive impact of bacterivorous nematodes on microbial density and EPS production. Surprisingly, the biofilm structure (in terms of microbial abundance/biomass and EPS content) was better explained by the complexity (i.e. the number of trophic levels) of the assemblages rather than by any specific types of organisms involved in the experiment.

Zooplankton biomass and community structure associated with mesoscale eddies in the Mozambique Channel

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Flow in the Mozambique Channel is dominated by a series of mesoscale (300-350 km) eddies that form in the narrowest part of the Channel, in response to westward pulses in the South Equatorial Current, and

propagate southwards along the coast of Mozambique, at a speed of 3-6 km d⁻¹ (Backeberg and Reason 2010). These eddies appear to be associated with elevated levels of primary and secondary production, providing favourable foraging areas for top predators such as tuna, swordfish and seabirds. Several multidisciplinary cruises (ACEP, ASCLME, MESOBIO) were conducted in this region between 2007 and 2010, during which we investigated zooplankton communities associated with cyclonic and anticyclonic eddies, and their role in ecosystem functioning. During all cruises, zooplankton biomass (and biovolume) was two to three times greater in the cold-core, cyclonic eddies (negative sea level anomaly [SLA]) compared to the warm-core, anticyclonic eddies (positive SLA). A similar trend was found for phytoplankton biomass, although the difference was less pronounced (<2-fold), possibly a result of zooplankton grazing on phytoplankton. Zooplankton and phytoplankton biomass were intermediate to high in frontal and divergence areas. Mean body length of copepods (primary consumers) and chaetognaths (secondary consumers) was significantly greater in the cyclonic eddies, suggesting the persistence of conditions favourable for feeding and growth. Mesozooplankton (>200µm) biomass was concentrated within the upper 100m of the water column. Weighted mean depth (WMD) was significantly deeper in the anticyclonic eddies than in the cyclonic eddies, as was the depth of maximum phytoplankton biomass. WMD of mesozooplankton during the day was not significantly different from that at night, indicating the absence of strong diel vertical migration in this size fraction, in contrast to the larger macrozooplankton (>500 µm). Copepods dominated both mesozooplankton (>70%) and macrozooplankton (~60%) communities, followed by larvaceans and ostracods (mesozooplankton), and chaetognaths and salps (macrozooplankton).

Monitoring the environmental impacts of reverse osmosis desalination plant discharges on the marine environment off the Garden Route, South Africa

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Prolonged and unprecedented drought conditions in the Garden Route region of South Africa's southwest coast resulted in severe potable water shortages in recent years. Several municipalities used emergency relief funding during 2009-2010 to develop reverse osmosis (RO) desalination plants in order to secure drinking and/or industrial water supplies for current and

projected future demand. This talk discusses anticipated marine impacts and provides preliminary monitoring data for three RO desalination plants that differ in production (and discharge) volume, intake and discharge design. In Mossel Bay, a relatively large plant designed to produce 15 million litres per day (Ml.day⁻¹) of potable water (brine discharge ~ 20 Ml.day⁻¹) uses marine pipeline intake and discharge (400m offshore) with chlorine dosing to prevent biofouling. Smaller RO plants (~1.5-2 Ml.day⁻¹) in Sedgefield and Plettenberg Bay use beach well intake and discharge and estuary well intake and pipeline discharge (100m offshore) respectively. Baseline and monitoring surveys have collected data on water quality (temperature, salinity and dissolved oxygen), sediment characteristics, benthic macro invertebrates and fish in sandy beach, rocky shore, estuarine, subtidal soft sediment and subtidal reef habitats.

(Poster 39) Phytoplankton cell size distribution in South Africa

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Phytoplankton cell size is potentially a useful indicator of changes in the phytoplankton composition and abundance as thermal stratification alters and may have application in determining consequences of global warming or cooling in local waters. More than two decades of particle spectra measurements have been made with a Coulter Counter TAPII or Multisizer, collected on Pelagic Fish surveys around the South African coast and seasonally during monthly transects in St Helena Bay, providing direct information on the relative sizes and concentration of phytoplankton and detrital particles in the shelf zone in the vertical and horizontal dimensions. Changes in particle spectra reflect changes in phytoplankton community composition and characteristic spectra for newly upwelled, stabilising and oceanic waters occur. The spectra provide a rapid and convenient additional means of characterising different water masses and to assess the suitability of particular areas and depths as feeding areas for zooplankton and forage fish in near real-time.

Ten years of seasonal shipboard transect monitoring in St Helena bay in the southern Benguela, 2000-2010

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The regional BENEFIT programme initiated monitoring of changes in the Benguela upwelling system at three sites which are important in the life history of some commercially important fish stocks in the region. Standardised shipboard transects were complemented by remote sensing, buoy data, mesoscale fisheries surveys and process-orientated cruises in order to determine variability at different time and space scales. The South African monitoring site was placed in St Helena Bay (32°S). Two oceanographic transects (12 stations and two stations) were sampled monthly from April 2000 to December 2010 and included hydrography, phytoplankton and zooplankton sampling. The data contribute to long-term data sets on dissolved oxygen and zooplankton, while providing information on seasonal changes. Inshore-offshore thermal gradients peak during summer months when maximum upwelling intensity inshore coincides with advection of water of Agulhas origin onto the west coast. Phytoplankton concentrations are high (100-150 mg chl_a/m²) throughout the year, with a slight decrease during winter months. Interannual variability is not marked. Dissolved oxygen concentrations are high in the upper mixed layer but low (<2 ml/l) throughout the bottom mixed layer inshore, particularly in late summer and autumn, when extreme low oxygen conditions may induce rock lobster strandings and mass mortalities and affect hake recruitment grounds. Intense mixing events during winter, or downwelling during summer, result in intermittent periods of increased oxygen concentrations. Prolonged periods of low oxygen have occurred in 1982/3, 1994-2000 and 2003-2007, with strong winter mixing in recent years ventilating the shelf waters. Mesozooplankton biomass exhibits strong seasonal variability in 2000-2003 despite the consistently high phytoplankton concentrations but seasonal patterns altered in 2004-2009. A reversal of the long term upward trend in zooplankton in autumn months is not reflected in the peak summer values, which continue to increase. Links between plankton and small pelagic fish are discussed.

(Poster 40) Investigating relationships between selected environmental parameters in St Helena Bay

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The St. Helena Bay monitoring line (SHBML) consists of 12 sample stations on a line running offshore out of St. Helena Bay on the west coast. It was initiated in March 2004 with the intention to perform comprehensive marine environmental sampling on a monthly basis. Although it had not always been possible to adhere to the intended monthly schedule, the program has, nevertheless, yielded probably the best set of environmental data yet available for a single location along the South African coast. The *in situ* sea surface SHBML data, consisting of temperature, salinity, dissolved oxygen, chlorophyll-a concentration and concentrations of dissolved inorganic nutrients (nitrate, phosphate and silicate) for the period March 2004 to December 2009 were examined in conjunction with a series of monthly Ekman upwelling estimates calculated from geostrophic wind data. The geostrophic wind components were compared with those obtained from a satellite (QuickScat) scatterometer and good correlation ($R^2 \sim 0.9$) was obtained which suggests that the geostrophic upwelling estimates would be good as well. The poster presentation reports and illustrates the seasonal cycles and interannual trends of the different environmental parameters and discusses their interrelationships.

Comparative dive behaviour of male southern elephant seals (*Mirounga leonina*) from two populations

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Southern elephant seals in the Southern Ocean encounter highly variable environments during their foraging migrations that may influence their diving behaviour. This study attempted to elucidate some of the factors directly influencing the diving behaviour of male southern elephant seals from the King George Island (62°14'S; 58°40'W) and Marion Island (46°54'S; 37°45'E) populations and to determine if inter-population differences exist in dive behaviour. Mixed-effects models were used to determine the influence of bathymetry, population, body length and individual variation, on the diving behaviour of adult male elephant seals from the two populations. Males from King George Island and Marion Island showed substantial differences in all dive parameters

investigated. The mean dive depths of the sampled Marion Island population (1111 ± 435.4 m) were deeper than those of the sampled King George Island population (723.2 ± 364.1 m). However maximum recorded dive depths were deeper in the King George Island population (1736 m) than the Marion Island population (1722 m). Individual variation explained substantial portions of the variance in models for both maximum dive depth and mean dive duration (48.82% and 28.50 % respectively). In the Marion Island population standard length (used as a proxy for animal size) appeared to influence dive durations, and individuals with standard lengths above the population mean also had dive durations that were longer than the sample mean dive duration. In the King George Island population however the dive duration appears to be correlated with the dive strategy (benthic, mixed or pelagic) undertaken by the individuals. Our results indicate that males of similar size from the two populations showed substantial differences in their dive behaviour when foraging in areas of similar water depth, although these behaviours may be additionally influenced by various environmental parameters, including the water temperature, productivity and sea ice.

Seabird distribution in relation to mesoscale eddies in the Mozambique Channel

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Within the framework of the joined UNDP research project “Agulhas-Somalia Current Large Marine Ecosystem (ASCLME)” and the MESOBIO project funded by the West Indian Ocean Marine Science Association (WIOMSA), three oceanographic cruises were conducted in the Mozambique Channel. During these cruises, we investigated seabird-eddy associations to identify the impact of these features on the foraging behaviour of seabirds. Anticyclonic eddies, cyclonic eddies, and boundary regions were surveyed for seabirds, using linear transects when the ship was under way at a constant speed. In November-December 2008, the cruise took place in the central part of the Mozambique Channel, in the vicinity of Juan de Nova Island where a large colony of Sooty

Tern (*Onychoprion fuscata*) breeds in austral summer. In October-November 2009, a second cruise took place in the southern part of the Channel along the Mozambican coasts. Finally the third cruise crossed the Channel in April-May 2010 between the Mozambican and the Malagasy coasts. We related geolocated satellite and *in situ* environmental data (sea-surface height anomalies, current speed and direction, chlorophyll concentration) to seabird distributions, abundance, and to their feeding activities. The results indicate that seabirds do not forage randomly but tend to avoid the core of both cyclonic and anticyclonic eddies, and favour boundary areas where geostrophic currents are stronger and aggregate food resources. Especially the number of birds fishing was significantly higher in convergence zone. In all cases, the presence of surface schools of oceanic predators such as tuna and marine mammals resulted in a significant increase in feeding observations. These associations between surface feeding predators and flocks of seabirds were more frequent and the size of the flock larger when they occur in the boundary areas between anticyclonic and cyclonic eddies. These results highlight the importance of these transition zones as hotspot of biological productivity.

(Poster 41) A structured decision support approach to management and conservation of penguins in South Africa

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Population numbers of the African penguin *Spheniscus demersus* are in rapid decline. The penguin colonies along the south African west and south coasts are subject to a number of pressures, including disease, predation on land and in the ocean, heat, flooding, oiling and starvation. An integrated approach to management of pressures on penguins requires that

their combined effects are taken into account. Penguin management and conservation requires the concerted effort and support of several widely different interest groups, comprising management authorities, conservation groups, as well as tourism and fishing industries. This notably requires the management decision process to be conducted in a structured, transparent and reproducible way. Penguin populations in a changing ecosystem are subject to stochastic dynamics, and models are therefore the only way to evaluate management measures, or combinations of measures, against management objectives. We present an approach in which a management-oriented process model of penguin dynamics is designed and tested in a participatory way, bringing together modellers and field biologists from the very beginning in a mediated group effort. Characteristics of the model are introduced and its use in a multiple criteria decision making process outlined. We reflect on the participatory process during the phases of model design and testing, with a view to further improve a successful pilot phase.

Models for synthesis and communication: decision support tools in support of an ecosystem approach to fisheries management in the Benguela

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An ecosystem approach to fisheries management spans a multitude of issues and needs to find viable compromise in a situation with multiple stakeholders, conflicting interests, and high scientific uncertainties. Management needs build on best available science, in a classical as well as in an ecosystem approach. The communication of the characteristics, strengths and weaknesses of models underlying classical fisheries advice among stakeholders typically has proved to be difficult, and has led to complacency or rejection of the basis for advice and lack of co-operation in the management process, an unhealthy position for fisheries management to find itself in. However, a management approach that is holistic and participatory, as implicit in an ecosystem approach, requires meaningful communication with a range of stakeholders. Seeking to combine the need for scientific rigour with the property of communicability, we explore the use of two semi-quantitative modelling approaches synthesizing complex, detailed scientific

knowledge, for improved communication among stakeholders. The first approach relies on knowledge-based systems, and is particularly well suited to integrate information from a multitude of indicators into an overall assessment or advice. The use of this methodology is illustrated with applications pertaining to the south African small pelagics fishery, the Namibian rock lobster fishery, and the overall state of the southern Benguela ecosystem. The second approach seeks a participatory approach to dynamic modelling, in order to link alternative management options to management objectives. We present two applications for the southern Benguela, modelling ecosystem regime shifts using a frame-based approach, and modelling penguin dynamics on Robben Island. Lessons learnt from these case studies in view of their applicability in management practice are discussed.

WWF and aquaculture: moving towards a sustainable future

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Over the last two decades there has been an increase in development in the aquaculture industry in South Africa. Although this is positive for the industry there are long term environmental concerns. There are two major concerns one being the placement of farms in vulnerable marine and coastal areas and the other the reliance of an industry on wild caught fish. WWF has taken the decision include aquaculture on the SASSI list and through this process has highlighted some overarching areas in which improvements can be made to ensure sustainability of our local aquaculture industry, the main area being the development of a sustainability policy for feed manufacturers. This project identified the requirements for a sustainability policy as well as good on farm feed management practice. SASSI assesses an industry as a whole and therefore does not distinguish farms which implement good sustainability practise from others. For this reason the Aquaculture Stewardship Council (ASC) has been developed and standards for each species are in the process of being developed. It is through methods such as these that aquaculture can move towards being a more sustainable industry and therefore develop further and remain a successful industry into the future.

(Poster 42) Population analyses of humpback dolphins (*Sousa plumbea*) in Richards Bay, KwaZulu-Natal, South Africa

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Inshore species of cetaceans are highly vulnerable to habitat alteration and destruction of these environments. This study focussed on the humpback dolphin, *Sousa plumbea*, in Richards Bay, KwaZulu-Natal, South Africa. In addition to habitat alteration and destruction, the humpback dolphins in Richards Bay are additionally exposed to gill shark nets for the protection of bathers. This study looked at population biology of the Richards Bay humpback dolphin population from 1998 to 2006. This study applied GIS technology and home range estimates to assess the distribution of the humpback dolphins within the bay as well as their behaviour patterns to determine areas of behavioural importance for the population in the area. There was a clear definition of different behaviours being displayed in different areas within the study area with feeding being highly concentrated around the harbour mouth and shark net area. Furthermore, using photo-identification techniques as well as mark-recapture techniques using Program MARK population estimates were also calculated. From 225 successful dolphin encounters an estimate of 203 (CL: 185 - 221) individuals was derived. With the proposed upgrade and enlargement of the Richards Bay harbour this small population size and the use of the shark net area by the dolphins needs to be taken into consideration in conservation management plans.

(Poster 43) Diet of Indian Ocean bottlenose dolphins (*Tursiops aduncus*) off the KwaZulu-Natal coast

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Consumers are able to influence the species they consume, as well as the community structure and ecosystem processes in the habitat they occupy. However, they themselves are also influenced by changes in the trophic levels below them. In this context, dietary studies in cetaceans can be used to determine the relative abundance and distribution of prey species in an area. In this study we used the Indian Ocean bottlenose dolphin, *Tursiops aduncus*, which is known to be an opportunistic predator, feeding on a large variety of prey, to examine temporal patterns and differences between the genders in the diet. The contents of 102 (58 Females, 44 Males) stomachs of bottlenose dolphins incidentally caught in the shark nets off the KwaZulu-Natal coast between 1990 and 2010 were analysed. Prey remains found were identified to the lowest possible taxonomic level, and an Index of Relative Importance (IRI) was determined for each prey species. A total of 96 prey species were identified, but four teleost species and two cephalopod species constituted the majority of the diet, namely: *Pomadasys olivaceum* (Piggy) (%mass=7.19, %IRI=24.8), *Trachurus delagoa* (African maasbanker) (%mass=13.41, %IRI=16.2), *Scomber japonicas* (Chub mackerel) (%mass=11.67, %IRI=8.1), *Pagellus bellotti natalensis* (Red tjor tjor) (%mass=4.97, %IRI=8.7), *Sepia* sp. (%mass=35.42, %IRI=29.7) and *Loligo* sp. (%mass=4.98, %IRI=8.6) respectively. This data suggests that bottlenose dolphins from KwaZulu-Natal make use of a variety of food sources, including sandy bottom, pelagic and reef fish. No significant difference in diet was found between males and females. However when compared to an earlier study conducted between 1975 and 1986 a clear shift in diet is seen with *Trachurus delagoa* (%mass = 4.9, %IRI =4) increasing in importance while *Pomadasys olivaceum* (%mass=11.2, %IRI=45) decreased. This indicates that diet composition has changed over the last three decades possibly indicating a change in prey distribution and abundance.

Nitrogen metabolism in phytoplankton as a function of light availability in the south Atlantic sector of the Southern Ocean

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The use of photosynthesis vs. irradiance experiments to determine light controls on nitrogen assimilation is sparse in the Southern Ocean. More attention has been given to iron and light limitation of photosynthesis, while we know that iron and light co-limitation play a role in nitrogen metabolism, particularly in regard to pNO_3^- , which is known to be more energetically expensive than reduced N (NH_4) assimilation. The use of this approach is important because we suspect that at

depth ρNO_3^- becomes light-limited with respect to reduced N uptake, as usually revealed by a declining f -ratio with depth. However, the only real way to rigorously test this is by using a P-E approach combined with ^{15}N tracer studies on light-dependent uptake of both oxidised and reduced N species. If such an approach can then be translated into quantifying new production at the basin scale using satellite remote sensing, this will be a considerable advance in the development of province-based remote sensing of primary production in the Southern Ocean. This study covered four oceanic regions within the south Atlantic sector of the Southern Ocean, the seasonal marginal ice-edge zone (MIZ), the permanently open ocean zone (POOZ), the shelf zone of the South Sandwich and South Georgia Islands (SZ) and the frontal zones of the Antarctic Polar Front (APF), the Sub Antarctic front (SAF) and the Sub Tropical Front (STF), each providing a natural laboratory to test light-dependent uptake of both oxidised and reduced N species. Four productivity stations were sampled in POOZ, five in the APF, SAF, and STF, one station in the MIZ and one in the SZ. Chlorophyll-*a* (Chl *a*) concentrations in surface waters of the frontal zones ranged from 0.267 - 0.658 mg m^{-3} , 0.212 - 1.142 mg m^{-3} in the open ocean zone, 0.851 mg m^{-3} in the marginal ice-edge zone, and 0.185 mg m^{-3} in the shelf zone. P vs. E results will be presented to illustrate the light dependency of nitrate uptake relative to NH_4 .

(Poster 44) An investigation of the offshore reefs on the Agulhas bank

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The Agulhas Bank represents the centre of the South African boat-based linefishing grounds and the bulk of the reef-associated species, many of which are severely overexploited, are caught in this area. A large part of the bank consists of rocky reefs, too rough for trawl gear, that harbour a diverse invertebrate fauna and constitute spawning and nursery grounds for some reef-associated species. Despite their potential ecological and economic importance, these habitats remain poorly researched and there is little information on species composition, abundance and size frequencies of fishes. Since 2009, the Linefish section of the Department of Agriculture, Forestry and Fisheries collaborates with the Department of Environmental Affairs and the South African Environmental Observation Network to survey

these habitats. We use a range of techniques, including standardised trap- and line fishing, SCUBA and remote underwater visual census to characterise fish and invertebrate fauna at historical linefish catch positions on the Agulhas Bank. A highlight of the project was the first deployment of the Remotely Operated Vehicle (ROV) housed at the South African Institute for Aquatic Biodiversity (SAIAB) to investigate reefs beyond the reach of SCUBA divers. Aims of the project include (1) habitat characterisation, (2) collection of biological and genetic samples of selected species, (3) collection of specimens of so far undescribed invertebrates, (4) collection of size frequency data, (5) comparison of current catch composition and size frequencies with historical information and (6) collection of fisheries independent abundance data for reef associated species. Results from these surveys are incorporated into the re-assessment of these line fish stocks and are expected to inform decisions around habitat conservation and spatial management of this important offshore environment.

Foraging behaviour of the anemonefish *Amphiprion ocellaris* at different light intensities

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Foraging behaviour is often a compromise between food availability, predatory threat and foraging capability which can be affected by intrinsic biological and behavioural factors as well as extrinsic environmental factors. For visual predators such as anemonefish, light is an important factor for visual acuity and may thus influence foraging activities. This study investigated the foraging behaviour of anemonefish by observing foraging activity at different times of day and at manipulated light intensities. Time of first feeding was shown to be influenced by light availability as shading delayed feeding compared to natural light regimes whilst illumination advanced feeding times ($F = 253.18$, $p < 0.05$). Feeding rates and distances travelled away from the anemone were generally higher at higher light levels, such as for midday compared to twilight times and natural compared to shaded light regimes ($p < 0.05$). It was also found that prey density influenced feeding rates and distances with higher foraging activity seen at higher food concentrations ($F = 455.39$, 69.36 , $p < 0.05$). However, when prey densities were taken into account light levels were shown to influence the feeding activity ($F = 10.17$, 5.55 , $p < 0.05$). In general, strike rates and distances were found to increase with increasing light intensity leading to the overall conclusion that light does affect foraging activities ($F = 173.56$, 45.7 , $p < 0.05$). Consequently, it was

concluded that environmental factors such as light intensity can influence the foraging behaviour of anemonefish and thus have consequences for their ecology.

(Poster 45) Total mercury in the Coastal Zone using DMA technology

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The IFERM (SA Mussel Watch) Program was initiated in response to increasing scientific concern for the quality of the marine environment and monitors trends of chemical contamination and assesses the effects of human activities on the dynamics of the coastal areas. The program makes chemical measurements on whole soft-parts of mussels (*Perna perna* and *Mytilus galloprovincialis*) and sites are designed to be representative of large areas rather than small-scale patches of contamination. The results gained are used to describe the spatial distribution of coastal contamination and temporal trends, and to help differentiate between the effects of human activity and those of natural influences. Presently samples are analysed to determine levels of trace metals (e.g. cadmium, copper, lead, zinc, iron, and manganese) using a uniform set of techniques to measure coastal and estuarine environmental quality over relatively large space and time scales. Data are presented in the form of assessments of status and trends enabling long-term trends and pollution sources to be recognised, appropriate actions to be decided, and their effects to be assessed. Thus far Mercury has not been measured as the detection limit using Atomic Absorption is poor but Direct Mercury Analyzers are more sensitive and thus the archived samples from January 2005 until December 2010 can now be analysed.

(Poster 46) A comparison of trends in heavy metals between the East and West Coasts of southern Africa

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The IFERM (SA Mussel Watch) Program was initiated in response to increasing scientific concern for the quality of the marine environment and monitors trends of chemical contamination and assesses the effects of human activities on the dynamics of the coastal areas. The program makes chemical measurements on whole soft-parts of mussels (*Perna perna* and *Mytilus galloprovincialis*) and sites are designed to be representative of large areas rather than small-scale patches of contamination. The results gained are used to describe the spatial distribution of coastal

contamination and temporal trends, and to help differentiate between the effects of human activity and those of natural influences. Presently samples are analysed to determine levels of trace metals (e.g. cadmium, copper, lead, zinc, iron, and manganese) using a uniform set of techniques to measure coastal and estuarine environmental quality over relatively large space and time scales. Data are presented in the form of assessments of status and trends enabling long-term trends and pollution sources to be recognised, appropriate actions to be decided, and their effects to be assessed. This is a five year assessment of the trends in Heavy Metals between at the metal loading, for Iron and Zinc, surrounding the Durban and Richards Bay area and comparing it to that of Saldanha Bay.

Indication of changes in sighting frequency, group size and behaviour of *Sousa chinensis* in Algoa Bay, South Africa since the early 1990's

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The Indo-Pacific humpback dolphin, *Sousa chinensis*, is a coastal dolphin, which lives in small groups within 500m of the shore. A number of previous studies have highlighted the effects of coastal development on this species and their conservation status, but despite that, *S. chinensis* is still listed as "Near Threatened" (IUCN) and even as "Vulnerable" in the South African Red Data Book. The last time research was carried out on the humpback dolphins in Algoa Bay was 15 years ago. The present study aims to re-assess the occurrence, group size, habitat use and behaviour of humpback dolphins in Algoa Bay and to examine potential reactions to human activities. Results will be compared to the previous study, conducted between 1991-1994, where possible. To date 606.5 hours of land-based observations from four different vantage points have been completed, resulting in 164 sightings covering 48 hours of observation. Preliminary results indicate that group size has decreased from a range of 3-24 animals (mean=7) in 1994, to 2-12 animals (mean=5.5). Nowadays, most of the sightings consist of single individuals (35.4%), which is considerably higher than the 15.4% found previously. These single individuals were mainly adults, showing a dominant behaviour of travelling (71.9%), which was also the dominant behaviour shown by groups (38%). These results differ from previous results when foraging was found to be the dominant behaviour (46%), followed by travelling (24%). Responses towards anthropogenic activities were mainly classified as neutral (71%). However, negative responses were also recorded (14.5%) and were found to be correlated to a smaller distance between a group of dolphins and the human activity (Tukey test, $p < 0.05$). These responses are characterised

by long dives, changes in direction, and a change to start travelling. Possible explanations for differences in results between the two studies will be discussed.

Shark Spotters: a pioneering shark safety program in Cape Town, South Africa

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In Cape Town, South Africa white sharks (*Carcharodon carcharias*) are responsible for the majority of bites on recreational water users. Although relatively rare, shark bites that result in human injury or death threaten existing shark protective measures through negatively influencing public perception regarding sharks and shark conservation, the possible introduction of culling programs by authorities and illegal hunting. Furthermore, shark bites can negatively impact local business and tourism. A unique shark safety program was initiated in Cape Town in 2004 with the aim of finding a balance between white shark conservation and recreational water user safety. This initiative, called Shark Spotters employs 14 - 28 spotters at 4 - 10 of Cape Town's popular beaches (numbers are season dependent). The Shark Spotters scan coastal waters for sharks from elevated positions during daylight hours, seven days a week, 365 days a year. A protocol using four informational flags and a shark siren warn water users of the nearby presence of sharks. Upon hearing the warning, water users are encouraged to exit the ocean and wait until the Shark Spotters give the 'all clear' before returning to the water. Data is recorded on the number of sharks detected, shark behaviour, sea conditions and the number of water users. During the period November 2004 to December 2009, 619 shark sightings were recorded. Limitations of the program include the ability to detect sharks in poor environmental conditions (water visibility, wind and glare), human error and operating hours. Despite these limitations the program has proven to be an effective shark safety system at appropriate beaches. Additional advantages of the program are job creation and skills development for historically disadvantaged South Africans, environmental education and awareness, and the collection of information that contributes to a better understanding of white shark coastal occurrence and behaviour.

(Poster 47) Impact of ocean acidification on decapod physiology - preliminary results

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The atmospheric CO₂ concentration has increased from about 280 ppm in the pre-industrial era to 380 ppm currently. Atmospheric CO₂ levels represent a balance of fluxes between, amongst others, the ocean and the atmosphere and its atmospheric rise has led to an increase in CO₂ being dissolved in seawater. As a consequence, the pH at the ocean surface has declined from ~8.2 in the 1700's to currently about 8.1. It is projected that the expected atmospheric CO₂ concentration of 700 ppm in 2100 will reduce the pH further to about 7.8.

The effect of acidification will set in subtly and will be difficult to monitor, and to separate from other effects, in the field. An experimental, laboratory-based approach is therefore required. The impact will be via acid-base regulation, respiration and, in calcifying crustaceans, shell formation. As a secondary effect, growth and reproduction will be negatively affected due to higher energetic costs.

In a cooperation project between South Africa and Germany, we have started to investigate the impact of ocean acidification in two decapod species: 1) the West Coast rock lobster, *Jasus lalandii* from the Atlantic coast of South Africa/Namibia and 2) the Edible crab, *Cancer pagurus* from the European coast of the Atlantic and the North Sea. Both species are economically important in their respective regions and support large fisheries. Any negative influence of lower pH and altered seawater chemistry will have potential consequences for the resources and sustainability of the respective fisheries.

Here, we present data on the baseline haemolymph properties (pH, concentrations of CO₂, calcium, magnesium, protein, haemocyanin, lactate) of both species which are important parameters to detect physiological responses. In addition, we show preliminary experimental results of exposure of rock lobsters and crabs to CO₂-acidified seawater.

(Poster 48) A morphological comparison of Sparid and Sciaenid fishes between Angola and South Africa

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Biogeographic barriers are important for the understanding of dispersal and evolution of marine fishes. These barriers cause isolation between fish populations that can result in differentiation in their morphology and genetic structure. The cold Benguela current situated on the west coast of southern Africa is thought to act as a barrier to the gene flow of many common warm temperate species found in South Africa and Angola. A recent study on a Sciaenid species showed significant genetic divergence with few morphological differences between Angolan and South African populations and confirmed the low levels of morphological variation. Sparid species are thought to be morphologically more plastic than Sciaenid species. It is hypothesised that despite the shared common evolutionary history, morphological differences would be more pronounced within the Sparid species than the Sciaenid species. Principle Component Analysis and linear models are used to compare the morphology of South African and Angolan populations of Sparid and Sciaenid species. The results of this study are discussed in the context of phenotypic plasticity and understanding the adaptability of fish species to the impacts of rapid environmental change.

(Poster 49) Bacterial numbers and biomass within the KwaZulu-Natal Bight: ACEP Cruise # 176, Leg 1 - Synoptic Survey

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The KwaZulu-Natal Bight is an oligotrophic system which is dependent both on allochthonous sources of nutrients such as intermittent upwelling of deeper water and nutrients supplied by riverine inputs, as well as the autochthonous nutrients supplied by phytoplankton production, microbial fixation and recycling of nutrients by the microbial loop. Heterotrophic bacteria are heavily dependent upon organic nutrient sources supplied by both allochthonous and autochthonous sources, and as such, the presence or absence of such nutrient sources can be correlated with bacterial numbers and biomass. Here, we present the first set of results showing spatial distribution of bacterial numbers and biomass across the Bight, derived from the synoptic sampling of the KwaZulu-Natal Bight of ACEP cruise #176, during the wet season sampling period of 22 January 2010 to 30 January 2010. Samples were taken in surface water, close to $\text{Chl-F}^{\text{max}}$ and in water well below $\text{Chl-F}^{\text{max}}$. Samples were fixed with formaldehyde, stained with DAPI and cells were visualised by epifluorescent microscopy. Images were digitally recorded and processed, and numbers and biomass were determined by digital processing using IPP ver. 6.2. Automatic counting techniques were used to reduce investigator bias of cell dimensions, as well

as to increase data accuracy, reproducibility and reliability. Numbers and biomass of bacterioplankton are shown to be higher in surface waters and in riverine influenced waters ($\sim 5 \times 10^5 \text{ cells.ml}^{-1}$, $8.69 \times 10^{-8} \text{ gC.ml}^{-1}$), with very low numbers and biomass in waters below the F^{max} ($< 1 \times 10^5 \text{ cells.ml}^{-1}$, $8.16 \times 10^{-9} \text{ gC.ml}^{-1}$).

The rise, fall and future of the Kosi Bay fishery

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Situated in the extreme north east of the South African shoreline, Kosi Bay is a series of estuarine lakes about fifteen kilometers long that contain important subsistence, recreational and small scale commercial fisheries. It is one of the most important estuarine systems in the region and it lies within a Nature Reserve, Ramsar site and is part of the iSimangaliso World Heritage Site. The fisheries are extremely important to local residents for the basics of survival, to the local economy as a tourist attraction and the commercial fishers as a source of income. It is the responsibility of Ezemvelo KZN Wildlife, as the Biodiversity Managers for the iSimangaliso Park Authority, to manage the resources wisely for all users and future generations. Fisheries monitoring at Kosi Bay since 1980 has resulted in one of the longest and most detailed data sets tracking fishing effort and catches, while fish tagging has given estimates of catch rates and fish populations. This information has resulted in many reports, recommendations and publications but its main aim was to feed information to management. Results suggest that the last thirty years' catches can be split into three phases, increasing, erratic and declining. The reasons for this are many and varied but mostly known. Dealing with such a diverse fishery and fishers is extremely challenging and the number of local fishers as well as visitors and commercial fishers has increased markedly. The results appear conclusive and, as part of a World Heritage Site, no one should be allowed to clearly and progressively deplete its resources. In theory Kosi Bay is one of the better functioning estuarine systems but recent results suggest that it is a sink to marine fish instead of a source of recruits. Urgent management intervention is now needed and the recommendations are clear.

(Poster 50) Species richness, endemism and distribution patterns of South African sea anemones

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Many South African marine invertebrate taxa are reasonably well documented; however, the order Actiniaria has been poorly studied. There are currently forty-nine anemone species documented in South Africa. Of these, thirteen are found on the west coast, twenty on the east coast and sixteen species are found on the east, south and west coasts. Fifty per cent of the South African sea anemone species are endemic, but this value is suspected to change dramatically as sampling efforts in surrounding countries improve.

Since 2004, three species new to science have been discovered. They include the 'clown anemone' found in False Bay, the 'purple spotted anemone' from the Cape Peninsula and the 'burrowing anemone' found in the St. Lucia Estuary. These species are currently being described. Five new anemone records have also been added to the South African species list. These species have been previously described from the Indo-Pacific, but until now have not been recorded in South Africa. The list is likely to grow even further, as different colour morphs of certain species that have substantially different morphology and behaviour have been observed. The two species in question are *Anthothoe chilensis* and *Corynactis annulata*. In these two cases it is unclear whether a variety of colour morphs exist, or if they are actually distinct species.

Taxonomic questions were addressed by looking at the histology and genetics of the anemones. As most molecular work performed investigates taxa at family and not species level, work is currently being done to confirm the species genetically. This study has greatly enhanced the current state of knowledge of sea anemones in South Africa and partially resolved the phylogenetic tree for the order Actiniaria.

Comparison of harder *Liza richardsonii* growth under differing fishing intensities and across biogeographical regions, estuaries, islands and the nearshore

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Harders, *Liza richardsonii*, were sampled in and around estuaries, islands and the nearshore on the cool west and warm temperate south coasts of South Africa and growth curves and mean length-at-age compared. The sex ratios of fish in estuaries and the nearshore were 9 females: 1 male as opposed to 1 female: 1 male

around the offshore islands. The low numbers of males sampled made disaggregation and comparison across different habitats difficult. Spawning occurs in the nearshore throughout the summer but with early and late season peaks. Females and males grow at the same fast rate to maturity during the first year whereupon female growth slows considerably and that of males becomes negligible. Females attained greater asymptotic length or larger size-at-age in all regions. South coast female fish were larger than west coast ones and estuary female fish were larger at age than those in the sea. There was no significant difference in growth between fish in permanently open and temporarily open/closed estuaries on the south coast. Females from islands on the west coast appeared to grow faster than those from the nearshore. Observed differences in growth are likely attributable to the interplay between harder life-history strategies and response to the environment and fishing. Females grow larger than males and continue to grow after maturity to maximise reproductive output. South coast fish are larger than west coast ones due to the west coast net fisheries catching larger fast growing fish thereby selecting for slow growth. Warmer temperatures and higher productivity in the south coast nearshore may also play a role. Similarly, favourable environmental conditions and lower fishing intensity around the offshore islands and in estuaries may account for the faster growth and larger fish there.

Primary production and phytoplankton physiology on the KwaZulu-Natal Bight

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During January 2010, time series studies were conducted at selected sites on the KwaZulu-Natal (KZN) Bight. These sites were located in the vicinity of the Durban lee eddy, in the mid-shelf region of the central part of the Bight, and to the north and south of Richards Bay. Primary production (PP) and physiological experiments were conducted around midday at four to five depths throughout the euphotic zone at each of the sites. Oceanographic conditions at the sites differed substantially. At the Durban eddy site, relatively strong thermoclines were evident, driven by the upliftment of cooler water from below. Although the surface layers were characterised by low silicate and nitrate concentrations (< 1 mmol m⁻³), nutrient concentrations below 40 m were ~5 mmol m⁻³. Over a period of five days, integrated PP ranged from 1.140 - 2.529 g C m⁻² d⁻¹ and taxonomic classifications based on High Performance Liquid Chromatography (HPLC) pigment indices indicated that diatoms and prymnesiophytes were the dominant groups. Around Richards Bay, surface waters were notably warmer

than further south with silicate and nitrate concentrations typically less than 2 mmol m^{-3} throughout the water column, and integrated PP was more variable. South of Richards Bay, integrated PP varied from $0.814 - 1.402 \text{ g C m}^{-2} \text{ d}^{-1}$, and prokaryotes dominated in the surface layers, while diatoms and prymnesiophytes dominated below $\sim 30 \text{ m}$. North of Richards Bay, integrated PP ranged from $0.345 - 2.256 \text{ g C m}^{-2} \text{ d}^{-1}$, and there was a shift from diatoms and prymnesiophytes to the predominance of prokaryotes with the influx of warmer Agulhas current water. The integrated PP, ranging from $7.222 - 9.710 \text{ g C m}^{-2} \text{ d}^{-1}$, was measured during a diatom dominated bloom at the mid-shelf site. Similar to the Durban eddy site, surface nutrient concentrations at the mid-shelf site were typically below 1 mmol m^{-3} , while below 40 m , they increased to $\sim 5 \text{ mmol m}^{-3}$. Our results show that integrated PP across the KZN Bight is highly variable, driven by the dynamic oceanographic conditions and the dominant phytoplankton groups. It is evident that these phytoplankton are extremely efficient at synthesising carbon under very low nutrient conditions.

Anoxia in Bar-Built Stratified Estuaries: the Russian River as a case study

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The coast of California, South Africa and several other regions are characterised by deep bar-built estuaries in drowned river valleys. Whether the mouth is closed or not, a lower high-salinity layer may be trapped in the estuary - resulting in oxygen depletion. Low levels of dissolved oxygen are aggravated by increased loading of particulate organic material and mitigated by penetration of photosynthetic light or flushing of deeper waters. We have observed hypoxia and anoxia in the Russian River estuary for a several years, including data on currents, temperature and salinity. Through an analysis of these data, and comparison with observations from other Californian and South African estuaries, we present a general view on this phenomenon. Specifically, we address the dynamics of stratification and the influence of local human activities on the trapping of high-salinity bottom waters. We discuss the possible breakdown of stratification and ventilation of these bottom waters resulting from wind mixing effects, seepage through the sand barrier at the mouth, and mixing due to any tidal or river flow.

(Poster 51) Plume patterns: assessing the role of land runoff in nearshore ocean environments

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The coastal ocean receives waters that run off land surfaces, either through natural channels or engineered conduits. While the fate of wastewater discharge through pipes and the fate of large river outflows have been reasonably well studied, the fate of runoff through smaller open channels (rivers/stormdrains) is less well understood. Somehow the importance of these smaller systems has been overlooked, and neither scientific models nor management protocols to-date have resolved common transport and mixing patterns at this scale. We have been conducting studies of a variety of small to moderate runoff sources, with an interest in identifying dominant hydrodynamic processes and thus developing an ability to describe typical patterns of transport and mixing. Our expectation is that a reasonable estimate of a probabilistic "zone of impact" can be obtained from knowledge of fundamental physical parameters that control transport and mixing e.g., wind, waves, tide, buoyancy. This link between physical forcing and response needs both a dynamical explanation and statistical support. The benefit of recognising a transport-based zone of impact is that this pattern is the basis of distribution patterns for a variety of non-conservative constituents, because transport terms typically dominate reaction terms at small time scales in constituent mass balances. Constituents of interest include dissolved and particulate contaminants, terrigenous sediment, and planktonic organisms (e.g. larvae and microbial pathogens). These preliminary studies throw out a challenge to the coastal oceanography community to develop sufficient understanding and data on small plumes to provide the critical input needed for effective spatial management of nearshore ocean waters.

(Poster 52) Spatial and temporal trends in habitat loss in estuarine ecosystems in South Africa

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Structurally complex habitats in estuarine ecosystems are significantly affected by human activities. While estuaries are generally known to support unique communities, complex habitats within these systems such as mangroves, seagrasses and fringing vegetation enhance habitat heterogeneity, and function as nursery and feeding habitats for commercially and ecologically important species, some of which are listed as threatened. This study reports on spatio-temporal changes in selected estuarine systems in South Africa over the last five decades, focusing on structurally-complex ecosystems using GIS and analysis of orthophotos and aerial photographs. Quantification of

the rates of habitat loss is crucial to understanding the full magnitude of anthropogenic alterations to estuarine systems and allow for comparisons with rates of losses of other structurally complex habitats. The study also aims to elucidate some of the major mechanisms responsible for habitat loss in South African estuaries. It is envisaged that this research would assist in providing the necessary scientific background to support conservation, management and restoration initiatives.

Anthropogenic impacts on the water and salt budgets of Lake St Lucia: the occurrence and persistence of water levels and salinities

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The St Lucia lake-estuarine system forms part of a World Heritage site and is home to a diverse array of species. The intermittent connection to the sea and cyclic wet and dry periods create a naturally dynamic environment. Significant anthropogenic impacts over the past century have placed considerable pressure on the system over the recent drought period. Anthropogenic impacts, particularly concerning the reconfiguration of the Mfolozi/St Lucia mouth can have a major influence on the mouth state, water levels, salinities and trophic food web dominance of the system. The occurrence and persistence of water levels and salinities were investigated for different scenarios and the risk of desiccation and hypersalinity was assessed. Results indicate that without the Mfolozi link, desiccation would occur for 32% of the time for about 15 month periods. By artificially maintaining an open mouth state, the probability of desiccation would decrease, however salinities would exceed 65 ppt about 20% of the time. Restoring the Mfolozi/St Lucia mouth configuration would reduce the risk of desiccation and hypersalinity and a mostly open mouth state would naturally be restored. Alterations to the configuration of the mouth cause significant changes to the dominant physico-chemical states and therefore the biological structure of the system. A simple rule-based model was used to make preliminary predictions of the biological responses to these changes in order to assist management decisions for the system.

(Poster 53) Productivity and nutritional value of the rotifer *Brachionus plicatilis* fed five microalgal diets

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Five microalgae, *Isochrysis galbana*, *Pavlova lutheri*, *Chaetoceros muelleri*, *Tetraselmis suecica* and *Nannochloropsis oculata* were fed to the rotifer, *Brachionus plicatilis*, to ascertain the nutritional value of these microalgae. The rotifers were exposed to the same conditions and analysed for density, egg production and ratio, growth rate, size and nutritional value. The PUFA (polyunsaturated fatty acids), Docosahexaenoic acid (DHA) and Eicosapentaenoic acid (EPA), were acquired by methylation and compared within each microalgae. The microalgae *C. muelleri* had a low nutritional value and rotifers exposed to this alga had high mortality and bacterial contamination. However, *B. plicatilis* fed with *P. lutheri* and *T. suecica* showed the highest density and egg production and hence suggests that these microalgae are ideal sources of nutrients for rotifers used in aquaculture practices.

Impact of the April 2010 Icelandic volcanic eruption on marine primary productivity in the North Atlantic.

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Over the last 20 years, it has been recognised that dissolved ferrous iron (dFe) is needed by phytoplankton in minute amounts to drive their photosynthetic machinery (PSII & PSI). Furthermore, nitrate assimilation and its subsequent intracellular reduction to ammonium requires the Fe-dependent enzymes nitrate and nitrite reductase. But the problem for phytoplankton is that while Fe is abundant in terrestrial environments, dFe is very scarce in many of the world's oceans, which severely limits phytoplankton growth, and therefore their potential to control atmospheric CO₂ concentrations. Iron in the oceans originates from terrestrial or marine sediment sources. Most is delivered by atmospheric dust, volcanic ash, industrial air pollution, riverine inputs, diffusion from sediments, melting icebergs, glacial erosion and from hydrothermal vents. Of these, atmospheric iron-rich dust transport and deposition from the world's major deserts is usually the most important; particularly from the Sahara Desert. However, the eruption of Iceland's Eyjafjallajökull volcano beneath a glacier in April 2010 introduced vast quantities of iron-rich volcanic ash into the North Atlantic Ocean to the south and west of Iceland. This infrequent event provided a unique opportunity to study the effect of natural iron fertilisation on phytoplankton growth rates and on their potential to control climate during two research cruises (2010) to

the region aboard the UK's *RRS Discovery* in spring (April / May) and again in summer (July / August). Beneath the ash cloud, dFe concentrations in the surface ocean increased by 10,000 fold relative to nearby ocean regions that were unaffected by the ash cloud. Phytoplankton biomass increased 3-fold, and the efficiency with which they photosynthesised increased substantially. Phytoplankton biomass was unusually sustained well into the summer, and nitrate assimilation was enhanced also. Rates of dFe uptake using radio-labelled ^{55}Fe allowed us to also estimate dFe turnover times, with about 6% of the ambient pool being removed on a daily basis. These results will be discussed, including the implication of terrestrial Fe inputs to the global ocean in the context of global warming.

(Poster 54) Testing the existence and direction of “spill-over” of mussel recruits beyond the boundaries of marine protected areas

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Marine protected areas (MPAs) are believed not only to protect adult populations, but also to enhance recruitment both within MPAs and on surrounding exploited shores, therefore improving their ability to recover from overexploitation. The Transkei region, on the east coast of South Africa, and the intertidal mussel, *Perna perna*, offer an ideal system to test the generality of the influence of MPAs on surrounding shores, due to the presence of multiple MPAs and exploited control sites. Patterns of adult abundance were surveyed at four MPAs and two comparably sized exploited control sites. Adult abundances were, in general, found to be higher within MPAs than at exploited control sites, with adult abundances decreasing towards the edge of MPAs and decreasing even more on the outside shores. Recruitment was estimated over three months during the main reproductive season at two of the MPAs and at appropriate control sites. There were no correlations between adult abundance and recruitment for any of the months or sites, with no clear spatial pattern of recruitment in any of the three months. There was, however, a slight trend of greater recruitment at northern sites. To explain this lack of consistency in recruitment and adult abundances, wind data were used to examine the near-shore surface currents in this area, with theoretical surface currents showing similar patterns and directionality to those observed for recruitment. These results emphasise that while MPAs may function in protecting adult abundances, their influence on supplying recruits and hence recovery of nearby exploited shores may be overestimated. This

lack of influence on nearby exploited shores highlights the need for rehabilitation of shores through re-seeding with adults in conjunction with suitable management plans.

Use of $^{13}\text{C}/^{12}\text{C}$ and $^{15}\text{N}/^{14}\text{N}$ isotope ratios to characterize trophic webs associated to artificial reefs: a case study from Reunion Island

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Non-responsible fishing practices threaten marine resources sustainability and may induce habitats alteration. Moreover, these impacts are combined to the effects of pollution, climate change and introduced species. To fully understand this process, an ecosystem approach to fisheries, which takes into account ecological components and the interactions that exist between them, is now recommended. At Reunion Island (southwest Indian Ocean), pelagic and demersal coastal resources exploited by traditional fishermen are reduced, due to a narrow continental shelf. To increase fish biomass and/or concentrate fish species, artificial reefs were immersed in a naturally low productive bay with soft-bottom. The aims of the present study were to assess the effect of the artificial reefs on the most common species diet and identify any trophic niche segregation between them. Between 2007 and 2010, fish, zooplankton and soft-bottom macrofauna were regularly sampled around the artificial reefs. Stomach contents and stable isotope analysis ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) of fish and their potential prey were used to analyse the fish diet and identify the trophic niches. Filamentous algae were also scraped off the artificial structures and surface particular organic matter (POM) was collected and analysed for stable isotope to identify the sources of carbon of the trophic web. The results revealed that pelagic and demersal species aggregated around artificial reefs depend mostly on the pelagic compartment, indicating a weak impact of the artificial reefs on the species diet and/or a low benthic prey availability. However, the diet of the different species did not overlap. Then, they tend to avoid competition by focusing on different prey categories. In conclusions, these artificial reefs do not seem to increase feeding opportunities and may rather

constitute a meeting point for schooling and/or a shelter from predators.

(Poster 55) Identification of key factors for rehabilitation of shores denuded of mussels (*Perna perna*) along the Wild Coast, South Africa

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In the former Transkei, meat is only available in some households on pay days. Consequently, mussels (*Perna perna*) play a significant role as a source of protein and have been harvested for generations by local communities. Recently, exploitation has become unsustainable with mussels collected as small as 30-40mm (when they are only just sexually mature). Dye and Dyantyi (2002) developed a technique to rehabilitate denuded areas with adult mussels. The Mussel Rehabilitation Project (MRP) uses this technique but only some sites have been successfully rehabilitated, reaching c. 80% cover within a year whilst others only reach about 5%. Here we test the effects of mussel size and wave exposure on rehabilitation of *P. perna*. Different size classes may respond differently due to their difference in energy allocation (growth vs reproduction), while wave action determines food supply. Small (2cm) and large mussels (3-4cm) were deployed for rehabilitation at two exposed and two sheltered sites, separated by 100s m. Mussels were deployed in clumps of 40 with 36 clumps (18 small, 18 large mussels) per site. In each clump, 10 mussels were tagged and measured. From each site, eight clumps were removed at two month intervals and measured for growth, condition and attachment strength. Preliminary results show no relationship between water motion and growth, but that small mussels grow faster and have weaker attachment than large mussels. This may be associated with the energetic demands of reproduction in large mussels and the high drag associated with their larger surface area.

Development, optimization and evaluation of a real-time pcr assay for detecting *Halioticida noduliformans* in South African abalone, *Haliotis midae*

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Haliotis midae exhibiting typical clinical signs of tubercle mycosis were discovered in South African abalone culture facilities in 2006, posing a significant threat to the industry. The fungus responsible for the outbreak has been identified by us as a Peronosporomycete, *Halioticida noduliformans*. Currently, histopathology and gross observation are the two methods used to diagnose this disease. However, these two methods fail to be rapid and sensitive enough to provide accurate and reliable diagnosis. Conversely, real-time quantitative PCR (qPCR) has emerged as a rapid and reliable method for detection and quantification of a variety of pathogens. The aim of the current study was therefore to develop a qPCR assay for species-specific detection and quantification of *H. noduliformans*. qPCR primer sets were designed for the small subunit (SSU) ribosomal RNA (rRNA), large subunit (LSU) rRNA, and mitochondrial cytochrome-oxidase subunit II (cox2) genes of *H. noduliformans*. Primers were tested for cross-reactivity to DNA extracted from related and non-related Peronosporomycete fungi isolated from seaweeds, crustaceans and healthy abalone. Results indicate that, although all tested primers sets could amplify fungal DNA, only the LSU and cox2 primer sets demonstrated no cross-amplification. Methodology for effective and routine extraction of *H. noduliformans* genomic DNA from laboratory grown cultures and tissues of experimentally infected abalone was also established and optimized to yield high quality DNA with little to no PCR inhibitors. The method of grinding samples at 250 rpm for one minute using a pellet pestle was identified as the most effective way to physically disrupt cell-walls and release fungal DNA. PCR amplification efficiency and potential inhibition using a range of DNA extraction and recovery methods were also tested. A simple heat-lysis in the presence of Chelax-100 beads was shown to be the most sensitive, reproducible and cost-effective DNA recovery method. The sensitivity of the qPCR assay was determined to be 0.266 ng DNA/ reaction. However, inclusion of a nested PCR step, utilising universal fungal outer primers, followed by qPCR with the *H. noduliformans* LSU specific primer set improved sensitivity to ~0.01 pg DNA/ reaction. Our results show qPCR has potential for monitoring and quantifying *H. noduliformans* for the surveillance and management of abalone tubercle mycosis in South Africa.

Macrobenthic distribution used to support abiotic derived ecological boundaries in a subtropical estuarine lake system

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Understanding factors influencing species ranges is central to ecology. This is especially true in estuarine ecology, as estuaries are transitional zones with varying interconnected ecological boundaries between marine and freshwaters. Testing macrobenthic species distribution according to individual drivers such as salinity and sediment type and combinations of abiotic parameters is not new to soft sediment studies. Also, using information on the abundance distribution of species assemblages alone to define specific estuarine ecotones is perceived as subjective, given the large tolerance ranges of true estuarine species. This work is an attempt to consolidate these two approaches and use macrobenthic abundance distributions to support *a priori* selected salinity zones with accompanying and hierarchically nested sediment sub-habitats. The subtropical study system Kosi, is one of few remaining relatively natural South African estuaries. It is typified by a fairly consistent salinity gradient across ~16km of four interconnected lakes. Data collected over replicated seasons from 18 stations, including transitional areas between lakes derived six primary ecological boundaries based on absolute salinity values and salinity range differences. Each boundary was subsequently divided according to correlation selected sediment characteristics. Multivariate species analysis using combinations of BIOENV and PCA with SIMPER to determine assemblages characteristic of each zone showed only 17 of the total 204 taxa were indicators of these ecological boundaries. Ten taxa exhibited zone fidelity with most of these limited to the polyhaline/euhaline zone. Only three truly estuarine species, *Ceratonereis keiskama*, *Corophium triaenonyx* and *Iphinoe truncata* were amongst the ecological boundary indicator assemblage and distributed in more than three zones. Given such high zone fidelity, macrobenthos can distinguish salinity zones with a greater degree of sensitivity than traditional oligohaline/mesohaline/euhaline zonation. There is a case for establishing macrobenthic assemblage ecological boundary indicators, which may be linked to estuarine hydrodynamics, so gaining further insight into estuarine processes.

(Poster 56) Spatial patterns in the diversity of sponges off the west and south coasts of South Africa

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Most work on South African marine benthic fauna has focused on shallow sub-tidal and inter-tidal hard substrata, and our knowledge of the deep water fauna

(especially from soft sediments) is relatively poor. The shelf areas along the south and west coasts of South Africa are subject to intensive trawling and mining activities and there is a need to more fully understand their faunal diversity and composition for management purposes. Here we investigate sponge communities from this region using data collected from a series of trawl surveys. The preliminary results show that diversity initially declined with increasing depth to ~100-150 m on both coast, then increased to about 150 m after which it declined again. Diversity remained relatively constant with increase in longitude on the south coast to ~24°E, after which it increased. Cluster analysis revealed three distinct groups of sponges (at the 35% level of similarity) on the south coast as opposed to five on the west coast of which two are overlapping in the deeper shelf area. The results are discussed in the context of offshore marine protected areas.

Rebuilding depleted line-fish stocks in the Pondoland Marine Protected Area and adjacent fisheries

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In June 2004, 80 km of the Pondoland coast was declared a multiple-use marine protected area (MPA). This coastline is a zone of transition between two biogeographic regions and was identified as a critical gap in South Africa's MPA network. Part of the protected area is a 40x10 km no-take area, which is closed to offshore exploitation. The objectives of the closure are conservation of biodiversity and the rebuilding of commercially important line-fish stocks, which have been depleted by over-fishing. Between 2006 and 2010, regular monitoring was conducted to evaluate the outcome of the fishery closure. The direct effects on previously exploited line-fish species were tested by means of a controlled fishing experiment, while an underwater visual census focused on indirect effects in the wider fish community. The potential benefit of the fishery closure on adjacent fisheries was investigated by means of a tag-recapture experiment, which assessed fish movement within and between the no-take area and the adjacent exploited area. Some of the region's most important line-fish species were significantly more abundant and larger in the no-take area than in the adjacent exploited area. For example, slinger *Chrysoblephus puniceus* accounts for 60% of the commercial line-fish catch in KwaZulu-Natal, and in the absence of fishing in the no-take area, has increased substantially in number and in body size. Significant differences were evident in the wider fish community between protected and exploited areas, possibly linked to contrasting levels of predation and

competition. Movement patterns indicated that the majority of fish maintained small home-ranges, while a small portion abandoned their home-range and headed northwards up the KwaZulu-Natal coast, becoming available to nearby fisheries.

(Poster 57) South African Linefish Website Project

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The South African National Biodiversity Institute (SANBI) in partnership with the Department of Agriculture, Forestry and Fisheries (DAFF), the Oceanographic Research Institute (ORI), and the SANCOR Marine Linefish Research Group (MLRG) aims to undertake a comprehensive review of the publication “Southern African Marine Linefish Status Reports” to develop a database containing updated information on prioritized species of fish and sharks caught by hook and line into a digital format that is easily searchable and easy to update. The database will be used to create an interactive website to enable users quick and easy access to information on regulations, conservation status, distribution, life-history, fishery parameters as well as conversion factors between different length measurements, mass and age (i.e. fork length-to-total length ratio; length-weight ratio etc.). A hardcopy product will also be produced under a new title and published in the ORI Special Publication Series as a joint publication acknowledging funders and participating departments and organisations. Depending on demand, an estimated 1000 hard copies will be printed and the book will also be made available as a downloadable pdf document on the ORI and SANBI websites.

(Poster 58) DNA barcoding of Western Indian Ocean reef fishes

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The Fish Barcode of Life programme (FISH-BOL) aims to barcode all fish species to facilitate reliable species diagnostics and rapid assessments of biodiversity. Recent advances using barcode data strongly support the contention that mitochondrial DNA cytochrome oxidase I (COI) sequences are useful for the identification of fish including juveniles and

larvae stages. The conservation of biodiversity and management of fisheries rely on accurate species identification to understand the diversity, dispersal and connectivity of fish populations. This project presents an important investigation into the feasibility of using DNA barcoding as a technique for identifying marine reef species in the Western Indian Ocean. Preliminary analyses of more than 1000 individuals indicated significant differentiation among genera and species using the COI DNA barcode. Although the distribution of genetic distances between species and those between genera/families partially overlapped, the differences among conspecifics were on average markedly lesser than those among congeners. In an overwhelming majority of cases the expert identification of the fish matched the barcode designation, suggesting that barcoding is indeed a reliable tool for identifying fish species in the region.

Shelf edge upwelling off northern Mozambique

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In this study satellite sea surface temperature and chlorophyll-a measurements from MODIS are combined with in-situ observations from an underwater temperature recorder and two shipboard oceanographic surveys to assess the occurrence of upwelling in the Mozambique Channel near Angoche, and study its temporal and spatial variability. It is shown that shelf edge upwelling occurs along the northern coast between 15 and 18S, covering an area of approximately 68 000 km². Two upwelling centres were identified: (1) the shelf core region, and (2) the slope core region, with the former being more persistent than the latter. Both locations displayed seasonal variations between persistent downwelling events from April to July and intermittent upwelling events from August to March. Generally, periods of increased upwelling events occurred every two months, but shorter period re-occurrence (8-30 days) of upwelling events were also observed. It was found that the upwelling is in part wind-driven, responding to weak northeasterly monsoon winds between August and March. The intermittent nature of the upwelling season is partly due to fluctuations of the wind direction during the austral spring / summer, and eddies in the Mozambique

Channel appear to play a limited role in driving the upwelling events.

(Poster 59) Development of probiotic diets for the South African abalone (*Haliotis midae*) industry

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Probiotics in aquaculture have been effective in a wide range of species in enhancing immunity, survival, improving feed utilisation and growth. Three putative probiotics identified as a result of *in vitro screening* have been found to be beneficial to laboratory-reared abalone *Haliotis midae*. The aim was to produce an abalone feed that contains a suite of probiotics that promote abalone growth and health under the stress of farming conditions. The objectives were to compare growth, survival and physiological responses of abalone fed Abfeed®S 34 and probiotics (i.e., the probiotic diet) to abalone fed Abfeed®S 34 as a control treatment, in a factorial design with handling stress as the second independent variable. At HIK Abalone Farm (Pty) Ltd there was no significant interaction between diet and handling on length and weight gain month⁻¹ after four and eight months ($p > 0.05$). Average length (stressed: 73.9 ± 0.5 mm; unstressed: 75.8 ± 0.57 mm) and weight gain (stressed: 68.5 ± 1.2 g; unstressed: 7.3 ± 1.9 g) increased significantly in unstressed animals after eight months ($p < 0.02$). Phagocytosis count was significantly different between dietary treatments with values of 74 and 53.5 counts per sample for the probiotics and control treatment, respectively ($p < 0.02$). There was no effect of stressor application ($p = 0.14$) and no interaction between dietary treatment and stressor application for this variable ($p = 0.61$). On a second trial at Roman Bay Sea Farm (Pty) Ltd, average length (68.2 ± 1.5 mm) and weight (53.6 ± 4.3 g.month⁻¹) of animals fed probiotic diet significantly increased over time ($p < 0.00001$), and were similar to those fed the control (length: 67.9 ± 1.5 mm and weight: 52.5 ± 3.6 g) after eight months. Abalone fed the probiotic diet had a significantly faster growth rate (g.month⁻¹) than those fed the control after eight months ($p < 0.05$). There was no significant difference in haemocyte counts between animals fed both probiotic or control diet after four and eight months ($p > 0.05$) in this trial.

(Poster 60) Developing an Internet-based tool for identifying coralline red algae (Corallinophycidae, Rhodophyta)

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Despite their ubiquity, coralline red algae are a poorly known group of marine organisms. Much of our lack of knowledge of this group stems from a legacy of poor quality taxonomic work. Over the past 30 years, however, we have made tremendous strides in understanding the taxonomy of these algae. The number of researchers paying attention to the coralline red algae has increased in recent years, but notably without any appreciable increase in the number of coralline taxonomists. The purpose of this research is to provide assistance to this increasing number of researchers by developing an Internet-based tool that will assist with basic coralline algal identifications. As a basis for developing the tool, a phenetic character analysis of all the coralline algal taxa now ascribed to the subclass Corallinophycidae, was carried out using both qualitative and quantitative data. Here individual taxa were regarded as Operational Taxonomic Units. Initially characters and character states were identified and assigned numeric (gap) codes and a data matrix of the codes for all taxa were then tabulated. The final tabulated codes were subsequently used to generate a phenogram as well as to write the software programme for the online identifications. In addition to these outcomes, a modern key to the coralline algae will be produced based on our current understanding of the taxonomy. It is envisaged that the online tool will supplement coralline algal taxonomy and systematics, and foster a greater interest in their ecology.

Social and natural sciences - breaking down boundaries

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Between human need and human greed, environmental destruction is probably the most serious challenge facing humanity today. In the past, the most common response to a crisis of this magnitude was to refer to science and technology, to seek a solution that would enable 'business as usual' and solve the problem. Unfortunately, it would appear that the current challenge is going to require more than better science

and technology, it is going to require some fundamental changes in human behaviour. The future of planet earth now requires both innovative technology and science, and the desire of every citizen, armed with knowledge, to make the right decisions to improve our collective future. Motivating people to make environmentally responsible decisions is an enormous task and one that requires the attention of every scientist concerned about the future of our environment. Inspiring people to change their behaviour and take actions for the 'greater good' requires a good understanding of human behaviour and how best to influence it positively. Without a better understanding of human behaviour, many of our efforts at environmental awareness may be futile. In order to address this, research has been initiated at uShaka Sea World, a marine based tourism venue in Durban, South Africa. The research is investigating the contribution that an aquarium can make in enhancing the environmental awareness of guests. The research will explore how the facility can, through a better understanding of guests' environmental knowledge, attitudes and behaviours, improve the impact that the facility has on guests commitment to participate in environmentally responsible behaviours. This paper will present the results of a preliminary survey and provide information on future research to be undertaken.

Characterization of eubacterial diversity profiles in the freshwater deprived Kariega Estuary using 16S rRNA analysis

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The Kariega Estuary is a permanently open, freshwater deprived river situated along the Eastern Cape coastline. By analysis of ribosomal RNA gene sequences attained by pyrosequencing, the eubacterial diversity in the hypersaline Kariega Estuary was ascertained and shifts in the microbial diversity were correlated to selected physico-chemical variables measured along the length of the estuary. Rarefaction analysis of the more than 27 000 sequences obtained verified that the diversity present at each point along the river length was comprehensively assessed with distinct phylotype distribution patterns observed along the salinity gradient present in the Kariega Estuary. The significant occurrence of *Bacteroidetes* and *Actinomycetes* highlighted the importance of a detrital food web within this ecosystem. While primary production obtained from unicellular algal sources within the water column was low, as evidenced by the

low chlorophyll-a concentrations ($< 0.1 \mu\text{g L}^{-1}$) observed, the presence of *Pelagibacter* and *Flavobacteria* suggests a potential contribution of microbes to the total primary productivity of this ecosystem. With respect to river health, no human pathogenic microbes were detected within the water column of the system underscoring the pristine nature of this ecosystem. As evidenced by the results, pyrosequencing is a versatile, readily applicable and efficient tool for ascertaining microbial diversity thereby providing valuable insight into the health and functional dynamics of aquatic ecosystems.

(Poster 61) Diversity and distribution of the brown seaweed *Sargassum* (Fucales) in the Indo-Pacific with focus on the South West Indian Ocean

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Sargassum C. Agardh is one of the most morphologically complex and species rich genera of the brown algae (Phaeophyceae). It is distributed worldwide in tropical to temperate regions and is especially well represented in the Indo-Pacific. It usually forms large beds of well known ecological importance and economic potential. The hotspot of species diversity is apparently based in the Indo-Malaysian and West Pacific regions. It has been shown to decrease eastward in the Pacific, but data available for the Indian Ocean are not accurate enough to discuss any trends. Over a hundred *Sargassum* species and sub-specific names have been listed in the literature available for the South West Indian Ocean during the last 200 years. These lists have not yet been revised with regard to recent systematic works, especially those using modern molecular taxonomic tools. The aim of the present study is to provide taxonomically revised species lists for regions of the South West Indian Ocean and to assess their geographical distribution. According to preliminary results we expect the diversity to decrease westward in the Indian Ocean and the species composition to change dramatically in the Atlantic. We attempt to correlate distribution patterns to environmental conditions using Bio-ORACLE, a global environmental data package designed to carry out species distribution modelling of shallow-water marine organisms.

(Poster 62) Thermal tolerance and temperature related heart function of aestivating littorinid snails from tropical, subtropical and temperate regions: general patterns and species adaptations

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The temperature relationships of heart function of aestivating temperate, subtropical and tropical littorinid snails of the genera *Afrolittorina* and *Echinolittorina* were investigated using impedance plethysmography, and related to their thermal tolerance, estimated as LT₅₀. There were clear differences in heart rate regulation between tropical and subtropical or temperate species. The tropical *Echinolittorina* species (*E. malacana* and *E. vidua*) showed good regulation of heart rate rendering it independent of temperature across a range of approximately 20 degrees. This falls within the range experienced under natural conditions. In contrast, the subtropical *Echinolittorina*, and subtropical and temperate *Afrolittorina* species showed mixed responses which include regulatory, semi-regulatory and non-regulatory response to heat stress. Overall, the subtropical *E. natalensis* showed semi-regulation, while *Afrolittorina* spp. (*A. africana* and *A. knysnaensis*) showed high individual variability, some animals exhibiting regulation while others did not. These effects seem to be largely phylogenetically determined as there were no difference in the response of subtropical and warm temperate *A. africana* or between warm and cool *A. knysnaensis*. The thermal tolerance conformed to expectations, with clear trends from high tolerance of tropical species to lower tolerances of temperate species. Thus, LT₅₀ seems to reflect biogeography, while heart rate function is largely phylogenetically determined.

Co-Management - the future of small scale fisheries management

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Recently, the coastal environment and marine living resources have been under immense pressure from various agents including waste disposal, fishing and environmental changes. These agents have contributed to the degradation of fisheries resources in both Inshore and Offshore marine areas. While the effects of global climate change and pollution on fisheries are acknowledged, this presentation will mainly focus on

commercial and subsistence fishing, its contribution to degradation of coastal fishery resources and how this impacts on the livelihoods of fisheries dependent communities. The presentation will cover the following: challenges faced by small scale fisheries managers in the South African context; management options a small scale fisheries manager may take as well as a discussion of pros and cons of each option. Finally, the advantages of co-management, where various stakeholders (e.g. government, fisherfolk, scientists, NGOs etc), work together to manage fisheries resources will be presented. Case studies of small scale fisheries co-management success in South Africa, Zambia and Philippines will be discussed. The presentation is intended to initiate a discussion on the ongoing coastal resource degradation, which will hopefully assist in addressing and formulating ways to improve small scale fisheries management for sustainability of both fisheries resources and coastal community livelihoods.

The influence of institutional arrangements in enabling access and facilitating equitable benefit sharing of coastal resources in rural coastal communities: Case studies from the Eastern Cape and KwaZulu-Natal

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Coastal resources play a significant role in supporting the livelihoods of poor and marginalised communities in the Eastern Cape and KwaZulu-Natal. Through an analysis of three case study communities in these provinces, this research sought to understand the role played by the fisheries and mining sectors in the livelihoods of rural communities. The key objectives of the study were to determine the extent to which communities benefit from use of coastal resources in these sectors; to understand how benefits arising from use of these resources are shared and associated institutional arrangements; and to elucidate why benefits are distributed in the manner that they are. Both qualitative and quantitative methods were used to collect the data and included 270 household surveys, 25 focus groups, and 33 key informant interviews. Research findings reveal that despite the fact that the communities have benefited from fisheries and mining, impacts from these activities have led to substantial economic, social and ecological losses to livelihoods. For both mining and fisheries, there was a gap between the benefits that decision-making institutions claimed were shared between themselves and communities, and the benefits that actually trickled down to the wider community. Various institutional blockages to benefit

sharing were identified. Findings reveal a lack of equity, accountability and transparency by the institutions charged with distributing benefits to the wider communities and wide ignorance of the livelihood needs of communities. Moreover, power dynamics within and between relevant government departments, the private sector, traditional authorities and local committees greatly influenced the manner in which benefits were distributed. Findings of this study affirm the importance of robust rural institutions for equitable benefit sharing.

Assessing the implementation efficacy of EAF in the South African sardine fishery

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An Ecosystem Approach to fisheries (EAF) requires that the performance of a fishery be evaluated in an ecosystem context, taking into consideration multiple societal objectives often characterised by uncertainty. The usefulness of knowledge based tools to evaluate the efficacy of the implementation of EAF in the South African sardine (*Sardinops sagax*) fishery has been demonstrated recently. This study revises the first prototype tool. With a view of the complexity of ecosystem dynamics, the revised model structure separates pressure from state indicators. The revised indicators and updated time series which underpin them are presented. The results of a sensitivity analysis to indicator thresholds and model structure are presented and discussed and we reflect on the process of expert involvement in building the model. The outcome of this study is a combined evaluation of the progress towards implementation of the ecological well-being component of EAF in the South African sardine fishery.

Putting sanctuaries into context: a comparison of estuary fish assemblages over multiple levels of protection and modification

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In recent decades there has been a significant effort to establish marine reserves for the purpose of protecting marine biodiversity and ecological processes. While many studies have demonstrated that marine sanctuaries (“no take” areas) increase the abundance, diversity, and trophic level of marine fish communities, few have compared these parameters across multiple levels of protection and modification. This study utilised baited remote underwater video stations to compare fish assemblages between marine parks, between different levels of protection within parks (sanctuary and habitat protection zones) and between parks and comparable highly modified systems. We demonstrate that sanctuary zones have higher species richness and abundance of species at higher trophic levels compared to habitat protection zones within marine parks. The total abundance of targeted species and key fisheries species (Pink Snapper and Silver Trevally) were found to be more abundant in sanctuary zones compared to habitat protection zones. This suggests that increased protection may be effective at improving these aspects of the fish assemblage. However, when marine parks were compared to highly anthropogenically modified environments we found that targeted species, several key fisheries species, and fish at higher trophic levels were more abundant in the highly modified systems. Notably, targeted fish species were +4.25x more abundant in modified estuaries, such as Silver Trevally (+7.5x), Yellowfin Bream (+20x), and Pink Snapper (+5.5x). Our findings suggest that while highly protected sanctuary zones may increase the diversity and abundance of targeted fish compared to less protected areas within the same estuary, parks may be designated in areas that would generally support fewer game fish and a lower trophic level fish assemblage than highly industrialized or urbanized systems. We discuss possible explanations for these seemingly counter-intuitive findings.

An assessment of the impacts of metals contamination and anthropogenic habitat modification on estuarine larval fish assemblages in southern New South Wales, Australia

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To date, very few studies have quantitatively assessed *in situ* impacts of anthropogenic modification and sediment metal contamination on estuarine larval fish communities. This study is one of the first to

demonstrate large scale impacts of these stressors on larval fish assemblages in estuarine environments. Larval fish were sampled using a benthic sled in six estuaries in southern New South Wales, Australia. Large differences were found in the larval fish assemblage between heavily modified and relatively unmodified estuaries. Larval fish abundances were significantly greater in modified estuaries and trends suggest that diversity was also higher in the modified estuaries. Differences in larval fish community composition were strongly related to both sediment metal levels and reduced seagrass cover in highly modified estuaries. Notably, two highly abundant species, the Wide Gape Paedomorphic Goby (*Paedogobius kimurai*) and Port Jackson Glassfish (*Ambassis jacksoniensis*), occurred almost exclusively in highly modified and contaminated and relatively unmodified estuaries (respectively). These findings suggest that contamination and habitat alteration are having major impacts on the composition of the estuarine larval fish assemblage.

Comparative phylogeography of the catshark, *Haploblepharus pictus* and its nematode parasite, *Proleptus obtusus*

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The comparative phylogeography of the host-parasite relationship of the southern African endemic dark shyshark, *Haploblepharus pictus* and its nematode parasite, *Proleptus obtusus* was investigated. To date, no studies have been conducted on the population structure of catsharks and their species specific parasites and little is known about the population dynamics of these species. A total of 116 catsharks and 201 parasites were analysed from seven localities. The mitochondrial marker COI was used and species specific primers were designed for both the host and parasite. Haplotype networks were constructed for both species and no strong geographically structured groupings were found. Pairwise Φ_{st} values for the parasite and host found Gansbaai to be significantly differentiated from the other sites. Fu's F_s were significantly negative for both host and parasite indicating population disequilibrium. *Proleptus obtusus* displayed a pattern of population expansion which was confirmed by Fu's F_s and the mismatch distribution. Mismatch distributions failed to indicate population expansion for the sharks. It is likely that the population disequilibrium was due to selection, migration or genetic drift. Interestingly, no barrier to gene flow was found around Cape Point, a known break for other species such as the clinid, *Clinus cottoides* (von der Heyden *et al.*, 2008) and the caridean shrimp *Palaemon peringueyi* (Teske *et al.*, 2007). The

outcome of this study suggests that levels of gene flow in *H. pictus* is high enough to maintain a pattern of mtDNA panmixia among sampling sites and this would imply that the suggested documented site fidelity is not as strong as originally proposed. The parasite, being dependent on the host, shows a similar high level of gene flow among sampling sites. Both species show an overall lack of structure with isolation of Gansbaai from the rest of the sites.

(Poster 63) Hydro-acoustic monitoring of pelagic fish availability around penguin breeding colonies on islands off South Africa

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The population of African penguins *Spheniscus demersus* has shown a marked decline over the past decade, resulting in the conservation status of this species being reclassified by the IUCN from vulnerable to endangered. One hypothesis for this decline is that fishing for small pelagic species such as anchovy and sardine, which are the penguin's principal prey, has resulted in localized depletion that is critical during the breeding season when penguins can only forage close to their island breeding sites. As part of an ecosystem approach to management of South Africa's fishery for small pelagic fish that aims to account for the food requirements of dependent species, a study to investigate the effects of closure to pelagic fishing around penguin breeding colonies was initiated in 2009. Part of that study included acoustic surveys around penguin breeding islands to collect high resolution data on the abundance and distribution of small pelagic fish. Such surveys were conducted around four Islands, namely Dassen and Robben islands off the west coast and St Croix and Bird islands in Algoa Bay. Surveys were conducted using a 6.5m inflatable fitted with a pole-mounted 38 kHz split beam echo sounder, and data were used to map fish distribution patterns and estimate their biomass around islands, in addition to assessing the level of variability in fish abundance between surveys. Additionally, data on fish shoal size, depth distribution, and other schooling characteristics were collected. This poster shows some results obtained during these island surveys.

(Poster 64) Investigation of the diurnal movements, behaviour and habitat use of cetaceans in Mossel Bay: baseline assessment prior to anthropogenic impacts

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The marine environment of Mossel Bay will be influenced in the near future by two anthropogenic impacts; a reverse osmosis (RO) desalination plant and a finfish farm. There is very little scientific information about the impacts of either industry on marine mammal ecology, demography or ranging patterns. While both industries release effluent plumes into the aquatic environment, the constituents and amounts are vastly different with consequently different potential physiochemical effects. This project collected 12 months of baseline data on cetacean habitat use in the bay against which to assess possible changes associated with these impacts using the BACI (Before-After Control-Impact) study design. Of the six whale and dolphin species seen regularly in the bay, humpback dolphins are regarded as the most vulnerable. All species were tracked from land using a theodolite and their behaviour, group composition and movements recorded. Humpback dolphins were year round residents while seasonal abundance was recorded for Indo-Pacific bottlenose dolphins (peak: Oct-Apr), southern right whales (peak: Jul-Oct) and humpback whales (peak: Jul-Nov). Some differential habitat use was evident for feeding and resting sites of bottlenose and humpback dolphins. Humpback dolphins ranged no deeper than the 25m isobath while bottlenose dolphins ranged throughout the bay. Southern right whales showed a preference for resting and nursing nearshore (<2km from shore) while humpback whales travelled through the bay and offshore on their southern migration route. Sightings of common dolphins and Bryde's whales were too infrequent to provide clear patterns of seasonality or habitat use. Possible changes in the future in habitat use or abundance of bottlenose and humpback dolphins will be the most likely indication of local ecosystem change and habitat exclusion due to the operations of the desalination plant and the finfish farm.

(Poster 65) Growth and trophic position of larval pelagic goby, *Sufflogobius bibarbatus* in the Northern Benguela upwelling system

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Pelagic gobies (*Sufflogobius bibarbatus*) are assumed to play an important role in the changing environment of the Northern Benguela upwelling system. The main distribution area of the species is the shelf area from Lüderitz in the south to Möwe Bay and Cape Frio in the north. There is evidence that the species is one of the few that may benefit from the declining oxygen situation and the changes in the food web of the pelagic system along the north Namibian coast. Material from two cruises in late summer 2008 (RV Maria S. Merian) and late spring 2009 (FRS Africana) was used to investigate condition, growth and food of the larvae and relate findings to environmental conditions. Larvae ranged from 3.6 to 31.5 mm. Daily increment deposition could be validated based on the width of the marginal increments at different daytimes. The estimated growth rate ranged from 0.1 to 0.5 mm d⁻¹, depending on region and season (average 0.23 mm d⁻¹). A relationship could be established between condition and growth rate. Higher temperature seemed to have a positive effect on fitness and growth. Stomach analysis indicated that foraging mainly took place during daytime and that it shifted to later daytime with increasing age. An ontogenetic shift could be observed from cyclopoid to calanoid copepods. Prey size (by volume) increased significantly at a larval size >15 mm. Food of later stages was less diverse constituting mainly of crustaceans, while diatoms, gastropods and bivalves completed the spectrum.

(Poster 66) Possible climate-related changes in the estuarine fish assemblages in the Mbashe and Mbhanyana Estuaries

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Changes in the occurrence and distribution of organisms linked to increasing temperatures have been recorded both locally and globally. The effects of global climate change on estuarine fish populations occurring in the transition-zones between biogeographical regions are not well researched in South Africa. The estuarine ichthyofauna in the permanently open Mbashe Estuary and the temporarily open/closed Mbhanyana Estuary, situated in the transition zone between the subtropical and warm-temperate biogeographical regions, were sampled during spring 1997 and 2010 using a seine net. The fish fauna were divided into four groups based on their documented distribution patterns, namely tropical, warm-temperate, cool-temperate and widespread. It is

hypothesised that in this study temperate species at the northern limit of their distribution will increase in abundance, while tropical species will increase in abundance. Although no clear trends were observed in either the number of tropical species recorded, or the proportion of tropical species in the catch in the permanently open Mbashe Estuary, there was a slight decrease in the abundance of temperate species at the northern limit of their distribution from 1997 to 2010. In the temporarily open/closed Mbhanyana Estuary, which is cut off from the effect of sea temperatures for longer periods, the contribution of tropical species to the total catch of marine species increased from 16% in 1997 to 44% in 2010, while warm-temperate species decreased from 82% to 55% of the catch. Although this could be linked to climate change, data collected over a longer time period, is required before any conclusions can be reached.

(Poster 67) Variation in community structure of infaunal Crustacea with depth and habitat type in Sodwana Bay, South Africa

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Benthic samples were collected from two habitats (seagrass beds and algal turfs) in Sodwana Bay, KZN at a range of depths along the rocky shore and coral reefs. Crustacean species were identified from forty-five 25cmx25cm quadrats. A species list was compiled for Sodwana Bay. Many specimens did not match any known South African fauna. Of these four amphipod species have been examined and described as potential new species.

In addition to a Crustacea species list, the community structure of the macrobenthos was examined. Communities were compared between habitats, and to a range of environmental variables to determine which factors were most important in structuring crustacean species assemblages.

Stable isotope analysis of gastropod diets in the coastal lakes of iSimangaliso Wetland Park, South Africa

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The SIAR stable isotope mixing model was used together with gut content analysis to estimate diets and address potential intra- and interspecific competition between a number of indigenous and non-indigenous

aquatic gastropods at three different coastal lakes in South Africa. The results were used in the formulation of a simple index of isotopic dietary overlap (IDO, %). This approach can simultaneously reveal patterns of niche differentiation or resource partitioning whilst assessing the potential for competition between different species. Prominent non-indigenous invasive species, *Tarebia granifera* and *Aplexa marmorata*, as well as the indigenous *Haminoea natalensis*, *Assiminea ovata*, *Stylocheilus striatus* and *Melanoides tuberculata* were included in the analyses. Results indicate that *T. granifera* has a wider, less specialised diet than other snails. Under favorable salinities, *T. granifera* can displace *A. ovata* by monopolising food stocks and taking better advantage of disturbances involving nutrient inputs. The competitive potential of *T. granifera* juveniles (76% IDO) can be greater than that of adults (66% IDO) and intra-specific competition (65% IDO) appears to be minimized via an ontogenetic diet shift. *T. granifera* may also contribute to changes in elemental cycling dynamics, thus causing ecosystem-level modifications which may facilitate the establishment of other invasive species.

(Poster 68) Genetic population structure of adult penaeid prawns and their juveniles in the Tana and Sabaki estuaries in Malindi-Ungwana Bay, Kenya

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Several co-occurring penaeid prawn species (mainly *Penaeus indicus*, *Penaeus monodon* and *Metapenaeus monoceros*) occur in shallow-water crustacean catches made by artisanal and commercial prawn trawl fisheries Kenya. However, gene flow patterns and population structuring are unclear between coastal and offshore stocks, as well as estuarine nursery areas. The aims of this study are to determine whether recruitment of *Penaeus indicus*, *P. monodon* and *Metapenaeus monoceros* to the offshore Malindi-Ungwana Bay fishing area in Kenya is from the local estuaries of the Tana and Sabaki rivers, and whether the offshore stocks are genetically distinct or an admixture of the populations in the two nursery areas. Analyses will include both mitochondrial DNA and microsatellite markers. Preliminary results show variation for each of the three species at the mtDNA control region level suggesting that the mtDNA control region is a suitable marker for investigating the phylogeography of coastal and offshore stocks of the three prawn species.

Investigating evolution of foraging behaviour amongst five sympatric intertidal limpets (Patellidae) along the coast of South Africa

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The general model of ecological specialization postulates that feeding specialists should be characterised by apomorphic characters resulting in higher level of genetic heterozygosity than feeding generalists which are characterised by plesiomorphic characters. This study investigated the level of phylogenetic diversity amongst ten populations of five patellid limpets, two feeding specialists (*Scutellastra longicosta*, *S. cochlear*) and three feeding generalists (*S. natalensis*, *S. granularis* and *Cymbula oculus*). The level of phylogenetic diversity was measured using mitochondrial CO1, r12S and r16S genes whereas foraging specialization was corroborated using stable isotopes. From each population, at least 10 individuals of each herbivore were used for genetic analyses whereas at least five individuals of herbivores and various algae species were used for stable isotope analyses. Preliminary genetic data appear to support the ecological specialists-generalists model with high level of genetic diversity observed in decreasing order from *S. longicosta*, *S. cochlear*, *S. granularis*, *C. oculus* and *S. natalensis*. Furthermore, the results suggest the observed genetic variation is more strongly correlated with biogeographic patterns rather than the effect of foraging behaviour. Thus gene flow within these species seems largely to reflect the effect of biogeographic patterns rather than of their foraging preferences.

(Poster 69) Observations of nonlinear internal waves at the Namibian shelf

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The sediment distribution at the shelf off central Namibia depicts an accumulation of carbon rich sediments in three belt-like patterns parallel to the bathymetry. This distribution is caused most probably by the interaction of enhanced sediment resuspension at critical slope angles and cross shelf advection. Time series observations of temperature and near bottom currents at the Namibian shelf reveal the occurrence of highly nonlinear internal waves, which cause enhanced levels of turbulent kinetic energy in the near bottom

layer. Satellite images show surface expressions of internal nonlinear waves as very common feature at the shelf off southwest Africa. The power spectrum of current velocities in the internal wave range (N...f) is dominated by the M2 (12.4h), diurnal forced motions (24h) and near inertial waves. It is hypothesised that the nonlinear waves are generated by breaking events of M2 internal tide at the shelf edge. This is supported by observations of well mixed bottom layers with high SPM concentration. Critical slopes angles for internal wave reflection are found in water depth between 100 and 500m, an area that compares well to the satellite observations of nonlinear internal waves. The locations of critical slope angles coincide with the distribution of total organic carbon in surface sediments. Implications of the observed processes for the suitability of benthic habitats and carbon transport from the shelf to the adjacent deep ocean are discussed.

Benthic metabolism and N-dynamics in mangrove sediments subject to shrimp farm effluents (New Caledonia)

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During their active period, shrimp farms in New Caledonia discharge their effluents in the adjacent Mangrove. This study examines effects of shrimp pond effluents on benthic metabolism, sediment-water column nitrogen and phosphorus fluxes, and N-cycle (nitrification, denitrification and DNRA). Using incubations and ¹⁵N Isotope Pairing Technique, we compared sediment cores collected within a mangrove impacted by shrimp farm effluents with cores collected in a nearby control mangrove. During the farm discharges, sediment oxygen demand and NH₄⁺ flux in upstream impacted mangrove, near the ponds outlet, were respectively 3 and 4-times higher than in the control mangrove. Denitrification processes were also enhanced during the farm rearing compared to the natural seasonal effect in the control (68.3 ± 23.6 vs 23.4 ± 9.1 μmol N m⁻² h⁻¹ in upstream parts). At the same time, dissimilatory nitrate reduction to ammonium (DNRA) was higher than in the control. Furthermore, we observed significant differences in nutrient concentrations (N and P) in the surface water at the outlet of the main mangrove creek between the impacted and control mangrove during the farm rearing. This suggests that effluents influence the nutrient dynamics in the surface water of the whole mangrove and not only near the ponds. Thus, shrimp farm effluents have a significant impact on benthic metabolism and N-dynamics in mangrove sediment. However, after few months following the end of the discharge period, the above mentioned effects ceased in

the impacted mangrove and biogeochemical processes seems to become similar to those of the control.

The exergy of a phase shift: ecosystem degradation in *Posidonia oceanica* meadows of the Ligurian Sea (NW Mediterranean)

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It is a common belief that biodiversity is an important descriptor of ecosystems, and that sustained functioning of the latter depends on the former. However, research in the last decades did not reach a general consensus about the relationship between biodiversity and ecosystem functioning. This might in part derive from the difficulty of finding the appropriate metrics for the two quantities. Most papers measure ecosystem functioning as primary production or, less frequently, nutrient cycling, while biodiversity is generally expressed as the number of taxa, rarely including the multiplicity of variables shaping community structure. Systemic indices, which try to embrace rather than reduce ecosystem complexity, might be more adequate. Exergy has been commonly equated to the Gibbs free energy of ecosystems, i.e., their capacity to produce work. Exergy might thus represent a measure of ecosystem functioning. On the other hand, experiences aimed at assessing the ecological quality of ecosystems led to the development of synthetic indices based on measures of structure that go beyond species diversity. This paper aims at comparing exergy content and structural ecosystem status in *Posidonia oceanica* meadows, a priority habitat that is undergoing regression along many Mediterranean coasts due to anthropogenic pressures. A phase-shift index has been used to quantify ecosystem degradation, based on the progressive substitution of more opportunistic plants for *P. oceanica*. Computing exergy values for each structural phase showed that advanced stages of the phase-shift match with a progressive reduction of exergy content, thus providing evidence that loss of biodiversity implies a reduction in ecosystem functioning.

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Is Marine Science a language?

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This presentation will explain the challenge of translating scientific terms across a range of industries and amongst groups of individuals from different backgrounds. By using marine scientific language in our industry we are confronted by a difference in fields of study and in the interests of a selected audience. I have lived out of South Africa for two years and on my return realised that the scientific language which we use in our work environment is a distinctive form of communication. I will use terms that have been incorporated into our daily scientific language and show how these can be translated. Each person attending this conference is a specialist in their field of study or work environment and to explain a term used by Estuarine Scientists, Ichthyologists, Fisheries Scientists and Oceanographers is the responsibility of anyone in the room who deals with public, be it personally or through popular articles. We, ourselves need to fully comprehend the terminology and be able to use the scientific research provided by all experts and relate it to any person in an everyday context. Some of the terms and phrases which I will explain in my presentation have been provided by our scientists whom work at the Oceanographic Research Institute at uShaka Marine World. In South Africa we work in a multi-lingual society and, dependent on one's location in the country, these languages are changing according to region and there is an intermingling of phrases and terms. Some languages develop according to a prevalence of scientists using their home language in studies. Our scientific language is growing and changing on a continual basis, as new research is being produced. Our industry is speaking a marine scientific language!

Regional genetic differentiation in the dory snapper (*Lutjanus fulviflamma*) in the western Indian Ocean

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The Western Indian Ocean (WIO) represents a good area for studying factors shaping patterns of marine species diversity because of its isolation and its physical complexities which includes the current systems (the Agulhas, East Madagascar, and the Equatorial Currents) and the large basins (the Arabian, Mozambique, and the Somali Basins) which may act as

barriers to some marine species. WIO is also characterized by regional endemism found in the Red Sea, around oceanic islands (Mauritius and Reunion), and the south-western Indian Ocean (southern Mozambique, and the subtropical and warm temperate zones of South Africa). These diverse fish faunas have hypothesised to have arisen and dispersed from a centre of origin (bounded by Indonesia, Malaysia and the Philippines), the other scenario being regional faunas with each region having endemic species with the other interesting part being no agreement on origins of this fish faunas. The aim of this study is to investigate the phylogeographic pattern of the dory snapper (*Lutjanus fulviflamma*) in the WIO and eventually compare these to the wider Indo-Pacific, and to determine the relationships, interactions and evolutionary history of localities and identify the processes influencing genetic diversity. The key questions are to determine if there is genetic connectivity among localities, or if there is regional differentiation. Five to ten samples of the dory snapper were included from different localities in the WIO, which included South Africa, Mozambique, Tanzania, Kenya, Red Sea and Seychelles. These localities were selected due to the expectations that populations will differ between localities due to biogeographic discontinuities and transition zones. Samples from Australia and Fiji were also included to determine the placement of the WIO in context to the Indo-West Pacific and the wider Indo-Pacific. Standard DNA extraction, amplification by PCR and standard cycle sequencing of two mtDNA fragments (Cyt-*b* and ND2), and a nDNA (the first intron of the *S7* gene). Cyt-*b* data included 34 samples with 729 base pairs (bp) long sequences, ND2 data included 20 samples with 850 bp long sequences, with the *S7* data including 24 samples with 600 bp long sequences. Analyses included investigations on genetic diversity, genetic differentiation among populations and the examinations/phylogenetics relationships among haplotypes. Preliminary results for the Cyt-*b* gene fragment showed low genetic structure with a number of haplotypes shared between localities. Higher genetic structure was observed in ND2 gene with few haplotypes shared between localities. The *S7* gene showed many unique haplotypes with no spatial structure. In summary, there is high genetic diversity (number of haplotypes), and high variation (Cyt-*b* & *S7* data), but coupled with high gene flow and connectivity among localities. Thus, there is little evidence of spatial genetic structure. These results will be discussed in light of patterns emerging from parallel studies on two other snappers (lutjanids) and in terms of published studies encompassing the wider Indo-Pacific.

High school deep sea monitoring

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This project involved the environmental monitoring of marine offshore conditions by high school learners in collaboration with SAEON's Argo Program, DEO's St. Helena Bay Monitoring line. From February to December, in-depth background work was accomplished in weekly after-school meetings focusing on the dynamics of Oceans conditions. Numerous visits to various coastal marine research facilities and Marine research Vessels were organised. This field planning culminated in two - three day research cruise aboard the RV Africana, with each learner having an opportunity to learn to use and participate in the use of CTD, Bongo Nets and various other methods scientists use when they are at sea. Follow up visits to the DEA labs for further analysis of the data were conducted. Finally, learner prepared a scientific reports, and poster which were presented at an Annual Science Camp Soetwater.

Mesoscale structure and dynamics of a northern Benguela upwelling filament during October 2010

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The mesoscale dynamics of a northern Benguela upwelling filament located at approximately 18.5°S were examined under the auspices of GENUS (Geochemistry and Ecology of the Namibian Upwelling System) during the R.R.S. Discovery cruise from 1-5 October 2010. The data set acquired consists of *in situ* measurements across two transects through the filament. The top 90-200 metres of each transect was worked first with a towed undulating CTD (ScanFish) and a towed ADCP catamaran and subsequently with a vertical CTD and a microstructure profiler (MSS). Nutrient and other biological parameters were also measured across the filament. Following seven days of strong upwelling favourable winds, sampling coincided with a period of relative wind relaxation and the filament was presumably in a decaying state. Cross-sections of the wider eastern transect revealed a sharp southern front and a distinctive cold, less saline and oxygen depleted core. There were also indications of a second cold, even less saline core at the northern end of the transect. The same sharp southern front was observed in the western transect, while the northern front was found to be more gradual. Filament depth was estimated at approximately 100 to 110m. The mesoscale structure of the examined filament appeared to be different to what had previously been observed in the southern Benguela. Instead the feature appeared more similar to those reported from the California Current system.

(Poster 70) The relationship between selected coastal oceanographic features and the movement of *Argyrosomus* fishes on the west coast of southern Africa

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The Luderitz upwelling cell, situated at 26°40'S, is considered to be the division between the northern and southern Benguela, where vigorous upwelling creates a potential fish dispersion barrier between the two regions. The evolution of this major upwelling cell is thought to have split the populations of the dusky kob, *Argyrosomus japonicus*, and the west coast dusky kob, *Argyrosomus coronus*, which have since adapted to the specific conditions present in their regions. Recent observations of the west coast dusky kob, far south of its traditional distribution, in the Olifants estuary (southern Benguela) as well as an increase in *A. coronus* catches in the southern periphery of its distribution, have led to speculation of a potential southerly shift in range of this species. *Argyrosomus coronus* is known to have an upper temperature range of approximately 19°C, and seems to move south seasonally to avoid the poleward pulse of the warm Angola current. During large scale warming events, warm, saline and oxygen depleted tropical Angola water has been recorded as far as 27°S. It is thought that this intensified warm water pulse, may be the oceanographic mechanism responsible for the extreme southerly movement of west coast dusky kob individuals. Moderate-Resolution Imaging Spectroradiometer (MODIS) satellite derived sea surface temperature (SST) data, provided by MRSU at UCT, is being used to track the movement of the 20°C isotherm along the southern Angolan coast. The MODIS SST was found to overestimate coastal temperatures in the region by ~1°C (64 day comparison). Tracking this isotherm allows the identification of intrusions of water above 19°C, into the distribution range of west coast dusky kob. The extent of the southerly movement of *A. coronus* can then be assessed by examining trends in CPUE (2005-2009) within the same region. This talk will discuss the trends in the movement of the 20°C isotherm in the southern Angola region and the possible effects this has on the distribution of *A. coronus*.

An evaluation of the illegal coastal fishing effort in the Tsitsikamma National Park Marine Protected Area, South Africa

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The absence of fishing pressure in Marine Protected Areas (MPAs) has contributed to our understanding of how pristine ecosystems function. However, the potential negative effects of non-compliance and illegal fishing activities are rarely taken into consideration. In an attempt to address this shortcoming, the present study evaluated when, where and how much illegal fishing takes place within South Africa's oldest and largest MPA, the Tsitsikamma National Park (TNP). This evaluation made use of broad scale (aerial surveys) and fine scale (roving creel surveys) methods, conducted between January and December 2009. Additional information was obtained from law enforcement patrol log books and interviews with research anglers. Aerial surveys revealed that angler densities in the MPA (0.03 - 0.14 anglers.km⁻¹) were significantly less than in adjacent open access areas (0.07 - 1.51 anglers.km⁻¹). Distinct "hot spots" were identified during the creel surveys; these localities being confirmed by interviews with research anglers. Evidence of fishing activities (proxy for fishing effort) showed no significant difference between three identified hot spots within the MPA compared to a popular site (Salt River) outside the park, suggesting that illegal fishing is prevalent at these spots. Angler effort within the park was noticeably higher on weekend days and concentrated over summer months. It was also evident that considerable effort is placed on targeting species that become vulnerable during summer-dominated upwelling events (e.g. santer *Cheimerius nufar*). Examination of log books suggested that records were poorly maintained and that most patrols took place during daylight hours on week days. Recommendations are made to improve monitoring and surveillance efforts in an attempt to counteract the potential impacts of illegal fishing within the TNP.

(Poster 71) Monthly pelagic fish (acoustic) abundance estimates along SHBML / transect

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The St Helena Bay Monitoring Line (SHBML) which is 100nm off Elands Bay is a long term project on environmental monitoring; it samples the nursery grounds and part of the transport zone for hydrology and productivity in areas which are important to early life history of pelagic fish resources. Hydroacoustic data have been regularly collected along the SHBML to obtain information on pelagic fish abundance, but the lack of directed midwater trawling to determine species composition and size distributions of acoustic ensonified targets during those cruises has restricted the use of these data in providing anything more than a rough estimate of pelagic fish biomass. Monthly sampling using acoustics in conjunction with midwater trawling will permit more accurate estimates of pelagic fish density along the SHBML/transect. These data may be useful for the Island Closure Feasibility Study (ICFS) currently being implemented, in that they will provide monthly estimates of pelagic fish density in a region upstream of Dassen and Robben Islands. Such estimates can be compared to the biomass of pelagic fish around Dassen and Robben Islands that will also be acoustical monitored at a monthly basis as part of the ICFS. Additionally, year-round sampling of pelagic fish from the same location will provide useful data that will be analysed to examine seasonal variability in selected fish biological characteristics. This will be particularly useful for anchovy (*Engraulis capensis*) and redeye (*Etrumeus whitehead*) since samples from commercial catches of these species are in too poor condition to be used for the collection of biological data.

Trends of Chondrichthyan bycatch in the inshore trawl fishery from 1898 to 2010

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The South African inshore trawl fishery was founded in the late 1800s. The fishery was opened by scientists who conducted scientific surveys in search of suitable trawling grounds, leaving an accurate and comprehensive record of surveys. Already in the early years of trawling, concerns were raised over the amount of juvenile fish and bycatch caught in the fishery. Today, these concerns continue as the total catch of the inshore trawl industry consists of approximately 42% bycatch, of which Chondrichthyans constitute approximately 12%. Chondrichthyans are especially prone to over-exploitation due to their slow growth and low fecundity.

Using historical survey data from 1898 to 1904 and 1920 to 1933, shark, skate, ray and chimaera catches in the inshore trawl fishery were compared with modern surveys from 1985 to 2010. Species from seven Orders

of Chondrichthyans were abundant in the surveys of both the early and recent periods. It was also found that there was a decrease of approximately 5% in the overall percentage of Chondrichthyans caught by the trawlers.

Between 1898 and 2010, on the Mossel Bay fishing ground, the Torpediniformes average abundance dropped significantly from 25.3 fish/hour to 0.33 fish/hour, whereas the Chimaeriformes average abundance increased significantly from 0.006 fish/hour to 14.93 fish/hour. Carcharhiniformes also increased significantly from 0.01 fish/hour to 4.9 fish/hour on the Mossel Bay trawl ground, however, the Myliobatiformes decreased significantly from 0.4 fish/hour to 0.06 fish/hour. The abundance of Rajiformes, Pristiophiriformes and the Squaliformes did not change significantly on the Mossel Bay trawling ground.

These changes may be attributed to effects of a century of intensive trawling, but changes in the efficiency of gear types and climate change may also explain differences between these data sets.

Phylogeographic history of two endemic rocky shore gastropods on the South African coast: a signature of Pleistocene climatic changes and contemporary oceanography?

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Pleistocene sea level changes that were coupled to climate change could have played a major role in the phylogeographic structures of South African coastal species. It is well documented that sea levels much lower than the current one occurred during the Pleistocene when wide areas of the continental shelf, particularly around the Agulhas Bank were exposed. To test the influence of the Pleistocene sea level changes, the phylogeographic history of *Turbo sarmaticus* and *O. sinensis*, rocky shore gastropods endemic to the South African coast, was reconstructed using the mitochondrial cytochrome oxidase subunit 1 and the nuclear ITS. Analysis of molecular variance and pairwise Φ_{ST} values suggest significant spatial population genetic structure in both species. A major genetic disjunction was observed in both species between Cape Agulhas and Cape Infanta corresponding to the widest part of the Agulhas Bank. Another genetic barrier was additionally observed in *T. sarmaticus* between Herold's Bay and Knyna Heads. No spatial genetic structure was detected within

phylogroups in both species, consistent with their having a pelagic larval stage. The species share a common history of population expansions that is most likely associated with the recurrent flooding and exposure of the continental shelf in Pleistocene. Coalescent analyses suggest gene flow was mainly westward on the south-west coast but mainly eastward on the south-east coast in both species. The spatial genetic structure and timing of population expansions observed suggest a significant role of the Pleistocene sea level changes in shaping biodiversity on the South African coast. The gene flow patterns observed suggest that the Agulhas Current and Agulhas counter currents predominantly influence dispersal on the south and south-east coasts. This study concludes that a combination of historical events and contemporary processes have shaped the phylogeography of *T. sarmaticus* and *O. sinensis* on the South African coast.

(Poster 72) Restricted dispersion in the South-West Indian Ocean

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Genetic studies constitute an indirect mean to determine effective dispersal, that is important in the context of Marine Protected Areas delineation. An mtDNA haplotype analysis was thus conducted on the pantropical reef fish *Myripristis berndti* (ten populations in the South-West Indian Ocean) to complete a pre-existing phylogeographic study of this species (mainly focused on Pacific populations) and to determine/examine patterns of connectivity in the less-known SWIO. MtDNA sequences confirm the genetic break between Indian and Pacific populations, with subsequent post-glacial population expansion in both oceans. Furthermore, some spatial pattern of differentiation is observed within the SWIO, with the three peripheral populations from Kenya, Reunion and Europa isolated from the seven central populations which form a densely-connected network of localities. The isolation of Kenya, Reunion and Europa from the seven other localities could be explained by both geographical distance, biogeographical boundaries and important hydrodynamic fronts; it is also consistent with previously reported isolation in other reef species of the SWIO. This study gives some crucial information about restricted connectivity in the SWIO. However, as a single-species and single-marker study, it is clearly insufficient as a tool for managers. That's why an effort is now necessary to collect additional data in the SWIO to be pertinent, as was recently the case for the more-studied Hawaiian archipelago.

Genetic stock assessment of the bronze bream (*Pachymetopon grande*), a South African endemic inshore sparid

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The bronze bream (*Pachymetopon grande*) is an endemic South African inshore species that is important in recreational and subsistence fisheries along the southern and eastern coasts. However, the fisheries stocks of the species have experienced declines in recent history despite species-specific management interventions. Current management practices have been based on a limited understanding of the stock dynamics of the species including recruitment, movement, residency and population structure. The species is a slow-growing, long-lived, sparid fish species that is highly resident (at different life-history stages) along inshore reefs, suggesting that stocks would benefit from “no take” zones or Marine Protected Areas (MPAs). Although, the abundance and diversity of most linefishes have been observed to be higher in MPAs, an assessment of the efficiency and potential of these reserves as sources for adjacent exploited areas is limited by an incomplete understanding of the genetic diversity of most species. This study will provide a genetic assessment of stock structure and variability of the bronze bream using the first intron of the ribosomal S7 nuclear gene and samples collected from the southern and eastern coasts. This genetic assessment aims to complement ongoing tagging and tracking studies in the examination of connectivity among populations, migration and recent changes in genetic diversity and demography of *P. grande*.

Establishing a baseline for evaluating population and condition dynamics of sardine (*Sardinops sagax*) in the Southern Benguela

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Developing indicators of comparable power for ecological processes will help focus attention on environmental conditions. This attention may in turn stimulate significant and informed management action with regard to an ecosystem approach to fisheries

management. Such ecological indicators are also needed as yardsticks to measure the influence of climate change and stock performance over time. Standard weight equations were developed for use in the computation of relative weight (W_r) and applied on sardine (*Sardinops sagax*) database that has been collected along the South African coast between 1953 and 2009. Three quadratic standard-weight equations, of the median, mean and upper quartile are established. The resultant W_r indices show areas and periods of varied fish conditions, with a visible distinct between sardine from the west and the east of Cape Agulhas. The possible causes of these spatial and temporal differences are discussed. Using sardine as an example, we outline how the W_r index could improve our ability to assess population status of exploited fish species in changing ecosystems and to evaluate interactions between different stocks of the same species and between various species.

Sea turtle monitoring in KwaZulu-Natal

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The Maputland Marine Turtle programme operating within the iSimangaliso WHS in northern KZN, was initiated in 1963 by the then Natal Parks Board (now Ezemvelo KZN Wildlife) to monitor the recovery of female loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coarctata*) turtles, following their near-total disappearance to poaching prior to this. The original objective was to allow for controlled harvesting once monitoring indicated sufficient recovery in the population, but this fell away given the worldwide decline in turtle numbers. The programme is now dedicated towards their conservation only. Ezemvelo monitors nesting female loggerhead and leatherback turtles annually from 15 October to 15 March along a 56 km stretch of beach from Mabibi to the Mozambique border. Female turtles are tagged and morphometric data are recorded to reveal trends in nesting behaviour. For the 2009/2010 season, 4803 loggerhead tracks and 228 leatherback tracks were recorded. This record number represents a year-on-year increase for loggerhead activity while the leatherback activity appears stable over the 47 years of monitoring. There were 899 loggerheads tags recorded, with 582 being identified as distinct individuals. 72 leatherbacks tags were recorded, with 49 distinct individuals identified. 3001 of the total 4803 emergences for loggerheads resulted in successful nesting events this season and of the 228 leatherback tracks, there were 221 nests. Overall, nest monitoring indicates the female loggerhead component of the population is increasing while the leatherback female proportion of the population is stable, but dangerously low. Beach protection overall is working well for these species

(especially loggerheads), with other factors that are possibly affecting recovery in leatherback population.

(Poster 73) Interpreting metal concentrations in sediment: a guide for benthic ecologists

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South African marine and freshwater benthic ecologists are increasingly assessing the influence of contaminants in sediment on benthic community composition, structure and functioning. These studies are to be welcomed and encouraged. However, many benthic ecologists examining the potential influence of metals on benthic communities make the fundamental error of directly comparing concentrations between sampling sites. The implication made by direct comparison is that higher metal concentrations must represent a 'worse' condition. This is not necessarily true. The failure to properly account for the features of sediment that influence natural metal concentration variability, before making comparisons between sites, essentially invalidates the findings of many studies. This presentation provides a background on the features that control metal concentrations in sediment and discusses the correct procedure for interpreting concentrations, through the use of data from practical studies. The implications of metal concentration data interpretation are further discussed in the context of sampling design. The use of sediment quality guidelines for interpreting sediment quality and the pitfalls that should be avoided in simply adopting guidelines from another jurisdiction are also discussed.

(Poster 74) Can eutrophication provide an explanation for a large fish kill in Durban Bay in December 2007?

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In late December of 2007 there was a large fish kill in the upper reaches of Durban Bay, both in terms of the number of fish that died and the spatial extent of deaths. The cause of the kill was clearly low dissolved oxygen concentration, which was near or slightly above 0 mg.l⁻¹ through the water column over a large part of the upper reaches the day that dead fish were first noted. The cause of the low dissolved oxygen concentrations was never established, but it was hypothesised that since sewage had leaked into a small river discharging into the Bay for several months prior to the kill that the low concentrations were a secondary symptom of eutrophication. This study examined the

spatial extent, frequency and intensity of the primary and secondary symptoms of eutrophication in Durban Bay. It was recognised that this after-the-fact data would not explain the cause of the low dissolved oxygen concentrations at the time of the fish kill, but it was considered that the trends would provide some understanding of whether eutrophication related impairment in Durban Bay is so significant that it might account for the kill. Water quality was monitored at 15 stations across Durban Bay in 23 surveys performed between October 2007 and March 2008. Water quality in Durban Bay is essentially a tale of two halves, with the upper reaches having a poorer water quality compared to the lower reaches. This is partly the outcome of nutrient rich freshwater inflows into the extreme upper reaches, but also due to hydrographic characteristics of the Bay. The primary and secondary symptoms of eutrophication were not pronounced and do not provide an explanation for the cause of low dissolved oxygen concentrations at the time of the fish kill. Options for managing water quality in Durban Bay are provided.

(Poster 75) A comparison of three different techniques to analyze abundance, size composition and vertical distribution of zooplankton associated with mesoscale eddies in the Mozambique Channel

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Traditionally, zooplankton are analysed taxonomically using a microscopic. However, this process is extremely time-consuming, and tends to limit the number of samples that can be processed timeously. This in turn can lead to fragmented information that may complicate interpretation and compromise understanding. Two fairly recent developments in zooplankton sampling are the ZooScan, a scanner with dedicated imaging software that has been developed to enumerate, measure and identify zooplankton, and TAPS (Tracor Acoustic Profiling System), a multifrequency acoustic profiler designed to provide high-resolution information on the vertical distribution of individual zooplankton organisms. These methods were used for comparison with traditional net collection and microscope enumeration of zooplankton during a research cruise in the Mozambique Channel in 2009. The Hydrobios MultiNet (five nets of 200-µm mesh; 0.25 m² mouth area) was used to collect zooplankton within the upper 200m. Nets were triggered individually via a computer onboard to close

and open the nets on demand, to provide zooplankton samples in five depth strata between the bottom and the surface. The TAPS was mounted on the Hydrobios MultiNet in order to measure mean zooplankton biovolume simultaneously as the net is hauled to the surface. TAPS, ZooScan and the microscope data were compared to determine the relative advantages and disadvantages of each method. Results show that TAPS detects smaller zooplankton than are sampled by the 200-µm mesh net, whereas the ZooScan is able to detect larger organisms than the TAPS. The TAPS is also able to provide much finer scale (2m-intervals) vertical distribution of zooplankton than the MultiNet. Microscope and ZooScan counts showed a high correspondence, although the microscope enables a higher level of taxonomic identification. Both the ZooScan and TAPS have the potential to enhance our understanding of zooplankton community structure, biomass patterns and size spectra effectively and (fairly) rapidly.

(Poster 76) New distribution records of Ophiocomid brittle stars (Echinodermata: Ophiuroidea: Ophiocomidae) from KwaZulu-Natal, South Africa

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The last major review of the echinoderms of the region, published in 1976, reported 115 species of brittle star (Echinodermata: Ophiuroidea) from southern Africa. By 2011, a total of 152 species have been recorded from South Africa (including the Prince Edward Islands), as a result of 37 new distribution records. Collections between 1999 and 2009 contributed to the majority of these new distribution records, which is a clear indication that the South African coast still remains poorly explored for this group. Data records in the Iziko South African Museum have also proven to be valuable source of new records. The Ophiocomid brittle stars are known to be associated with coral reefs in subtropical and tropical areas. Up till now, the number of *Ophiocoma* species recorded in South Africa was four, but as a result of recent collections, this number has increased to eight. The four species previously reported from South Africa are *O. erinaceus* Müller & Troschel, 1842, *O. pica* Müller & Troschel, 1842, *O. scolopendrina* Lamarck, 1816 and *O. valenciae* Müller & Troschel, 1842. The four additional *Ophiocoma* species newly reported are *O. pusilla* Brock, 1888, *O. brevipes* Peters, 1851, *O. dentata* Müller & Troschel, 1842 and *O. doederleini* de Loriol, 1899. The general taxonomic features and global distribution of the genus *Ophiocoma* are discussed,

together with the taxonomy, geographic distribution and ecology of the eight species listed above. A brief overview of the biogeography of the *Ophiocoma* species of KZN will also be provided.

(Poster 77) Coral and Rocky reef monitoring in KwaZulu-Natal, South Africa

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The year 2011 marks the fourth year of the Ezemvelo KZN Wildlife long term monitoring programme of the subtidal reefs of KwaZulu-Natal (KZN). This project falls within a larger programme that monitors the marine and coastal resources of KZN to facilitate the decision making process in order to manage these resources effectively. The reefs of KZN are subject to a number of threats, i.e. diving, fishing and climate change. This project aims to detect subtle changes or stress echoed by the change in the benthic cover on seven reefs, namely Kosi Bay, Leadsman Shoal, Sodwana Bay, Umhlali North and South, Aliwal Shoal and Umtwalume which are monitored annually. Benthic cover is estimated using a random quadrat method in which photographs are obtained and analysed. To compliment this data, underwater temperature recorders record sea surface temperature (SST) at four sites along the KZN coast. The benthic results show patterns typical to a marine environment which changes from subtropical in the north to warm temperate in the south. The abundance of algae and sponges increase from north to south while the soft and hard coral cover decrease from north to south caused by a variety of factors, i.e. SST, turbidity and light. Two-mile reef at Sodwana Bay is showing evidence of impact and this may be due to a combination of factors including the fact that this reef has the highest number of divers on the South African coast. The SST data showed a rapid and unusual decrease in temperature between March 2009 and May 2009 on all the KZN reefs. Currently, the reefs on the KZN coast appear to be in good condition with the exception of the Sodwana Bay reefs which may require improved management.

Distribution and abundance of alien invasive fish species in a South African RAMSAR wetland, the Wilderness Lakes

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The Wilderness Lakes System, comprising three lakes (Island Lake, Langvlei and Rondevlei) and their interconnecting channels, the Touw Estuary and the Serpentine channel, forms a component of the Garden Route National Park under the jurisdiction of South African National Parks (SANParks) and with the exception of the Touw Estuary has been designated a RAMSAR site. Previous ichthyofaunal surveys have reported the presence of three invasive fish species in the system namely, an extralimital population of the Mozambique Tilapia *Oreochromis mossambicus*, the Central American mosquitofish *Gambusia affinis* and the North American largemouth bass *Micropterus salmoides*. The introduction of alien species can have a drastic effect on ecological communities and has contributed to species extinctions worldwide, particularly in freshwater fish. However, the impacts of alien species on estuarine communities are largely unknown. The objectives of this study, some 15 years after the last survey included: an assessment of the spatial, temporal distribution and relative abundance of endemic and alien fish species throughout the system and to investigate these results in relation to various physico-chemical water quality parameters. Each lake, two interconnecting channels and the Touw Estuary were sampled seasonally with multiple gear types including fyke nets, multi-meshed gill nets, 30m and 10m seine nets. In addition to a permanent array of underwater temperature loggers various physico-chemical parameters were collected at each sample site on each sampling trip. Preliminary results confirm the persistence of the alien *O. mossambicus* and *G. affinis* in the system, whilst also confirming the presence of a new invader, *Cyprinus carpio* (common carp). There appear to be strong spatial and temporal variations in the distribution and abundance of fish within the lakes.

(Poster 78) Phytoplankton studies in the Natal Bight

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The KwaZulu-Natal Bight is subject to nutrient inputs from terrigenous features such as the Tugela River and ocean processes such as bathymetry-induced upwelling and surface return eddies. The aim of the project is to examine the influence of these features on phytoplankton ecophysiology. Synoptic surveys were conducted to provide an indication of the distribution of phytoplankton in the Bight, while focussed experiments looked at rate processes involving C and N acquisition, as well as sources of N available in the surface water. During the wet season a large variation in chlorophyll-*a* fluorescence was observed across the Bight, while natural abundance isotope data indicate a seasonal change in the nutrient source available. The assimilation efficiency and uptake rates of ¹³C and ¹⁵N tracer additions were examined in the light of the

underlying synoptic scale patterns of dissolved inorganic nutrients and phytoplankton concentration in the Bight. Further analysis will highlight spatial and temporal patterns and reveal energetic constraints mediated by nutrients.

Genetic diversity of *Polysteganus undulosus* after stock collapse

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Globally it is estimated that 75 % of fish stocks are either overexploited or have reached maximum exploitation levels. Information about species recovery after stock collapse is scarce. Here we have the opportunity to compare the level of genetic variation before and after such a stock collapse event in the seventyfour *Polysteganus undulosus*. The species is a south-east African endemic found from the Cape to Maputo. Seventyfour made up more than 50% of the total commercial line-fish catch along the KwaZulu-Natal coast between the early 1900s and the 1960s before the stock collapsed. The first management regulations to protect this species were only implemented in 1984 (i.e. bag limits, size limits and a closed season). This was followed by a total closure (recreationally and commercially) of the fishery in 1998 in accordance with the South African Marine Living Resources Act (No. 18 of 1998). In this preliminary study of intraspecific diversity, we compare samples collected from 1962/63 (before the collapse of the stock) with samples collected during 2005/06 using the mitochondrial ND2 gene and newly developed polymorphic microsatellite markers. From the microsatellite genotype data, total gene flow patterns are estimated and contrasted with maternal gene flow estimated from the mitochondrial ND2 alleles. The results obtained from this study will be integrated in conservation and management strategies.

A systematic conservation plan for the proposed Addo ENP MPA

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Historical decisions on where marine conservation takes place, has generally been based on expert opinion and fisheries needs. Systematic conservation planning has become best practice, and has been used in the NSBA, OMPA Project and Sea Plan. The proposed

Addo MPA is one of the first to take such planning to implementation. The SCP was based on fisheries data, published data, and recent baseline studies. The proposed Addo MPA is an example of informed opportunism, and will demonstrate that both Systematic Conservation Planning, expert opinion and capacity is crucial for implementation. Addo MPA is adjacent to a larger terrestrial protected area and the expansion was particularly driven by 1) forming a contiguous terrestrial marine protected area and 2) because of the capacity held within the protected area management authority to implement. Initial planning of Addo MPA in terms of biodiversity important areas and appropriate zoning was done through expert opinion. The later Systematic Conservation Plan based on fisheries data, published data, and current baseline studies 'confirmed' expert opinion, and based on expert opinion zonation, 70% of targets were met. The larger Algoa bay area has also been highlighted as a biodiverse hotspot through other regional and national SCP planning initiatives.

Trophic model-generated indicators of the southern Benguela ecosystem for communicating with fisheries managers

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Ecosystem modeling is recognised as a tool that may be used towards achieving an Ecosystem Approach to Fisheries (EAF). Trophic models are explicitly based on the interactions between ecosystem components and therefore allow stakeholders to view how pressures (environmental or anthropogenic) impact upon the ecosystem, as well as its individual components. An updated trophic model representing the 2004-2008 period within the southern Benguela ecosystem was constructed. This current model complements historic 1900s, 1960s and 1980s trophic models previously published. Examinations of the model outputs signify a change in the food web structure of the southern Benguela ecosystem. Model consumption patterns of predators have also changed in response to fishing sectors becoming significant consumers of potential food sources, as well as changes in environmental conditions which have changed geographical distributions of potential food sources, i.e. small pelagic fish. Indicators were extracted from the range of the southern Benguela ecosystem trophic models available. The indicators emphasise that small, planktivorous fish have become more abundant, whereas large, predatory/piscivorous fish have decreased in abundance within the southern Benguela ecosystem. Community- and ecosystem-based, model derived indicators can therefore provide fisheries managers with insights regarding the state of the

southern Benguela ecosystem. The indicators which were deemed most meaningful for management within the southern Benguela ecosystem were selected for use within an expert system. Expert systems are computerised decision trees providing users with a logical framework in which to access synthesised information. To assess the trend in ecosystem status in response to fishing, three decision trees were developed which examined the southern Benguela ecosystem on a community level (Pelagic-caught fish and Demersal-caught fish community decision trees) and on the system level (ecosystem decision tree). The expert systems, which are based on the decision trees developed, therefore provide fisheries managers with a logical framework to access the synthesised information and the reasoning behind the conclusions reached.

(Poster 79) Agglutinated foraminifera in surface sediments from the Thukela Shelf, South Africa

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Foraminifera are marine unicellular organisms that build calcareous or agglutinated tests, which stay well-preserved in sea sediments. The most diverse is the group of benthic foraminifers that occupy a wide range of marine environments from brackish estuaries to deep sea and are very useful as environmental indicators. Using water depth ranges of benthic foraminifers helps determine sea level changes in coastal regions. Changes in benthic foraminiferal assemblages and test morphologies are becoming increasingly useful for assessing environmental quality, viz. changes in water salinity, temperature, dissolved oxygen, nutrient input, heavy metals and other toxic materials in coastal regions, and reconstructing historical changes in near-shore ecosystems. A survey of agglutinated foraminifers of KwaZulu-Natal Bight is very important by itself, as it provides a modern detailed inventory of the foram biodiversity along the east coast of South Africa. Twenty-one samples were analysed. In total 41 species of 27 genera from 15 families with agglutinated test were recorded. Species of the following genera have been identified: *Adercotryma*, *Ammobaculites*, *Ammomargulina*, *Ammoscalaria*, *Cribrostomoides*, *Dendrophrya*, *Discamina*, *Dorothia*, *Gaudryina*, *Haplophragmoides*, *Hyperamina*, *Protonina*, *Pseudoflintina*, *Pseudogaudryina*, *Recurvoides*, *Reophax*, *Rhabdammina*, *Saccorhiza*, *Sigmoilopsis*, *Siphotextularia*, *Spiroplectammina*, *Spiroplectinella*, *Textularia*, *Textularioides*, *Tritaxis*, *Trochammina*,

Veleroninoides. The most abundant are species of the genera *Textularia*, *Textularioides*, *Spiroplectinella*, *Reophax*, *Cribrostomoides*, *Haplophragmoides*, *Sigmoilopsis*, *Pseudoflintina*, *Ammoscalaria*, and *Ammobaculites*. Tests of most species of *Textularia* and *Textularioides* from the Thukela Shelf consist of hematite or ilmenite grains collected from the sea floor. While the majority of species belongs to a relatively shallow-water assemblage, *Reophax dentaliniformis* is a deep-water species that is found on the Thukela Shelf.

(Poster 80) Determining the recruitment preference of the coralline alga *Spongites discoideus* (Foslie) Penrose & Woelkerling

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The exploitation of microhabitats increases biodiversity of an area especially when space is the primary limiting resource. In marine ecosystems, mollusc shells often provide such microhabitats, increasing the surface area for the settlement of a variety of epizoic organisms. One such interaction has been observed between the non-geniculate coralline red alga *Spongites discoideus* (Foslie) Penrose & Woelkerling and the molluscan winkle *Oxystele sinensis* (Gmelin). Juvenile *O. sinensis* were found almost exclusively in intertidal rock pools and bore a thin film of the coralline, whereas mature *O. sinensis* bore lumpy, convoluted forms of the coralline alga. Individuals (juvenile and mature) of the morphologically similar winkle, *O. tigrina* (Anton), lacked these encrustations even though they share some habitats with *O. sinensis*. The aim of this study was to determine if *S. discoideus* has a recruitment preference for shells of *O. sinensis*. To test this, a caged experiment was set up in the shallow subtidal zone of Kalk Bay. Living individual juveniles and empty shells from both winkle species (*O. sinensis* 13.3 ± 0.24 mm; *O. tigrina* 14.18 ± 0.12 mm; p > 0.05), with no visible coralline algae present on their shells, were placed inside cages along with boulders bearing reproductively mature individuals of only *S. discoideus*. Cages were left in the field for 3 months and then removed to determine the degree of coralline recruitment on all shells. The results firstly show that there was no recruitment preference between both living individuals and empty shells of *O. sinensis* (p = 0.23), or that of *O. tigrina* (p = 0.78) and secondly, no recruitment preference between the two species (p > 0.05). It appears therefore that the substantially overlapping habitats of the two species are largely the reason for the high occurrences of coralline epizoics on the shells of *O. sinensis*.

Seepage of groundwater through coastal sediment layers: coastal ‘mudbanks’ formations with greening of near shore waters

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In water budget and mass flux estimations for coastal regions, submarine groundwater discharge is often overlooked because it represents a non-point source. The investigations in coastal Arabian Sea waters had sufficient hints of ground water seepage through the narrow strip (2 - 14km) of submerged porous sediment beds running almost parallel to the coastline. This ground water may supply considerable quantities of primary nutrients to the coastal waters and precondition it for rich primary production. The present study revealed the highest value of 14 mg/m³ for chlorophyll a, approximately three times greater than the peak values reported so far from these waters. During the post monsoon season, the regions in the vicinity of the mudbank region had nutrient enrichments with nitrite (0.5 - 2.0 µM), phosphate (0.4 - 2.8 µM), ammonia (1 - 7 µM) and nitrate (1 - 6 µM). A band of N/P > 15 funneling out from the coastal region was an indication of ‘external source’ of nitrogenous compounds into the coastal waters. The long-term (decadal) trend of chlorophyll showed a “greening” of the near-shore waters. The low saline ground water influx could be a triggering mechanism for mud bank formation in coastal region. The groundwater fluxes depend on factors such as: climatic (monsoon) variability, which controls the fresh water discharge into backwaters providing the necessary force to overcome the frictional resistance of the porous lime shell deposits, human factors (land use mosaic, socio-economic, and sanitary conditions), and tidal factor that controls the hydraulic difference between seawater and brackish water. A significant quantity of groundwater flow occurs during the monsoon months when water level in the backwater is high and the sea level remains at its annual low. The possibility of heavy rains and flash floods is high with climate change, such conditions can occur during other seasons and also at similar coastal locations. The differences in land-use mosaic among sub-watersheds result in differences in the rate of nutrient loading to groundwater and hence to receiving coastal waters. The details of the exchange of coastal water and groundwater across the sediment-water interface deserve more attention and research.

(Poster 81) The effects of the tongue-replacing isopod *Cymothoa sp.* on largespot pompano (*Trachinotus botla*) from the northern KwaZulu-Natal

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A parasitic tongue-replacing isopod species (*Cymothoa sp.*) belonging to the *Cymothoa* genus was found to parasitise largespot pompano, *Trachinotus botla*, along the Zululand coastline. Larger, female isopods attached to the tongue of the host while smaller males attached to the gill rakers. These attachment sites are typical of the genus. Female isopods occupy a large proportion of the host’s buccal cavity which may result in a modification in the diet of the host as only smaller food items can be swallowed. Infection is likely to be linked to hosts consuming intermediate hosts as prey. Prevalence rates were high with 50% of all fish sampled found to be infected. Results show that prevalence rates are higher in smaller fish; 100-199mm (63%), 200-299mm (46%), 300-399mm (12%) and >400mm (0%). There is also a strong linear relationship between parasite length and fish length ($R^2 = 0.74$). Condition factor did not differ significantly between infected and uninfected fish (t-test; $t = 0.80$, $df = 71$, p -value = 0.43) suggesting that the host may modify its diet to consume smaller prey items.

(Poster 82) Aspects of the dynamics of the primary producers in Sodwana Bay, KwaZulu-Natal, South Africa

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Sodwana Bay, situated in the iSimangaliso Wetland Park, is home to the southernmost known population of coelacanths, *Latimeria chalumnae*. The clear subtropical water of the Agulhas Current, which flows close inshore near Sodwana Bay due to the narrow continental shelf, and the lack of nearby silt-laden rivers, result in a relatively deep euphotic zone of 30 m that facilitates the existence of corals that are among the southerly-most distributed in Africa. These characteristics make Sodwana Bay a unique system and one that is important from a conservation perspective. This study aims to elucidate energy flows and nutritional sources of importance to the marine community in the bay. Surface and deep water samples were collected on a monthly basis for stable isotope analysis of the particulate organic matter (POM), to

detect the relative importance and transport of different sources of organic matter in the system. Inshore-offshore as well as depth gradients were investigated in the vicinity of submarine canyon heads. Additionally, CTD transects were deployed to determine local physical parameters and to investigate vertical and horizontal movement of water on the coastal shelf.

Are we losing historical marine habitats? Scales of homogenization and differentiation of rocky reef habitats across a decadal period

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Understanding patterns of species diversity in space and time is a major focus of ecological research. Diversity can be partitioned across spatial scales to identify the relevant ecosystem processes. Biotic interactions are usually considered to play a major role at local scales, macro-ecological and climatic processes at broader scales. In the present study we focused on diversity change of rocky reef habitats across a decadal scale period. Diversity was measured in three sites of the Ligurian Sea (NW Mediterranean) considering two habitats (i.e. shallow and deep rocky reefs) and two different spatial scales: local (i.e., within sampling stations, meters) and site (hundreds of meters to kilometres). The pattern of variation of diversity across time was assessed thanks to historical data: the three sites were firstly investigated in the early 1990s and then re-sampled in 2008 or 2009. In the period considered those sites were subjected to different human uses ranging from protection to coastal exploitation. Our results indicate that local diversity increased while site diversity decreased at all reefs investigated, regardless of their individual disturbance history and present regime. Importantly, the difference between shallow and deep rocky reefs weakened. Differentiation of rocky reef communities at local scale highlights that the recent arrival of new species (e.g. invaders) enhanced local diversity. This suggests that the local success of invaders may be driven by small scale biotic processes (e.g. competition) rather than the availability of species within the regional pool. On the other hand, the broad success of invaders and stress-tolerating species at all scales led to a general homogenization of rocky reef communities at all sites.

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(Poster 83) Linking biotic data with socio-economic data to improve effectiveness of MPAs

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As a result of the decline in fisheries, the local government of Rodrigues recently gazetted four marine reserves north of the island using mainly local knowledge from fishing communities. A spatial analysis of biotic data was done to validate the design of these Marine Protected Areas using a systematic conservation planning approach (Marxan). The aim of the project was to design a marine protected area network for Rodrigues using available spatial data for optimum fisheries benefit and to achieve marine biodiversity protection. The results showed that two of the marine reserves already established are close or fall partly into the reserve design obtained from the analysis. The four marine reserves should be expanded to improve their effectiveness by covering regions of high biodiversity. The south part of the island is subject to extensive fishing and requires protection. The results from this analysis can be used to inform decisions; illustrating regions of high marine biodiversity to stakeholders while jointly identifying regions which require protection. Acquisition of new data can be incorporated into Marxan to constantly review and evaluate the effectiveness of the marine reserves so as to promote sustainable fisheries.

The worm and the diatom: an association of ecosystem engineers which improves sandy sediment stability

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Benthic organisms influence the near-bed flow dynamics in the intertidal area through the production of biogenic structures. Although the effects of these structures (especially those of tube-building annelids) on macrofauna communities are well documented, little is known about their impact on other benthic organisms. An *in situ* experimental study was designed to estimate the impacts of artificial annelids tubes on benthic microbial abundances, extracellular polymeric substances (EPS) production as well as on sediment

stability, for natural sandy sediments. Benthic chambers with different densities of artificial tubes were positioned at the sediment surface and monitored for two months. Results showed that biofilms differ significantly between the treatments (no tubes, low and high tube densities). Biofilm development, in terms of microbial abundances and EPS concentrations, is more substantial when tubes are present, and the sediment is more stable at highest tube density. Thus, microbial communities associated to tube-building organisms could be considered as ecosystem engineers, in that their presence strengthened the overall sediment stability. The cohesive strength induced by the microbial activity was however strongly dependent upon the density of artificial worm tubes. We highlighted here what could be called a “cascading engineering effect”.

(Poster 84) Larval fish associated with varying reef habitat types and the shallow nearshore of the proposed Addo Elephant National Park Marine Protected Area, Algoa Bay

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The survival of the larval fish stage and the completion thereof determines the success of any adult fish population. There is however, a general lack of knowledge of the early developmental stages of many commercial and recreationally important fish species that occur within Algoa Bay. Furthermore, there is almost no early development information available for species which contribute significantly to the biodiversity in Algoa Bay. Composition, abundance and distribution of larval and juvenile fish assemblages were investigated within Algoa Bay across various habitat types. Research focuses on larvae associated with different reef habitat types, and spatial distribution within the shallow nearshore. A mixed-method approach using submerged light traps and towed plankton ring nets have been used. Sixty-nine larvae and early juvenile fishes were captured in light traps placed over selected reef habitats, with catches dominated by the Family Engraulidae (Anchovies) and the greatest catch rate recorded near Bird Island on low-profile reef. A total of 1190 larvae were captured over the selected reef habitats within Algoa Bay using a plankton ring net with preflexion larvae dominating catches. The Gobiidae (Gobies) dominated catches at the St Croix Island reef stations while the Tripterygiidae and Blenniidae fish family dominated catches at the Bird Island reef stations. Greatest mean larval density was recorded near St Croix Island on high-profile reef (134 larvae/100m³). In the nearshore habitat, along the 30m depth contour spanning the

length of the Bay, 692 larval fishes were captured using a plankton ring net, with the Family Cynoglossidae (Tonguefishes) dominating this habitat. Larval fish density varied spatially across the bay with the highest mean density recorded in the far western sector of the Bay (466 larvae/100m³) and the lowest mean density recorded in the eastern sector of the Bay (26 larvae/100m³). Differential larval fish communities are associated with various habitat types in Algoa Bay. Furthermore, links between offshore spawning and coastal nurseries can be determined with the proposed MPA serving as a nursery area for several important commercial and recreational fish species.

Conservation concerns for the South African Inshore Bryde's Whale

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Unlike the other migratory whale species encountered off South Africa; the distribution of the inshore form of Bryde's whale is restricted to the Agulhas Bank region of South African coastal waters where it has been recorded as subsisting almost entirely on pelagic fish. Photographs, sightings data and biopsy samples were collected in Plettenberg Bay between October 2005 and July 2008. Additional genetic material was obtained from the Iziko South African Museum, Marine and Coastal Management, and the Port Elizabeth Museum. Mark-recapture methods applied to photo-identification data were used to estimate abundance. Estimates obtained using multi-sample open and closed models ranged from 130 to 250 (CV = 0.07 - 0.38). This compares to a range-wide sightings estimate of 582 ± 184 animals in 1983. Seasonal increases in the encounter rate and number of individual whales were observed during summer and autumn, with a peak in April, which corresponded to increased feeding activity and larger average aggregation sizes. Chlorophyll-a, sea surface temperature and wind speed were all significant factors in explaining the variability in the occurrence of whales. No seasonality in the occurrence of calves was detected. Mitochondrial DNA control region sequences (685bp) of 26 specimens were compared to published sequences of the two nominal Bryde's whale species, *Balaenoptera brydei* and *B. edeni*, as well as the sei whale *B. borealis* and Omura's whale *B. omurai*. The inshore form was separated from other Bryde's whale populations at higher than the population level and appears to be a subspecies of the South African offshore form, *Balaenoptera brydei*. Phylogenetic analyses support complete separation between the two forms. The unique nature of this

genetically isolated population, its low abundance and possible competition for prey with the pelagic fishery, highlight the importance of further research to ensure its conservation.

Lost in transit: a mismatch of onshore transport mechanisms limits larval delivery of intertidal invertebrates

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Although settlement time series of intertidal invertebrates have been broadly used to infer how various oceanographic processes deliver planktonic larvae to coastal adult habitats, the cross-shelf extent and interactions among these processes have received little attention. To address the extent to which the pelagic larval pool is coupled with intertidal settlement, we recorded mussel and barnacle settlement in their intertidal adult habitat and on inner-shelf moorings up to 1400 m from shore, at two sites with contrasting topography - a headland forming an upwelling centre and a downstream bay. Four proposed transport mechanisms, namely upwelling-relaxation-downwelling, internal tidal motions, diurnal sea breezes and surface waves, were considered individually and in combination to establish the most likely scenario(s) of larval onshore transport. Settlement of both taxa was substantially lower at the headland than in the downstream bay, suggesting that retention facilitates concentration of the larval pool in the bay. Settlement was consistently orders of magnitude lower on the shore than on nearshore moorings, apparently due to depletion of the larval pool in the surf zone, probably caused by a temporal decoupling of a series of onshore transport mechanisms needed to deliver larvae to shore. Mussel larvae were transported to the nearshore during upwelling in the bay, but during downwelling at the headland, and delivered to the shore by surface waves. In contrast, barnacle larvae were transported onshore when relaxation or downwelling events coincided with spring tides. Thus, sequential mechanisms appear to be utilised by larvae to get to the shore, involving interactions of large-scale and small-scale processes, which may differ among taxa and among sites with different topography. However, for both taxa and at both sites, a bottleneck in the supply of larvae to the shore existed due to losses while crossing the surf zone.

(Poster 85) Using school descriptors to aid species identification during hydroacoustic surveys

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Hydroacoustic surveys have been used extensively in stock assessment of small pelagic fish species off the South African continental shelf. This technology does, however, not as yet have the ability to distinguish between echoes of co-occurring fish species of a similar size. Furthermore, changes in the aggregation patterns of fish over time may also affect schooling characteristics. This potentially influences the accuracy of acoustic estimates of fish biomass through incorrect partitioning of backscattered energy between species. A Discriminant Function Analysis (DFA) trained on data collected during 1997-1999 to discriminate between echoes of anchovy (*Engraulis capensis*), sardine (*Sardinops sagax*), and round herring (*Etrumeus whitehead*) was tested on survey data collected between 2000 and 2001 during adult spawner biomass surveys. Preliminary results indicate that the overall correct classification was only 57.8% (71.9% for anchovy, 60.3% round herring, 41.2% sardine) for both years combined. Furthermore, many anchovy schools were incorrectly classified as sardine schools. These results suggest that previous DFAs cannot be used to classify schools from more recent surveys, particularly in situations where substantial changes in the biomass and distribution of species have been observed. These results emphasize the need for frequent trawl identification and the need for experienced acoustic operators to minimize bias caused by incorrect species identification.

Industrial fishing, no-take zones and endangered penguins

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Industrial fishing can profoundly alter marine environments, and no-take zones are an important tool to achieve sustainable fishing and re-establish ecosystem integrity. However, the potential benefits for vagile species such as top predators are still questioned. The numbers of endangered African penguins *Spheniscus demersus* have halved since 2004. They depend on small pelagic fish, also targeted by a purse-

seine industry. We studied penguin foraging behaviour and breeding output at two colonies supporting 60% of the global population in relation to fishing activity by purse-seine vessels. In 2008, both sites were open to fishing, but in 2009 and 2010 waters within 20 km of the world's largest colony were closed to fishing, while waters around the neighbouring colony, 50 km away, remained open. Birds' foraging effort increased with the size of catches around the colony and decreased with the implementation of a reserve. Total fishing catches in the bay remained constant, but shifted toward the boundaries of the reserve in 2010. Mass of adult penguins and chick growth rates from both colonies decreased over time, suggesting deteriorating environmental conditions. The no-take zone reduced the effect of fishing, but the 20 km-closure was too small to offset intensified fishing pressure at the reserve boundaries ("fishing the line") in 2010. Optimizing the benefits of marine reserves requires complementary fishery management measures, such as buffer zones around reserves. The collapse of Africa's only breeding penguin species adds urgency to the wider implementation of such measures, which are likely to also benefit other predators.

(Poster 86) Limiting predation by gulls on penguins: artificial burrows versus culling

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The African penguin (*Spheniscus demersus*) is endangered, with their population *ca* 3% of that in the early 20th century. Reduction of suitable nesting habitat, through former guano exploitation, forces penguins to often breed in open nests, where they are vulnerable to over-heating and to predation by kelp gulls *Larus dominicanus*. Global changes increase the frequency of extreme climatic events and kelp gulls can present a serious threat for some seabirds. Artificial burrows for penguins could reduce gull predation and protect breeding birds from extreme weather. On the other hand, reducing gull numbers can aid the recovery of seabirds, although great care should be taken in such management decisions. Here, I compared (1) behavioural observations of predation by gulls on penguins, (2) daily counts of predated penguin eggs and chicks, (3) breeding output of penguins breeding in artificial burrows and open nests, before (in 2009) and after (in 2010) the culling of gulls on Bird Island, Nelson Mandela Bay.

In 2010, predation by gulls on penguin eggs and chicks decreased dramatically, while penguin breeding success in open nests increased threefold. Hatching success in artificial burrows was consistently lower than in open nests, but fledging success before culling was higher, resulting in similar breeding successes.

Removing problematic gulls can efficiently increase African penguin breeding output in the short-term. However, new gulls keep arriving at seabird colonies in search of food. Artificial burrows probably could increase penguins' production more sustainably, if their design is improved to increase ventilation and thus avoid too high temperatures that prevent eggs from hatching.

(Poster 87) Investigating the age at which it would be most effective to cull slow-growing and shell damaged abalone, *Haliotis midae* (Linnaeus, 1758)

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The production efficiency of abalone farms could be improved if inherently slow growing or damaged abalone *Haliotis midae* were replaced with faster growing animals. The aim was to determine if shell damaged abalone had reduced growth rates and if it is possible to predict growth based on past growth rates. Abalone growth between 0-302 days could not be used to accurately predict future growth, using regression analysis ($P > 0.05$); while weight gain per month between 302-415 days was used to predict future growth rates ($R^2 = 0.492$; $P = 0.0001$). However, when abalone were grouped as either slow (< 0.1 g/month), intermediate (0.10 - 0.18 g/month) or fast growing (> 0.18 g/month) at 302 days, the growth rates between these groups remained significantly different after 415 and 544 days, with the fast growers gaining significantly more weight than the slow and intermediate growers (Repeated measures ANOVA; $P = 0.01$). Under normal farm conditions, abalone with damaged or deformed shells grew significantly slower than undamaged abalone, at 0.49 ± 0.08 and 0.81 ± 0.05 g/month, respectively (ANOVA; $P = 0.0001$). There was no significant difference in growth between abalone with induced shell and/or mantle damage and undamaged animals (ANOVA; $P > 0.05$), possibly due to low level of damage induced. In conclusion, weight gain data over the first 302 days of production can be used to accurately predict the future growth of abalone. These data could be used to determine the extent of the benefits to be gained by culling slow growing abalone on an economic timescale on commercial farms.

Ecosystem change in Langebaan Lagoon (1960-2009): role of seagrass loss and anthropogenic disturbance

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Structurally complex habitats such as seagrass meadows play important roles in structuring marine systems, but are declining worldwide due to human activities. The consequences of these declines are poorly documented, primarily due to the scarcity of historical data. In this paper, we report on the loss of seagrass meadows in Langebaan Lagoon since 1960, and some of the community and ecosystem level consequences. Aerial photography and GIS revealed a 38% loss of seagrass meadows at selected sites in the lagoon between 1960 and 2007, leading to major shifts in invertebrate communities at severely affected sites. Abundance and species richness of invertebrates declined significantly following losses of seagrass meadows, and seagrass-associated species such as the limpets *Siphonaria compressa* and *Fissurella mutabilis*, and the starfish *Parvulastra exigua*, declined almost to extinction locally. Generalists such as the gastropod *Assiminea globulus* also declined in abundance. However, sandflat species, particularly burrowers, increased in abundance and vertical range. Wading birds were also affected by changes in seagrass cover. The terek sandpiper, which depends on *Z. capensis* for feeding, showed three local population crashes, each corresponding to periods of seagrass collapse. The loss of seagrasses in the system, together with anthropogenic disturbance such as bait harvesting and trampling, had severe impacts on invertebrates, the most significant being the virtual extinction locally of the critically endangered limpet *S. compressa*. Cascading effects on wading birds, possibly through changes in availability of invertebrate prey, were also evident. The study identifies important mechanisms by which marine ecosystems are altered following losses of structurally complex habitats.

(Poster 88) Trophic pathways: foodweb interactions in a demersal ecosystem vs. gut content analysis of medium trophic levels

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Historically, management has focused on economically important species, usually associated with the fishing or tourism industry. An analysis of fisheries and/or

their resources needs to be taken into account in the broader marine context. But, even in a stable ecosystem with a consistent species composition, a predator-prey system could not be adequately managed by managing one species. The management of such a system therefore has to be holistic, taking into account the various natural and environmental factors together with social and economic needs. The problem is turning these principles and concepts into operational objectives. From an ecological stance, this translates into acknowledging, understanding and quantifying the interactions between the different components within marine ecosystems. One of these connections is complex interacting food webs. This study focuses on the trophic pathways on the west and south coasts of South Africa to determine the diets, trophic position and feeding areas of marine organisms. The technique of stable isotope analysis (SIA) is used and may be coupled with gut content analysis to corroborate the former methodology. Samples of particulate organic matter, zooplankton, other invertebrates and fish species were collected to determine the trophic pathway within the demersal fishery. This data was then compared to the gut contents found within the fish species to determine if the traditional method of gut content analysis confirms the patterns seen using stable isotope analysis.

(Poster 89) Learners (Grade 9 & 10) attitudes and knowledge of the ocean, the role of the ocean in global change and the effects of global change on the ocean in South Africa

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United Nations (UN, 2005) state that “education in addition to being a human right, is a prerequisite for achieving sustainable development and an essential tool for good governance, informed decision-making and the promotion of democracy. Therefore, education for sustainable development strengthens the capacity of individuals to make judgments and choices in favour of sustainable development” (in Zografakis *et al.*, 2008). However, global change education in South Africa, and in particular the role that the oceans play along with the effects on the marine ecosystems, has been acknowledged but not viewed as very urgent and therefore not adequately addressed. This may be due to other imperatives (job creation, poverty alleviation, environmental security, i.e. housing, food security and the AIDS pandemic) taking precedence when juxtaposed against global change. Another plausible explanation for the lethargy in driving global change education may be because what has been communicated thus far has been fragmented, vague and

biased and hence not readily accepted. This could stem from the fact that the debate around global change and its effects are controversial, amorphous in nature, evolving and lacks scientific consensus. Hence the translation and communication of global change science into global change education has been slow, uncertain and plagued with misconceptions. A classic example of a misconception is when learners at the annual Grahamstown Science festival are asked, “What is global warming?” Their response is that it is the “hole in the ozone layer” that is causing the average temperatures to increase - hence global warming. Another example is “What will be effect of global change be on the oceans?” Their response is very often – “not much, the sea will just absorb the coolness from the melting ice and the marine life will not be affected”. Clearly then the current global change education being passed on to learners is inaccurate, inadequate and thus would have no result in terms of awareness let alone behaviour changes. This study aims to assess the knowledge and attitude of learners (Grades 9-11) on the marine environments, global change and how these two factors interact and react and identify the gaps in the current school curriculum. Then the study will consolidate scientifically sound information on global change and the marine ecosystems and make recommendations for the inclusion into the South African natural sciences school curriculum and the teaching syllabus.

Seasonal hypoxia and episodic anoxia on the southern Namaqua shelf of the Benguela upwelling system

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The expansion of hypoxia and anoxia represent major perturbations to the diversity, structure and functioning of marine ecosystems. It is recognised that dissolved oxygen is a property of the ocean that has changed dramatically during recent decades, with oxygen deficiencies having increased in frequency, duration and severity. Anthropogenic influences such as eutrophication are considered important causal factors for this increase, and warming associated with climate change is likely to further intensify shelf hypoxia and anoxia. Of the world’s four major eastern boundary current systems, low oxygen waters are best known in the Humbolt and Benguela, although declining oxygen concentrations have recently been reported in the California current system. This study reports on the scales of variability of dissolved oxygen in the nearshore region of the southern Namaqua shelf. A high resolution time series of bottom water oxygen exhibited pronounced variation with nearshore hypoxia driven by the upwelling of oxygen depleted waters

onto the shelf, while bottom water oxygenation episodes were observed in association with downwelling events and winter mixing. These remotely forced advection events ensure a close coupling of dissolved oxygen concentration and water temperature. However, decoupling of the oxygen-temperature relationship is observed during episodic events of anoxia, attributable to local oxygen depletion triggered by the decay of high biomass dinoflagellate blooms. Decay is advanced through the inaccessibility of subthermocline nutrients during downwelling and oxygen consumption is sufficient to cause anoxia throughout the water column. The challenge of monitoring and predicting these events of anoxia is exacerbated by their episodic and localized character.

Associations in ephemeral systems: do close links between sandhoppers and beach wrack reflect trophic relationships?

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In ephemeral systems, material subsidies can play a key role in the persistence and connectivity of populations, especially if the organisms living within them are trophically dependant on imported resources. Sandy beaches are heavily subsidized by organic material of both terrestrial and marine origin. For highly mobile supratidal fringe species such as amphipods, such material potentially provides both food and shelter. We investigated the relationship between beach wrack and amphipods by examining the trophic contribution of allochthonous food sources to sandhopper diets using stable isotope analysis. Replicate samples of the sandhopper *Talorchestia capensis* and several types of beach wrack (including seagrass, wood and different macrophytes) colonized by these amphipods were collected from 11 sites within one biogeographical region along the south coast of South Africa. Analysis of variance showed that the $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ signatures of sandhoppers were significantly affected by the type of wrack with which they were associated, but stable isotope mixing models showed that there was no close relationship between *T. capensis* diet and the material under which they were found. Thus amphipod isotope signatures differed with wrack type, but were not clearly derived from wrack, which is likely an indication that amphipod feeding is extremely opportunistic. Different amphipod populations may also be feeding at different trophic levels (based on $\delta^{15}\text{N}$ signatures), and obtaining their $\delta^{13}\text{C}$ signatures either from material associated with specific wrack types (rather than directly from the wrack itself) or from imported suspended particulate material. These results suggest alternative links in sandy beach food webs, with amphipods obtaining

their carbon indirectly from wrack via bacterial communities that are specific to different types of imported material, and opens up new avenues for trophic exploration in sandy beach communities.

Spatial patterns of distribution of mussel larvae along the western Agulhas Bank

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The spatial distribution of mussel larvae (*Perna perna* and *Mytilus galloprovincialis*) was investigated in the nearshore shelf region of the southern Agulhas Current during the 2010 ACEP Agulhas Bank cruise. Sampling was scheduled around 123 stations along 15 onshore-offshore transects in the Western region of the Bank in order to determine the general onshore-offshore patterns, vertical distribution and nearshore densities of mussel larvae in relation to coastal topography. Sampling was done using a submersible plankton pump for 10 minutes at three depths at each selected station: surface, below thermocline and bottom (or closest to bottom as possible). Preliminary results suggest that larval distribution is mainly confined to the very nearshore coastal environment and, within the inshore stations, most larvae occur in the upper layer of the water column. These results are relevant to the understanding of the hydrodynamics and the transport of pelagic invertebrate larvae to benthic settlement sites. Mussel larvae have often been described as acting like passive particles in the water column. Further analysis of the physical characteristics of the area sampled and correlations with these biological data will clarify the degree of dependence of mussel larvae on ocean hydrodynamics during the dispersive phase and help to explain the retention of larvae within nearshore waters.

Trophic role of riverine particulate organic matter for inshore filter-feeder communities in the Natal Bioregion

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In the Natal Bioregion, biomass of shallow subtidal filter-feeders is particularly high relative to bioregions to the north, and makes a central contribution to distinguishing these bioregions. This study focuses on the trophic role of riverine suspended particulate organic matter (POM) and the extent to which

subsidies from rivers may explain the high filter-feeder biomass in the Natal Bioregion. The isotopic composition of inshore POM available to filter-feeders was determined, and stable isotope analyses conducted for four filter-feeder species, three possible end-member food sources and inshore POM (of mixed-source origin) for sites lying various distances from four river mouths. Using carbon, nitrogen and sulphur isotopes, and a 3-end-member Bayesian-mixing model, the proportions of various primary producers comprising the inshore POM pool and the relative amounts of seaweed, pelagic POM and river POM assimilated by filter-feeder communities at various distances from four river mouths. Depending on season and study area, riverine-derived POM contributed 17-62% of the inshore POM pool, 18-77% was derived from pelagic POM and 6-53% from seaweed. Analysis of covariance showed that the contribution of river POM to inshore POM was significantly related to distance from river mouth, but was not related to river size. Most material assimilated by the filter-feeders was of marine origin, especially seaweed detritus (39-62%); but a noteworthy amount of riverine-derived POM ranging from 9 to 33% was also assimilated. Minimal seasonal differences (<10%) and biologically insignificant spatial trends in the proportions of the three food sources assimilated by filter-feeders were detected, possibly due to slow tissue equilibrium rates and constraints on digestive physiology. It was concluded that although important, river POM is likely to play a subordinate role to other factors such as turbidity and productivity in explaining the high biomass of filter-feeders in the Natal Bioregion.

What climate-induced changes can we expect for coastal fishery species?

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With strong scientific agreement that coastal ecosystems are under threat from global climate change; the prediction of the impacts is key to successful mitigation and adaptation. The coastal zone is expected to be impacted by a range of changes, many of which can have direct and indirect effects on fishes. Here, examples from recent research on a migratory and resident fish species on the west coast of southern Africa are used to discuss some of the impacts caused by warming coastal temperatures. With a 0.8°C increase in temperature for the last three decades, southern Angola's coastal zone provides an ideal opportunity to conduct climate change research. The

west coast dusky kob (*Argyrosomus coronus*) is a migratory fish species with a known distribution from central Namibia to northern Angola. In Namibia, it overlaps with the congeneric, morphologically similar *Argyrosomus inodorus*. The movement of adult *A. coronus* appears to be correlated to sea temperature, with individuals avoiding water warmer than 20°C, thereby making it an ideal candidate to study climate-induced changes. Molecular and catch rate information on this species indicated a southerly distributional shift to cooler waters. This change is predicted for other migratory fish species in areas of warming throughout southern Africa. The blacktail (*Diplodus capensis*), on the other hand, is a resident reef species distributed between northern KwaZulu-Natal and northern Angola. A biological study in southern Angola showed that reduced water temperature (<19°C) was a proximate cue for reproduction and suggests that reproduction may be unsuccessful for this and possibly other species in areas of warming. Other potential changes to migratory and resident species are discussed.

(Poster 90) Copepod biomass distribution over a wet and dry season in the KwaZulu-Natal Bight

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Zooplankton form one of the most important components in the food web through the transfer of energy to higher trophic levels. Past research has focused mainly on zooplankton on the West and South Coasts of South Africa, due to their prominence in the diet of commercially important fish species in this region, but little is known about the zooplankton communities of the East Coast. The aim of this study is to improve our understanding of the role of zooplankton in ecosystem functioning of the KwaZulu-Natal (KZN) Bight, with reference to three focus areas of high productivity, namely the St Lucia upwelling cell, the Durban lee eddy and the Thukela plume. The project focuses on copepods, and addresses the following questions 1.) How do the physical processes shape observed patterns of copepod abundance, distribution and community structure in the KZN Bight? 2.) How do copepod vertical migration and grazing contribute to particle flux and vertical transfer of nutrients within the KZN Bight? Vertical bongo nets and a Multi-net (both 200µm-mesh) were used to collect zooplankton samples on two cruises during contrasting wet (Jan-Feb 2010) and dry seasons (July-Aug 2010). Bongo samples were split for dry weight measurements and species identification under a stereo microscope. Multi-net samples collected day and night during 48-hr stations in the focus areas were used to investigate the vertical migratory behaviour of the zooplankton communities. A drift net was used to

collect copepods every 4 hours at the focus sites to measure gut pigment content to assess diel feeding by copepods. Biomass during the wet season was greatest near Durban (40 mg dry weight.m⁻³) while during the dry season highest biomass was recorded near St. Lucia (120 mg dry weight.m⁻³). Both these sites are upwelling areas, where nutrient enriched waters are brought to the surface, encouraging the growth of phytoplankton and providing food for copepod communities. During the wet season zooplankton biomass showed a diel signal in the deeper waters found off Durban, while in the shallower focus sites biomass was relatively constant over time. Gut pigment content indicated that copepods were feeding in the evening.

Making a difference - working with and influencing fisheries management

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The Fisheries Branch of the Department of Agriculture, Forestry and Fisheries has the national responsibility for fisheries management in South Africa. Many scientists from other institutions also wish to become involved in issues around fisheries management with the hope of influencing management. The past two phases of the Sea & Coast and SeaChange programmes of SANCOR, collectively spanning some 15 years of marine science, have attempted to create a focus on management-directed research. However, the reality is that to date this has not had the expected impacts.

The shortfall between expectation and reality has been created by a number of challenges, both on the part of the national fisheries management authority, and on the part of scientists outside of this system. The presentation will highlight some of these challenges and explore ways in which research outside of the national fisheries authority can make a more meaningful contribution to fisheries management. To this end the presentation will give insights into the functioning of the fisheries management system and what mechanisms are available to make contributions, what types of approaches are available and effective, what types of research information are required for fisheries management, and ways in which researchers from other institutions can support and influence fisheries management.

Growth rate and population dynamics of the mangrove species at Mngazana Estuary - towards sustainable harvesting limits

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Mangrove growth rates were determined at Mngazana Estuary in the Eastern Cape, the third largest mangrove forest in South Africa. The growth rate (in terms of height) of *Avicennia marina* individuals increased from seedlings (0.31 cm.month⁻¹) to adults (1.2 cm.month⁻¹), while the growth of *Bruguiera gymnorhiza* stabilised from a height of 150 cm at 0.65 cm. month⁻¹. The growth of *Rhizophora mucronata* peaked at 0.72 cm.month⁻¹ (height 151-250 cm) and then decreased to 0.4 cm.month⁻¹ for taller individuals. Increases in DBH ranged between 0.7 and 2.3 mm.month⁻¹ for all species. Selective harvesting of particular size classes of *Rhizophora mucronata* was recorded when comparing length of harvested poles (~301 cm) and size class distribution of individuals. Taking into account the differences in growth rate for each size class for this species it will take approximately 13 years to attain a height of 390 cm which is the height at which trees are selected for harvesting at this estuary. This is 2.6 times slower than those individuals growing in Kenya. The feasibility of harvesting is dependent on the growth rate of younger size classes to replace harvested trees as well as the rate of natural recruitment feeding into the population. Results from harvesting intensity scenarios within a matrix model framework showed that limits should be set between 5 and 10% per year to maintain seedling densities at >5 000.ha⁻¹ for *Rhizophora mucronata*. Harvesting of *Bruguiera* should be restricted due to the low density of this species at Mngazana Estuary. Harvesting of the tallest trees of *Avicennia* could be maintained at levels less than 10% per year. Overall results from this study show that the harvesting of mangroves at the Mngazana mangrove forest is not sustainable. The number of trees that may be harvested is too low to meet the demand of poles by the communities that use them.

(Poster 91) Management of mangrove forests in South Africa

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A historical assessment of all mangroves forests in South Africa has revealed the potential threats to mangroves in South Africa. Mangroves were completely lost from eleven estuaries in KZN between 1982 and 1999 and a further two estuaries by 2006. Mangroves only occurred in those estuaries where the mouth was open for more than 56% of the time with the exception of St Lucia, where the mangrove communities have persisted because the roots were not submerged. A survey in 2006 indicated that most of the existing mangrove forests in KZN were regenerating in terms of population structure as they had reverse J-shaped population curves as well as high

adult: seedling ratios. Kosi Bay and Mhlathuze Estuary were two of the larger forests that showed signs of harvesting (presence of tree or branch stumps). The greatest threat to smaller estuaries seems to be altered freshwater inflow patterns due to freshwater abstraction in the catchments coupled with salinity changes, prolonged closed-mouth conditions and subsequent long term flooding of mangroves and the change of land use from estuarine vegetation to sugar-cane plantations. These threats affect the hydrology of estuaries and the sediment characteristics (particle size, redox potential, pH, salinity, temperature) of the mangrove forests. Effective management of mangrove forests in South African is important to maintain the current state, function and diversity of these ecosystems and management recommendations begin with determining the freshwater requirements of the estuaries to maintain the mouth dynamics and biotic communities and to end the harvesting of adult trees particularly those species that do not coppice. Effective management is needed to ensure that forests are cleared of pollutants (plastic and industrial), and any further developments near the mangroves should be minimised.

(Poster 92) Biochemical Composition of *Hypnea spicifera* in Relation to Shore Position

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Hypnea spicifera is commonly distributed along sub-tidal and infra-tidal zones. The intertidal area is highly variable and are subject to alternating periods of air exposure and submersion depending on the tides. Within the intertidal area macroalgae are found at varying elevations (vertical shore positions), along a gradient of stress across the shore. The aim of this study was to determine whether shore position has an effect on the biochemical composition, yield and selected rheological properties of carrageenan from *H. spicifera*. The biochemical compounds analysed were nitrogen, phosphorus, protein, carbohydrates, the major pigments (chlorophyll-*a*, *r*-phycoerythrin and *r*-phycocyanin) and carrageenan. The concentration range of analytes found in *H. spicifera* were comparable to other studies on phycocolloid containing algae. Chlorophyll-*a*, *r*-phycoerythrin and *r*-phycocyanin content ranged from 0.0138 - 0.0758 (g/g); 0.0010 - 0.0912 (mg/g) and 0 - 0.0076 (mg/g) respectively. Nitrogen, phosphorus, protein and carbohydrates content (%) ranged from 1.02 - 1.91; 0.0620 to 0.8600; 2.7225 - 68.0810 and 2.2491 - 30.7935 respectively. There was a general trend for nitrogen, phosphorus and protein to have higher concentrations at lower elevations. There was also a

correlation between the protein, nitrogen, phosphorus and *r*-phycoerythrin content. There was no difference between the biochemical composition of *H. spicifera* collected from emersed and submerged localities. The constant supply of nutrients at lower elevations may account for the higher concentration of structural material and the lower *r*-phycoerythrin content may be a result of the quality of light received in these localities.

Fat and Fecund: Total lipid content in reproductively successful southern right whales (*Eubalaena australis*)

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Evidence for the relationship between body-fat condition and reproductive performance in large whales has been provided by Lockyer (1986; 1987). It was an objective of this study to determine the total lipid content of blubber from free-swimming southern right whales, something that has not previously been achieved. This information would hopefully set the baseline for comparisons between this species that is exhibiting maximum population growth rates and the North Atlantic right whale whose reproduction has been erratic. According to the analyses done by Heyerdahl (1932, in Slijper, 1948) and Feltmann, Slijper & Vervoort (1948) in other mysticetes, the percentage of lipid was related to blubber thickness. In order to collect representative samples from members of the Balaenidae, a system for deep-core sampling was developed (Reeb & Best, 2006). Twelve samples from dorso-lateral areas of cows and calves were collected in South African coastal waters in November (about three months after parturition) and analysed with gas chromatography following Association of Official Analytical Chemists (1984) methodology and procedures. The average total fatty acid content for calves (n = 5; average sample length = 8.9 cm) was 41.2 % (SE ± 2.83) and for cows (n = 7; average sample length = 17.8 cm) was 42.9 % (SE ± 1.36); the differences were not significant (p > 0.05). Total lipid values between 14 and 85% have been obtained in bowhead whale tissue (G. Ylitalo, pers. comm.), which bracket the values obtained here for southern right whales. Linear regressions revealed no correlation between length of sample and total fatty acid content for both cows and calves (cows: p = 0.773; calves: p = 0.689). Acknowledging the small sample size, this suggests that the sampling technique used was successful in obtaining representative cores of blubber for total lipid analysis.

(Poster 93) Parasites as biological tags for South African sardine

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South African sardine, *Sardinops sagax* (Jenyns, 1842), were collected from several localities off the coast of South Africa and examined for parasites. The aim was to identify suitable parasitic species that can be used as biological tags. The use of parasites as biological tags for marine fish stock discrimination has been successfully implemented in many parts of the world but has never been attempted in South Africa. To date 107 fish have been examined from six localities, ranging from south of Cape Columbine on the west coast to east of Algoa Bay on the east coast. Initial results show the regular occurrence of at least five different parasitic species. A digenean metacercaria of the “tetracotyle” type was found infecting the eyes of 41% of all fish, a coccidian protozoan, *Eimeria sardinae* (Thélohan, 1890) Reichenow, 1921, was found infecting the testes of 17% of all fish and a myxozoan, *Kudoa thyrstites* (Gilchrist, 1924), was found infecting muscle tissue of 17% of all fish. A parasitic copepod, *Clavellisa cf. ilishae* (Pillai, 1962), was found attached to the gill rakers of 7% of fish examined and an unidentified, possibly new species of parasitic copepod of the genus *Nothobomolochus* Vervoort, 1962 was found infecting the gills of 8% of fish. Initial indications are that the “tetracotyle” digenean holds the most potential to act as a biological tag.

Population genetic structure of the hottentot seabream *Pachymetopon blochii* (Valenciennes, 1830) along the coast of South Africa based on newly developed microsatellite markers

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The hottentot seabream (*Pachymetopon blochii*) is an endemic sparid occurring along the west coast of southern Africa, found mainly in kelp beds and rocky outcrops. This species is considered vulnerable due to its slow growth and restricted movement. The hottentot is a serial spawner with increased spawning in late autumn and summer. This species has pelagic larvae and the juveniles are found in the same habitats as the

adults. There are two hypotheses in this study, the first being that the eggs and larvae remain in the habitats where the adults are found and this would lead to less gene flow between geographically separated habitats. Alternatively the eggs and larvae could be transported by the inshore currents which would lead to a single population identified along the west coast. The main aim of our study was to investigate the spatial and temporal genetic variation of the species along the South African west coast. Microsatellite markers were developed from the hottentot genome using an enrichment protocol and high-throughput DNA sequencing. Thirteen highly polymorphic loci were developed from these sequences and through cross amplification with other sparid primers. These loci were genotyped for 288 individuals across nine locations sampled in 2001 and in 192 samples from six locations in 2009. Individual based statistical analyses suggested the presence of one population or stock along the coast and we estimated the effective population size to be relatively small ~ 9989 individuals. Weak spatial structure was identified between the sampling locations from 2009 using Factorial Correspondence Analysis (FCA) and an Analysis of Molecular Variance (AMOVA). Between the 2001 sampling locations no significant spatial structure was identified. In conclusion one population is identified along the coast with weak spatial and temporal variation between years.

(Poster 94) Aspects of the life-history of blacktail (*Diplodus capensis*) and the management needs of this species in southern Angola

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The blacktail (*Diplodus capensis*) is a member of the family Sparidae and is distributed from Mozambique to southern Angola. It is an important component of many coastal fisheries, none more so than the southern Angolan subsistence fishery. With its importance in the local fisheries, a biological study was conducted to provide information for the management of this species. Samples of blacktail were collected monthly from an unexploited area from April 2008 - March 2009. Additional biological samples were collected from an exploited area during May, June and December 2009. Standard laboratory techniques were employed for a life-history comparison between the two areas. Results show that blacktail is a rudimentary hermaphrodite in Angola with peak spawning in June and July. The overall sex ratio (M:F) was 1:4.7 and 50% maturity was attained at 149.5mm FL and 5 years. Blacktail in Angola exhibit very slow growth and high longevity with a maximum observed age of 31 years.

Females dominated the larger size classes and older age classes and growth differed significantly between males and females. In the exploited area, the length and age frequencies were severely truncated and the sex ratio was less female biased at 1:2.2. There was an increase in the proportion of small females in the exploited area, which may be a response to the selective removal of large female fish. Blacktail displays life-history characteristics that render it susceptible to overexploitation, even at low levels of fishing pressure, as was shown by the exploited area comparison in this study. The current lack of enforcement capacity renders traditional linefish regulatory tools such as size and bag limits and closed seasons inappropriate. Suitably designed marine protected areas are therefore recommended as the best management option for this species in the area.

Fatty acid ecology in aquatic ecosystems: potential for development in South Africa

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The use of lipids to study aquatic ecology is a relatively new practice in South Africa, and the first fully equipped GC/MS laboratory dedicated towards addressing questions of fatty acid ecology has been newly established at Rhodes University in the Zoology & Entomology Department. Up until now, samples were processed outside of the country, in makeshift laboratories, or in facilities dedicated to other fields of study (e.g. pharmaceutical labs, etc.) that lacked personnel trained specifically in lipid protocols. This new facility provides South African researchers with a fresh platform to contribute to ecological research utilising lipid techniques. Thus far, fatty acids have been used to examine detritus-based food webs in South African estuaries, contributions of oceanic and freshwater sources to rocky shore communities, variations in seabird diet and food webs in the Southern Ocean, and ontogenetic changes in the diets of fish in the Benguela ecosystem. New efforts are currently being explored to study the subtidal realm in both marine protected and exploited regions around the South African coastline, and the potential for expanding our research into additional marine and freshwater ecosystems is substantial and highly dependant on the interests of new collaborators. In this seminar, I will explore the current status of fatty acid ecology in South Africa and its potential for future development.

(Poster 95) Gonad development and growth in farmed South African abalone *Haliotis midae*

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The growth rate of farmed South African abalone varies periodically. It is hypothesised that the reduced growth rate is a due to an energetic investment in gonad rather than somatic growth, since the reduced growth is only apparent in sexually mature abalone. The project aims to monitor changes in abalone growth rate and gonad investment throughout the year and to evaluate the effect of dietary energy on abalone gonad development. Preliminary growth rates of 50 - 60 g abalone varied from 1.63 ± 1.40 to 5.66 ± 2.39 g month⁻¹ and 0.86 ± 0.28 to 1.66 ± 0.42 mm month⁻¹, with lowest growth rates in October, the peak spawning period of farmed abalone. The proportion of gonad to body weight varied from 12.62 ± 2.15 % to 14.38 ± 1.99 %. The growth of abalone fed seven diets with a range of protein to energy ratios was compared in a second trial. This trial was started in January 2011 after peak spawning season, and will run for 10 months through the period of maximum gonad size. Environmental data are also being collected to correlate these parameters with abalone growth and gonad size.

Dynamics of macrophytes in the East Kleinemonde, a small temporarily open/closed South African estuary

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The East Kleinemonde Estuary is one of 175 temporarily open/closed estuaries (TOCEs), the major estuary type in South Africa. TOCEs are small (mostly less than 100 ha), shallow systems (average depth < 2 m) that respond quickly to freshwater inflow events and have high variability in abiotic conditions. Macrophytes were assessed monthly over a five year period (March 2006 to January 2010) to determine their responses to abiotic change. Results showed that salinity and water level were the two main drivers influencing the macrophytes. They were able to endure inundation but only for a few months (three months or less) and when habitat was available, they responded quickly reaching 100% cover within a month. Based on the average elevation above sea level position of the macrophyte habitats, a threshold water level of 1.56 m amsl was identified above which there would be a switch from salt marsh to submerged macrophytes. Salinity above 30 ppt resulted in significant macroalgal

growth. From these thresholds four abiotic states were identified for the East Kleinemonde Estuary with characteristic macrophytes. Intertidal salt marsh, reeds and sedges were dominant during the open phase. Submerged macrophytes were dominant during the closed polyhaline state and macroalgae during the closed saline state. During the five year study the estuary occurred predominantly in a closed mouth state. A spatial habitat availability model was also developed to produce empirical relationships between water level and available macrophyte habitat. Both the threshold and spatial model method were used successfully to assess the past, present and future condition of the East Kleinemonde under varying freshwater inflow volumes.

Influence of the Agulhas Current on circulation patterns, hydrological structures and retention of shelf waters in the KZN Bight, South Africa

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The east coast of South Africa is characterised by a narrow continental shelf which is strongly influenced by the swift, warm, southward flowing Agulhas Current. Between Cape St Lucia and Durban the shelf widens to some 70 km, an area referred to as the Natal Bight, which appears to offer refuge from the Agulhas Current. The Natal Bight is purported to play an important role in the life cycle of many east coast species, but apart from several early descriptive studies conducted by the NRIO in the 1970s, little is known about the functioning of the Bight in particular nutrient sources, productivity, circulation and retention - requirements conducive for successful recruitment. This paper focuses on the latter and provides a base for the numerous complimentary ecosystem studies simultaneously undertaken in the recently initiated ACEP II KZN Bight project. New hydrological (CTD) and S-ADCP data collected during ship surveys of the Natal Bight in June 2005, Sept 2007 and the ACEP II cruises in March 2009 and July 2010 is presented. Each S-ADCP data set showed similar circulation characteristics in that the continental slope and outer shelf of the Natal Bight was strongly influenced by the Agulhas Current. This was particularly evident in the extreme north between Cape St Lucia and Richards Bay where the shelf is narrowest and velocities adjacent to the coast exceeded 2 m s^{-1} . The widening of the Bight southwards evidently moved the Agulhas

Current further from the coast and resulted in little direct influence inshore of the 100 m depth contour. The southern region of the Bight was mostly influenced by the Durban cyclonic eddy, and in June 2005 and Sept 2007, by a greater cyclonic swirl which occupied the entire southern half of the Natal Bight - the latter seen clearly in both satellite derived SST and ocean colour data. The satellite imagery showed that the large swirls developed from the Durban eddy (which is driven by the Agulhas Current) and eventually evolved into southward migrating Natal Pulses which removed large volumes of shelf water from the Natal Bight. The S-ADCP data also showed that the Durban eddy and the large swirls advected warm Agulhas Current surface water, very low in nutrients (CTD data), into the Bight in the vicinity of Durban which then flowed northwards along the inner shelf reaching the Thukela River. Satellite-tracked surface drogues deployed in the Durban eddy highlighted this coastal current remarkably well with velocities which exceeded 90 cm s^{-1} at times. Several of the drogues, however, were also removed from the southern Bight in a matter of days indicating poor retention here. The greatest inconsistency between the four S-ADCP datasets was found on the inner shelf between the Thukela River and Richards Bay where currents were weak ($< 20 \text{ cm s}^{-1}$) and variable in direction. This was confirmed by satellite-tracked drogues which travelled alongshore in sympathy with the wind. Retention of these drogues in this area confirmed the lack of influence of the Agulhas Current here, and suggests that this region of the Natal Bight is of biological importance - especially recruitment.

The abundance and biology of langoustines *Metanephrops mozambicus* and pink prawns *Haliporoides triarthrus* captured in deep-water trawls off eastern South Africa

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Commercial trawl fisheries for crustaceans on shallow offshore banks (5-30 m) and in deeper water along the upper continental slope (200-600 m) are of major economic and social importance to several countries in the South West Indian Ocean (SWIO) region. Industrialised deep-water crustacean trawl fisheries are restricted to Mozambique and South Africa at present, however in the past trawling also took place in Madagascar, Tanzania and Kenya. These fisheries target species aggregations consisting of deep-water prawns (several species), langoustines, deep-water spiny lobsters and deep-sea red crabs, and they often catch fish and sharks as a retained or discarded bycatch. The South West Indian Ocean Fisheries

Project (SWIOFP) has identified deep water pink prawn *Haliporoides triarthrus* and langoustine *Metanephrops mozambicus* as priority species for research, as they make up a large proportion of trawl catches and may have the potential to support expanded fisheries in the region. However, information on the abundance, distribution and biology of both species is out-dated, being mainly based on studies done in the 1960s and 1970s. The present study examines historical trends in fishing effort, catches and catch rates recorded on the South African database (1988-date) to establish abundance trends, while biological data from specimens collected quarterly at sea are used to assess trends in size composition, sex ratios, maturity and reproductive seasons at seasonal and spatial scales.

Flow and transport of the East Madagascar Current system

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In 2008 the first full survey of both the southern and northern branches of the East Madagascar Current (EMC) was undertaken under the auspices of the Agulhas Somali Current Large Marine Ecosystem project. The focus of the study was on the flow pattern and transport of the two currents that impact on the biology and other mesoscale oceanic circulation features further afield. A total of 115 hydrographic stations were occupied to resolve the water properties which together with direct velocity measurements were used to quantify the synoptic circulation of the EMC. During the survey period the flow at the southern end of Madagascar was dominated by cyclonic and anti-cyclonic eddies. Two cyclonic eddies were observed along the slope that pushed the southern branch of the EMC a 100 km offshore. At the southern termination of the EMC, indications were that some of the EMC water was transported northwards into the Mozambique Channel whilst another part retroflects and flows eastward. This shallow retroflexion was however part of an anti-cyclonic eddy at the termination of the EMC and no retroflexion comparable to the Agulhas Current was observed. The average geostrophic transport of the EMC at the southern tip of Madagascar was -34 Sv. In contrast to other studies, this survey revealed the southern branch of the EMC to start as far north as 20°S with surface velocities greater than 60 cm s^{-1} . The northern branch of the EMC on the other hand was only a defined current north of 16°S. Between the two branches the strongest velocities were associated with cyclonic and anti-cyclonic eddies. At the northern tip of Madagascar the EMC transported between 19 and 23 Sv which was slightly less than that previously calculated.

(Poster 96) The development of a “least-cost” diet for dusky kob, *Argyrosomus japonicus* (Pisces: Sciaenidae)

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Fish meal and fish oil are used as finfish feed ingredients. With increased pressure on fisheries worldwide, such ingredients are becoming increasingly scarce and more expensive. Therefore it is essential to explore the use of alternative ingredients. The aim of this study was to investigate the use of vegetable oil as an alternative to fish oil in aquafeeds. Six diets (18% lipid and 46% protein, with fish meal and soya as the main protein sources) were formulated with a decrease in the contribution of fish oil and a corresponding increase in vegetable oil at 1, 14, 28, 42, 56 and 70% replacement, and fed to dusky kob *Argyrosomus japonicus* for 84 days. There were significant decreasing trends in specific growth rate ($r^2=0.4$, $p=0.019$) and condition factor ($r^2=0.3$, $p=0.03$) with increasing vegetable oil replacement. Similarly, hepatosomatic index (HSI) increased significantly with an increase in vegetable oil replacement (ANOVA: $F=9.9$, $p=0.0006$; $r^2=0.5$, $p=0.001$), as well as the visceral fat index (VFI) (ANOVA: $F=5.2$, $p=0.009$; $r^2=0.5$, $p=0.0005$). There were no differences in red blood cell counts, haematocrit and haemoglobin concentration among treatments. The increase in HSI and VFI with increasing oil replacement suggests that dusky kob is less able to metabolise soybean oil, which would account for the poorer growth. This hypothesis will be confirmed with proximal analyses and histological examination.

Spatial dynamic of picophytoplankton communities along the continental shelf adjacent to the Northern Agulhas Current

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Picophytoplankton (i.e. cyanobacteria and pico-eukaryotes) are abundant and ecologically critical components of autotrophic communities in the pelagic realm. While the roles of physical forcing related to upwelling, water mass intrusion, nutrient availability, mixing and stratification on microphytoplankton blooms have been widely investigated, these are often overlooked for picophytoplankton, especially in continental shelf waters. This study investigates changes in abundances and community composition of

picophytoplankton along the shelf adjacent to the northern Agulhas Current in relation to nutrient availability, water column stratification and spatially localized oceanographic events such as upwelling. Samples were collected from the shore to the shelf edge, most inside the Agulhas current, along 21 transects from Maputo to Cape St Francis in October 2009. Picophytoplankton populations were identified and quantified using flow cytometry. Samples were characterized by high abundances of *Synechococcus* and the absence of *Prochlorococcus* cells. Distinct populations of *Synechococcus* exhibiting different levels in orange and green fluorescence were discriminated along the Agulhas shelf. Total abundances tend to decrease along the inshore to offshore gradient and different populations were observed in surface and at the deep chlorophyll maximum. This study highlights the importance of physical forcing and localized oceanographic events to the community composition of picophytoplankton that may be critical for the structure of the pelagic food webs along the eastern continental shelf of South Africa.

Macrozoobenthos as indicators of carbon and nitrogen processing and productivity in estuaries

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Macrozoobenthos in estuaries are ideal candidates for tracking ecological conditions such as ecosystem state and health and ecosystem successions, resulting from a range of effects including pollution and flooding. Common to all organisms, macrozoobenthos are highly influenced by environmental conditions and varying influences of inter- and intra-specific relations. In this study, we investigated the ability of macrozoobenthos to contribute to particular estuarine ecosystem services. Firstly, the contribution of these animals in processing estuarine and riverine derived organics is estimated and secondly the role of macrozoobenthos in enhancing estuarine productivity by maintaining high invertebrate biomass and thus providing a food source to predators is presented. For this study, macrozoobenthos abundance, community composition and biomass were measured over a short time-series (weeks), including open and closed mouth conditions, in the Mhlanga Estuary, KwaZulu-Natal, South Africa. The processing capacity for carbon and nitrogen was inferred by scaling consumption ratios for the various organisms to the biomass measurements using literature values. Measured information on biomass and feeding guilds was furthermore used to calculate biomass available for

predators. The processing capacity and productivity so calculated was scaled up for the entire Mhlanga Estuary, and a first rough estimate of the processing capacity of similar, temporarily open/closed KwaZulu-Natal estuaries is made using similar data from other estuaries along the coast.

Perceptions of Co-management theory and practice in small-scale fisheries in South Africa

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Since the late 1990s, co-management has been advocated as an alternative approach to small-scale fisheries management in South Africa. However, successful operation of co-management in the country differs between provinces and between case study sites. In KwaZulu-Natal, co-management arrangements continue to function whereas in the Eastern and Western Cape many projects have collapsed. Findings from the international literature suggest that fostering shared perceptions towards resource management can improve management practices by obtaining greater community support, increase understandings of site-specific conditions and improve conflict resolution amongst stakeholders. This study sought to identify stakeholders' perceptions of co-management theory and practice in four case study sites in South Africa. A further objective focused on ascertaining whether there were differences in perceptions across case studies and exploring factors that could be influencing these perceptions. Information was gathered from a review of the co-management literature relevant to these cases as well from semi-structured interviews with 40 stakeholders.

Findings from this research project illustrate that although there is a common understanding of the term co-management, stakeholders have very different perceptions about other aspects of co-management (such as objectives and benefits). However, findings also show that the perceptions of stakeholders in KwaZulu-Natal towards co-management are more aligned than the perceptions of stakeholders from the Eastern and Western Cape. A key factor that appears to be influencing stakeholders' perceptions of co-management is the type of institutional arrangement in place. In particular, the top-down approach towards co-management in the Eastern and Western Cape has resulted in negative perceptions of co-management as an effective management approach, whereas the devolved institutional approach in KwaZulu-Natal has promoted shared perceptions amongst stakeholders. However, findings also highlight that despite the collapse of co-

management arrangements at two of the identified sites, almost all stakeholders support the concept of co-management and view it as the most appropriate approach for small-scale fisheries management in South Africa.

Effects of climate change on high-latitude coral reefs

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South African coral reefs are marginal, being located at high latitude, and are limited in size. They nevertheless attain a high biodiversity at this latitude on the East African coast. They are related to reefs in the southwest Indian Ocean (SWIO) and their resilience and connectivity are being studied in view of climate change. Two studies designed to deal with management issues in the local and regional context will be considered. a.) Reef monitoring was initiated in 1993, entailing temperature logging and image analysis of photographs of fixed quadrats on representative reef. Sea temperatures rose by 0.15°C p.a. up to 2000, attaining the coral bleaching threshold. While this resulted in relatively little bleaching, the increased temperatures appeared to have a deleterious effect on coral recruitment success which diminished up to 2004; it appears again to be improving. Changes also occurred in community structure, involving an increase in hard coral cover and a reduction in soft corals, resulting in a 5.5% overall drop in coral cover. These appeared to be "silent" effects of temperature change. b.) The success of MPAs in conserving reefs is, to a degree, dependent on the degree of their connectedness. Functional inter- and intra-population connectivity of two representative corals, *Acropora austera* and *Platygyra daedalea*, are thus being assessed at various spatial scales. At the small scale, 220 colonies of each species have been sampled at eight sites on a reef at Sodwana Bay. East African reefs have been included to provide regional context. Assignment and parentage analysis are being undertaken to obtain estimates of contemporary gene flow. Results will be presented to date, revealing the level of dispersal of coral larvae in the region. Both studies are being employed to develop a management strategy to ensure that south East African coral reefs retain their biodiversity and resilience to climate change.

The effect of different micro algal feeds on development and settlement of *Tripneustes gratilla* (L) larvae and the prospect of echinoculture in South Africa

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The echinoid *Tripneustes gratilla* is currently under investigation in South Africa for its culture potential. Optimizing growth and settlement conditions of *T. gratilla* are essential to ensure efficient and cheap production. Diet type is one of the major factors governing early development, settlement and survival rates of echinoids. The effects of the following micro algal diets *Isochrysis sp.*, *Pavlova lutheri*, *Chaetoceros muelleri* were tested in May and *Tetraselmis suecica*, *Skeletonema pseudocostatum* and *Chaetoceros muelleri* were tested in September on development and survival of *T. gratilla* larvae. Success of larval settlement and metamorphosis was also investigated. All larvae were reared in 100L conical tanks (n=4 per treatment) with finely aerated recirculating natural seawater (35ppt) at 24-25 °C. Larvae were fed approximately 4000 algal cells per larvae each day while the flow was turned off for approximately 8 h. Settlement assays using four species of benthic diatom, *Amphora sp.*, *Cocconeis sp.*, *Navicula jeffreyi*, and *Nitzschia closterium* (n=10 per treatment) were tested using coated sterile Petri dishes. Settlement assays were conducted at 25°C in temperature controlled chambers in complete darkness and ambient photoperiod (13:11, light: dark). In May, larvae died after 23 days fed *Pavlova lutheri* and did not reach competence. Larvae grew significantly better on *C. muelleri* and *Isochrysis sp.* reaching competence on day 18 and 20 respectively. In September, larvae reared in the *Tetraselmis suecica* culture died at day 9 whereas the larvae of *S. pseudocostatum* and *C. muelleri* cultures survived until competence at day 20. Competent larvae significantly preferred to settle in dark conditions, with no significant differences between benthic species overall. Settlement percentages per species were *Amphora* = 41%; *Cocconeis* = 26%; *Navicula jeffreyi* = 41%; *Nitzschia closterium* = 35%; Control = 18%. The larvae fed *Chaetoceros muelleri* (particularly in May) reached competence most rapidly; although other feeds such as *S. pseudocostatum* and *Isochrysis sp.* could also be used. Larvae should be subjected to dark conditions for desirable settlement rates. Techniques for mass production will be studied in the next phase of the project.

(Poster 97) The influence of sex on the uptake of trace metals in *Mytilus galloprovincialis*

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Bivalves have been extensively studied and utilised as bio-indicators of trace metals. Trace metals can potentially be accumulated by the organism and possibly transferred to higher trophic levels.

The aim of the study was to determine trace metal concentrations in water, sediment and the associated mussel, *Mytilus galloprovincialis* in Milnerton and Scarborough. Trace metals measured were Mn, Al, Fe, Co, Ni, Cu, Pb, Zn, Cr and Cd. The study also aimed to determine whether male and female Mediterranean mussels (*Mytilus galloprovincialis*) were significantly different in terms of their uptake of trace metals from the environment.

Metal concentrations within the sediment from the Milnerton Beach site were high, but in contrast the Scarborough site only had elevated concentrations for Zinc and Iron. The water samples from Milnerton illustrated peaks of Lead and Aluminium, while Scarborough had high concentrations in Zinc and Cadmium. Milnerton Beach had slightly high concentrations of Manganese, Aluminium and Lead, and Scarborough had elevated concentrations of Zinc and Cadmium. There was no significant difference between the accumulated concentrations within the male and female *Mytilus galloprovincialis*.

The results obtained from sediment samples for Milnerton could be a result of higher sources of the pollutants like sewerage, road runoff and pollutants that are being pumped into the coastal section by factories. Scarborough's results indicated lower trace metals concentrations which would have no effect on the ecosystem. The ecosystem for both sites needs sufficient management to ensure the future sustainability of the sites.

Trophic positions of calanoid copepods of the northern Benguela upwelling system identified by stable isotopes and fatty acids

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The Benguela upwelling system is one of the most productive marine ecosystems. The mesozooplankton community is dominated by calanoid copepods such as *Calanoides carinatus*, *Metridia lucens* and Eucalanidae. Ten calanoid copepod species were collected during two cruises in April 2008 and December 2009 in the northern Benguela upwelling

system from Walvis Bay to the border of Angola. Stable carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) isotope ratios as well as the fatty acid composition of the copepods were analysed to reveal their trophic levels and dietary preferences. High proportions of 'herbivory' fatty acid (FA) markers (e.g. 16:1(n-7), 18:4(n-3)) and low 'carnivory' FA markers (e.g. 18:1(n-9)) were found in *C. carinatus* (18% of total fatty acids (TFA) and 4% TFA, respectively) and *Eucalanus hyalinus* (14% TFA and 6% TFA, respectively). Both species, particularly *C. carinatus* showed also low $\delta^{15}\text{N}$ values (6.1‰), supporting the idea that this copepod is predominantly herbivorous. *Nannocalanus minor*, *Aetideopsis carinata* and *Pleuromamma robusta* showed no clear differences between the amounts of 'herbivory' and 'carnivory' FA markers, indicating omnivory. *Rhincalanus nasutus*, *Euchirella similis* and *Euchaeta marina* exhibited lower proportions of 'herbivory' FA markers (6-21% TFA) in relation to 'carnivory' FA markers (10-34% TFA) with carnivory markers always exceeding herbivory FAs by < 20% in each species. The $\delta^{15}\text{N}$ isotope signatures of these species ranged between 8.1 and 11.6‰, in line with an omnivorous to carnivorous trophic level. The study showed that fatty acids together with stable isotopes are useful tools for examining trophic relationships.

(Poster 98) Experimentally-established correction factors for signal attenuation by air bubbles in bad weather conditions during acoustic surveys

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Accurate estimation of fish density made via acoustic echo integration is known to be problematic in bad weather conditions due to acoustic signal attenuation by waterborne air bubbles, which result in an underestimation of fish abundance. Because research costs are constantly rising world-wide research institutes are often bound to conduct research in bad weather conditions. Correction factors have as yet not been established experimentally to account for acoustic signal attenuation in bad weather conditions. In this study, the nautical area backscattering coefficients (NASCs) of corrugated and flat sea beds were measured by three 38 kHz split beam Simrad EK60 echosounders during different weather conditions (calm, moderate, and bad). The ratios of integrated sea bed NASCs under these different weather conditions were evaluated in order to estimate correction factors for acoustic signal attenuation. Vessel roll and pitch were also used as an index of acoustic signal attenuation at a given wind speed, wave size, and vessel-encounter angle. The estimated NASC ratio strongly increased with wind speed, but at a lower

magnitude than reported and expected in previous studies at 38 kHz. Results show that stable sea bed NASC ratios are found during periods of low (0-10 ms^{-1}) wind speed, whereas at high wind speeds of around 30 ms^{-1} a multiplicative correction factor of 2.3 must be applied. The results also suggest that acoustic signal attenuation is vessel specific, and that transducer mounting position and vessel hull shape influence such attenuation. Therefore, correction factors should be established for each transducer frequency on its mounting platform in different weather conditions to improve the quality of the obtained data.

(Poster 99) Developing a science base for implementation of the ecosystem approach to fisheries in South Africa

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South Africa's commitment to implementation of the Ecosystem Approach to Fishing (EAF) requires a solid scientific basis comprised of a toolkit assembled through concerted efforts from which management measures can be carefully considered and implemented. Workshops were held to assist in identification of issues in South Africa's key fisheries that are cause for concern and may have EAF implications. Several of these were addressed under various projects. Food web studies have been undertaken and models constructed of changes in structure and functioning of the southern Benguela. The combined effects of fishing and environmental change on SA fisheries have been examined using various observation-based and modelling methods. These are contributing to assessment of changes at multiple spatial and temporal scales, from the impact of pelagic fishing in key foraging areas of critically-dependent predators, to impacts of demersal trawls on benthos and demersal fish assemblages, to decadal-scale dynamics, and global comparative classifications of ecosystem status. To address some of the EAF issues, practical implementation measures are being developed and applied in collaboration with stakeholders. Stakeholders are also actively involved in the process leading to development of indicators to address the human dimensions of EAF, and knowledge-based systems are being developed as decision support tools. Future priorities for SA EAF research will include placing more emphasis on conservation and biodiversity aspects, linking of environmental/oceanographic knowledge to management objectives, spatial aspects, as well as increased focus on the human dimension and transdisciplinary approaches. Indicators are a

promising means of synthesizing multi-disciplinary information for consideration in management, providing measures of anthropogenic pressures (including fishing, social and economic pressures), in combination with environmental drivers, and providing a means of assessing how these affect the Benguela ecosystem. Respectful scientific collaboration will be required to bridge the gap between classical single-species fisheries management approaches and broader ecosystem approaches.

IndiSeas: comparing indicators across fished marine ecosystems

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Appropriate indicators are required to translate ecosystem impacts and changes into management measures that can be assessed for their effectiveness. The scientific community is challenged to provide a generic set of synthetic indicators to accurately reflect the effects of fisheries on marine ecosystems, to facilitate effective communication of these effects and to promote sound management practices. IndiSeas was established to evaluate fishing impacts on the status of marine ecosystems using indicators. A suite of eight ecological indicators were assembled for 19 marine ecosystems. Results of comparative analyses were synthesized to inform stakeholders of relative states and recent trends in the world's fished marine ecosystems. A web-based "dashboard" was developed, evaluating the exploitation status of marine ecosystems in a comparative framework, guiding fisheries management in each ecosystem. Reference levels were explored for the indicator suite, ecosystems ranked according to exploitation status, a decision tree developed to classify ecosystems based on trends, and roles were assessed of non-fishery drivers in determining ecosystem changes. Analyses suggest most of the ecosystems are overexploited and the declining trends in ecological indicators led to 79% of the ecosystems being classified as deteriorating. IndiSeas has moved into its second phase; IndiSeas2 aims at "Evaluating the status of marine ecosystems subject to multiple drivers in a changing world" in support of an ecosystem approach to fisheries. Although IndiSeas indicators were selected to reflect impacts of fishing, results need to be considered in the context of human dimensions and environmental drivers. IndiSeas2 will explore the response of a broader suite of ecosystem indicators to ecosystem change across a wider range of ecosystem types and drivers. Combined effects of fishing and climate on indicators trends will be modeled, and means of testing indicator responsiveness and performance will be developed. Further work is planned to identify indicator thresholds and reference points.

Stable carbon isotopes and the possible role of aquatic macrophytes in the diet of estuary-associated fish species

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Temporarily open/closed estuaries (TOCEs) are the dominant estuary type in South Africa. These systems are often characterized by extensive beds of submerged macrophytes, which form important foraging and shelter habitats for fishes. A loss of submerged macrophytes from an estuary has been shown to affect the fish community as well as reducing overall system productivity. In this study, the importance of macrophytes as a primary energy source for selected estuarine fishes was explored through the analysis of carbon and nitrogen stable isotopes of fishes from neighbouring TOCEs that differed in macrophyte cover. Samples were collected from a wide range of fish species from the East Kleinemonde Estuary which was almost free of the submerged macrophytes *Ruppia cirrhosa* and *Potamogeton pectinatus* and compared with individuals of the same species from the West Kleinemonde Estuary, where extensive beds of *R. cirrhosa* and *P. pectinatus* were present. Mixing models suggested the influence of submerged macrophyte material in the diet of fishes in the latter system but, rather than being directly consumed, this material contributes to the detrital pool that forms a food source for most invertebrate and some fish species. In comparison, fishes from the East Kleinemonde Estuary showed more depleted isotope signatures (specifically carbon); likely indicating a diet with a high proportion of benthic or pelagic diatoms and microalgae. This study therefore supports the concept that estuarine foodwebs are largely based on detritus, to which macrophytes may be a significant contributor when their biomass is high.

(Poster 100) A comparison of toxicity of decadienal and plocoraldehyde C toward abalone (*Haliotis midae*) larvae

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Abalone are herbivorous; the planktonic larvae are lecithotrophic but post-larvae feed on encrusting diatoms, gradually progressing to macro-algae as they grow. In the Western Cape adult *Haliotis midae* feed

predominantly on *Eklonia maxima*, but in its absence they prefer *Plocamium* spp. When the cell walls of certain diatom species are disrupted, they produce unsaturated aldehydes such as decadienal which can inhibit reproductive success and larval survival and development of marine invertebrates. Similarly, *Plocamium corallorrhiza* produces a number of halogenated monoterpene aldehydes (plocoraldehydes) which are moderately cytotoxic towards cancer cells. Thus abalone at different developmental stages are potentially exposed to chemicals derived from their food which might affect them negatively. Twenty-four hour old abalone larvae were exposed to decadienal and plocoraldehyde C at 3.26, 6.73, 16.82 and 33.63 $\mu\text{M.mL}^{-1}$. The lowest concentration of both compounds inducing 100% mortality was 6.73 $\mu\text{M.mL}^{-1}$, although significant mortality also occurred at 3.26 $\mu\text{M.mL}^{-1}$ plocoraldehyde C. In South Africa the densities of diatom species known to produce decadienal are too low to produce very high concentrations of decadienal, thus potentially putting only the youngest larvae at risk. The ecological roles of the plocoraldehydes isolated from *Plocamium corallorrhiza* are still uncertain. However, their toxicity toward *Haliotis midae* larvae seems to suggest that they may play a role in reducing herbivory. Further studies on morphological changes induced by plocoraldehydes at sub-lethal concentrations are in progress.

(Poster 101) Oxygen in air as the abiotic driving force to crab terrestrialization: an ontogenetic approach.

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The main abiotic driving force that promotes terrestrialization in crabs is probably the 30-fold increase in oxygen concentrations in air compared to water, since all other abiotic parameters are obstacles to land invasion causing problems of desiccation, excretion and osmoregulation.

A huge body of literature describes functioning and structures of air breathing apparatuses that adult terrestrial crab have evolved exploiting sub-aerial environment, as well as mechanism to reduce desiccation and perform excretion and osmoregulation in the new milieu. On the other hand, few observations are available about the terrestrial adaptations of embryos. Since a compact mass of adherent small eggs could impede the flux of the respiratory medium inside the mass itself, many authors speculate that more

terrestrial species could enlarge the egg size, resulting in a mass with bigger interstices that would facilitate medium flux. To test this hypothesis, we performed a meta-analysis on 159 species from deep-water to terrestrial crabs using the level of terrestrialization, egg size, number of eggs, size of clutches and larval strategies as factors. The outcome refutes the expectations, showing that the larger eggs belong to species with larval retention strategies, regardless of their degree of terrestrialization. As a consequence, we hypothesised that the embryos of terrestrial species could also have shifted to air-breathing, in response to the problem of water viscosity within egg masses. We selected the Sesarmidae as a model family and compared respiration in air and water of developing embryos, using micro-optodes. Data from eight sesarmid species (six from Gazi Bay, Kenya and two from Mngazana, South Africa) show a clear landward trend in air-breathing, with more efficient oxygen extraction in air than in water in the more terrestrial species, confirming that adaptation to respiration in air exists at an early ontogenetic stage.

(Poster 102) The use of pop-up archival tags to monitor the movement of Great White Sharks tagged in False Bay, Western Cape, South Africa

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Pop-up archival satellite tags were used to investigate the movements of four white sharks tagged in False Bay between 2007 and 2008 tracked over periods of approximately four months. The two males measured 3.7-4 m TL and the females were 3.5-4.5 m total length. Three of the four sharks stayed in the Western Cape while the fourth, the 3.5 m female, travelled as far north as the Limpopo River mouth in Mozambique where the tag was recovered. This wider ranging individual was later detected in False Bay in October 2008. Three of the tags were recovered and all the archival data downloaded allowing details of their vertical diving behaviour to be analysed. The sharks exhibited patterns of diving from surface waters to deeper waters, probably showing the surface or bottom patrolling behaviour previously described for this species. While on the continental shelf the deepest they attained was 109 m but in oceanic waters, they dived deeper than 900 m. Habitat use, philopatry and hunting behaviour is discussed and compared to previous studies of these apex predators.

The status of coastal and marine biodiversity in South Africa

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South Africa's last National Spatial Biodiversity Assessment used an expert based approach to assess ecosystem status for 35 marine biozones. The 2010 assessment used a data driven systematic approach to assess ecosystem threat status and protection levels for 136 ecosystems. A National Coastal and Marine Ecosystem Classification System was developed and seamless benthic and pelagic ecosystem maps were produced. The classification and maps include 58 coastal, 62 offshore benthic and 16 offshore pelagic ecosystems grouped into a total of 14 broad ecosystem types. A total of 27 pressures were also mapped at a 5 minute resolution and an ecosystem-pressure matrix was developed to help assess the relative impact of each pressure on each ecosystem. This data was used to define site condition. By comparing areas with different conditions to biodiversity targets, ecosystem status was determined. A total of 64 ecosystems (47%) were considered threatened with 17% critically endangered, 7% endangered, 23% vulnerable and 52% least threatened. A revised MPA map and spatial analyses were used to assess the representation of all ecosystems in South Africa's Marine Protected Area network. Forty percent of ecosystems have zero protection and only 6% of ecosystems are considered well protected. Patterns in ecosystem threat status and protection levels between the coastal and offshore environment, broad ecosystem types and different habitat types were examined. The assessment identified research priorities to address data gaps that limit our ability to assess biodiversity. The top ten priority actions for the conservation of coastal and marine biodiversity were also identified.

(Poster 103) Accumulation and toxicity of selected metals in the feral oyster, *Striostrea margaritace*, on the South African south- western coast

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Metal contamination/pollution of the coastal environment continues to attract the attention of environmental researchers world wide. The current status of metal pollution off the Southern coast of South Africa is not well known. Objectives of the study undertaken include the determination of the degree of metal contamination in the feral oyster, *Striostrea*

margaritace, as well as determining the toxicity of selected metals to these oysters, by using a biomarker (lysosome destabilisation) as tool. The biomarker was tested using the neutral red retention time (NRRT) assay and metal concentrations were obtained through acid digestions. Four metals (Al, Cu, Fe and Zn) were selected for the study. Oysters were collected from Witsand, Wilderness and Goukamma MPA seasonally over a one year period. Results indicated significant differences between the selected sites as well as seasonal variation for metal contamination. The biomarker study identified significant differences between sites only in the winter (Jun) and spring (Sep) samples. The oysters from the MPA had a higher retention time of the Neutral red dye, an indication that they were less stressed. Results obtained from this study do indicate the presence of metals in the oysters. The correlation between metal contamination and lysosomal destabilisation is inconclusive. In order to determine this, a comparative laboratory study should be conducted.

An in-shore *in situ* temperature climatology for the South African coast

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Seawater temperature is the most important environmental variable that determines the distribution of marine species at regional and global scales. Numerous globally complete gridded sea surface temperature (SST) products have facilitated studies of biogeography, climate change and climate variability in oceanic regions, but coastal biogeographical investigations have suffered because of difficulties extrapolated these data to areas close to the land-water edge. This and the the general paucity of *in situ* temperature data at high resolution in shallow waters (2 - 10 m depth) have prompted the development of a detailed, high-resolution coastal alongshore seawater temperature climatology for the South African coast. This paper discusses i) the constraints of using gridded SSTs in coastal systems, ii) elaborates on the development of a monthly seawater climatology based on time-averaged, multi-annual continuous seawater temperature records obtained at 37 coastal localities, and touches on iii) their subsequently interpolation to fill in data-sparse regions. This inshore climatology differs markedly from extrapolated remotely sensed SST measurements, but shows a surprising coincidence with seawater temperatures at 75 m depth extracted

from the World Ocean Atlas (2009). Some thoughts are ventured about the physics of the inshore water masses and the processes that determine their temperatures.

Roving creel surveys, more than just catch and effort

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Roving creel surveys are an on-sight intercept method used to assess and describe recreational fisheries. SANParks has three ongoing roving creel surveys in the Knysna estuary, Swartvlei estuary and the Natures Valley coastal section adjacent to the Tsitsikamma Marine Protected Area. These surveys have been conducted over a two year period and have been designed to gather information on effort, catch, angler awareness and knowledge of fishery regulations and specific socio-economic parameters of participants. Not only do these monitoring programmes aid in complying with the National Environmental Management: Protected Areas Act, but efficient objective driven monitoring is an essential component of the Strategic Adaptive Management (SAM) approach adopted by SANParks, in which management actions are continuously assessed and improved. However, all too often the link and feedback between management actions and monitoring outcomes becomes weak or non-existent and in such instances the monitoring programme itself becomes the end rather than a means of obtaining relevant data. This paper explores how results from the Garden Route surveys are currently being used to feed into the SANParks adaptive management strategy. In particular, we highlight how the information gathered is used to inform the design of key elements within a local angler awareness program. To date monitoring results have aided in identifying target audiences, identified key messages to convey and helped identify and quantify potential weaknesses with our current management process. The challenges facing SANParks include adapting information to a range of target audiences whilst maintaining relevance and understandability and importantly initiating and maintaining dialog with resource user groups.

Individual variation in bottlenose dolphin ranges in Walvis Bay, Namibia. Implications for managing restricted areas

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A small population (77-122) of common bottlenose dolphins (*Tursiops truncatus*) range along very nearshore waters of the central Namibian coast. Walvis Bay is the only embayment of significant size within their known range and is used regularly by members of this population and may represent an important feeding and resting habitat. Human threats within this shallow ~100km² bay are numerous and include a commercial harbour, aquaculture, and a large marine tourism industry operating >25 boats. The tourism industry is regarded as the most immediate threat due to the high level of directed encounters and large number of boats. Recent trends suggest that this population may be decreasing or leaving the Walvis Bay area. This study determined the habitat utilisation and individual ranging patterns of bottlenose dolphins within Walvis Bay to evaluate the potential for a conservation area in which boat traffic could be restricted. This area should be used regularly, used by the majority of individuals, and used for the most impact-sensitive behaviours (e.g. resting). We analysed three years (2008-2010) of photographic boat based mark-resight surveys and associated spatial and behavioural observations to investigate optimal locations for a protected area. Habitat use patterns varied considerably between seasons and individuals but over the longer term, two key habitats were identified. Behavioural use of the bay showed feeding and socialising to occur throughout the bay, but resting behaviour occurred predominantly in one of the key areas. Individual recognition showed this area to be used by the majority of individuals (86%) and all mother-calf pairs, thus fitting all identified needs for a protected area. The implications of this area for the dolphin population and marine tourism industry are considered. We discuss the importance of considering individual identity and behaviour to maximise the effectiveness of protected areas for wide ranging species such as dolphins.

(Poster 104) Hake long line fishery and related issues in the development of catch rates as input data into operational management procedure (OMP)

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Hake historical commercial long-line catches are disaggregated using the species split algorithm developed for the trawl catches into two hake species, *Merluccius capensis* and *Merluccius paradoxus* and by coast, south and west coasts. These data were analysed using General Linear Modeling (GLM) to provide standardized catch per unit effort (CPUE) for the hake long line catches. The current assumption that 100%

and 30% of the catch on south and west coast respectively consists of *M. capensis* is examined. Initial results seem to indicate that 95% and 40% of the catch in the south and the west coast respectively consists of *M. capensis*. Standardized catch per unit effort for both species indicate a decreasing trend in catches since 1994 which is the year that marked the beginning of long-line fishery.

(Poster 105) Heavy metal concentration in *Choromytilus meridionalis* along the west coast of the Cape Peninsula

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The concentrations of metals in *Choromytilus meridionalis* along the west coast of the Cape Peninsula (Cape Point to Bloubergstrand, Cape Town) sampled between 1985 and 2008 during the Mussel Watch Programme (MWP) are presented. Levels of copper, cadmium, lead, zinc, mercury, iron and manganese from five sites (Cape Point, Hout Bay, Sea Point, Milnerton and Bloubergstrand) sampled during autumn and spring showed consistent similar mean values for the five sites. The mean (\pm sd) order of metals for the sites was Zn (136.70 $\mu\text{g/g} \pm 135.46$) > Fe (40.36 $\mu\text{g/g} \pm 109.14$) > Cd (4.72 $\mu\text{g/g} \pm 5.13$) > Cu (4.38 $\mu\text{g/g} \pm 4.96$) > Pb (3.43 $\mu\text{g/g} \pm 13.76$) > Mn (1.33 $\mu\text{g/g} \pm 3.97$) > Hg (0.04 $\mu\text{g/g} \pm 0.10$). There was a highly significant temporal (annual and seasonal) difference between all metals ($p < 0.001$) as well as a significant difference in metal concentrations between the five sites ($p < 0.01$), albeit that there were no trends between the sites. The concentration of Zn, Fe, Cd and Pb are higher than previous investigations and are indicative of increasing heavy metals entering the west coast of the Cape Peninsula from anthropogenic sources and provides a strong motivation to increase efforts in marine pollution research in the area.

Regional connectivity and differentiation of three goatfishes (*Parupeneus* spp.) within the Western Indian Ocean

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Goatfishes inhabit inshore reef and coral areas and are commercially important throughout their areas of distribution in the Western Indian Ocean (WIO). However, the biogeography of these species has not been explored. A phylogenetic approach using molecular markers can provide an understanding of the origins of regional fauna and relationships among

biogeographic regions. It may be predicted that species differ in genetic structure or show different patterns in response to their life history strategies or physical factors of the environment. This study will assess the genetic diversity, connectivity, patterns of differentiation and origins of the three goatfish species of the genus *Parupeneus* (*P. barberinus*, *P. macronemus* and *P. rubescens*) in the WIO. Analysed samples were collected from East and southern African continental coastlines, island regions and the Mascarene plateau and around Madagascar. Mitochondrial DNA (NADH Dehydrogenase Subunit 2, cytochrome *b* and 16s ribosomal RNA) and nuclear DNA (ribosomal protein S7 gene) markers were amplified. Diversity and variance measures of sequences within species, among regions will be analysed to see if species differ between localities or they are the same. In addition, phylogenetic analyses using parsimony, Bayesian Inference and Maximum Likelihood will be performed to determine relationships. This study should provide clarity on the connectivity, origins and the processes that have influenced the distribution of the selected goatfishes in the WIO.

Response of estuarine macrobenthos to episodic flooding in urban and non-urban temporarily open/closed estuaries in KwaZulu-Natal, South Africa

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During June 2008, the KwaZulu-Natal south coast experienced an abnormally high rainfall event that resulted in severe flooding of numerous estuaries. Given the extensive physical changes that occurred, this paper documents the re-establishment of macrozoobenthic communities in four small flood damaged temporarily open closed estuaries (TOCEs) Post-flood recolonisation patterns of infauna of the Amanzimtoti, Little Amanzimtoti, Intshambili and Mhlabatshane estuaries were described according to temporal changes in species composition, abundance, and diversity, and spatial differences between urban and non-urban environmental settings. Sampling was undertaken for approximately one year, over six collection trips beginning one month after flooding. For comparative purposes replicate samples were collected in the lower reaches of each estuary using a Zabalocki-type Eckman grab, with simultaneous measurements of ambient physico-chemical conditions, including sediment characteristics. A total of 66 taxa from six Phyla were identified, including marine, estuarine and freshwater invertebrate species. Analysis

of Similarity (ANOSIM) revealed that macrobenthic communities differed significantly between adjacent estuaries within the urban ($R=0.519$; $p<0.0001$) and non-urban ($R=0.418$; $p<0.0001$) environments, thus disproving a global difference between our selection of urban and non-urban condition. The overall dissimilarity between all four estuaries was significantly high ($R=0.736$; $p<0.0001$), indicating the uniqueness of benthic communities between these TOCEs. The Amanzimtoti community was dominated by the Asian invasive gastropod, *Tarebia granifera*, the Little Amanzimtoti and Mhlabatshane communities by polychaete worms (*Prionospio multipinnulata*, *Dendronereis arborifera*), and the Intshambili community by amphipod crustaceans (*Grandidierella* species, *Corophium triaenonyx*). Benthic recolonisation patterns varied between estuaries and did not follow a predictable sequence of recolonisation, compounded by open/closed mouth conditions. Changes in community structure between time periods were pronounced in the Little Amanzimtoti ($R=0.786$; $p<0.0001$), Mhlabatshane ($R=0.89$; $p<0.0001$) and Intshambili ($R=0.524$; $p<0.0001$) estuaries. The findings of this study emphasised the importance of individual estuary characteristics in determining the recovery of benthic communities following environmental disturbance such as a flood.

Ichthyoplankton in temperate South African estuarine nurseries: an assessment of local, regional and geographic community trends

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This work represents a review of ichthyoplankton abundance and diversity in no fewer than 25 estuarine systems spanning 13 years of research in temperate South Africa. Estuaries are important hatching and nursery areas for young fishes, many of which enter and leave these environments in the larval stage. Estuaries provide a complex array of macro- and micro-habitat choices for young fishes. Habitat heterogeneity, often as a function of freshwater supply, drives the occurrence, community structure and diversity of larval stages occurring in the water column. Biological diversity is discussed at the alpha (no. of species within communities), beta (species in neighboring communities) and gamma (community trends over geographical scales) levels. Resident Clupeidae and Gobiidae dominate mid-channel waters of temperate estuaries in preflexion stages, closely associated with copepod prey, from which survival depends. Marine species that are dependent on estuaries as nursery areas typically utilise marginal waters, either associated with structure or clear waters,

depending on camouflage benefit, where shallow-water refuge is critical for predator avoidance. Ichthyoplankton peaks in warmer months coinciding with adult spawning and local productivity and ties well with peak rainfall periods along the coast. Preliminary diet studies indicate that postflexion larvae of estuary-dependent marine species are capable of a mixed feeding strategy once in estuaries and are able to feed on benthic as well as planktonic prey with the larval stages of insects making up a large proportion of the diet in species in the genera *Pomadasys*, *Liza*, *Monodactylus* and *Rhabdosargus*. Given the apparent diet plasticity in these young fishes, data trends suggest that physico-chemical habitat heterogeneity is the critical feature defining a good estuarine nursery.

(Poster 106) Patterns in shallow water sponge richness and biogeography within the western Indian Ocean

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Sponges are, in many respects, ideal organisms for the study of biogeographic patterns on shallow, marine hard benthic reefs. They have relatively similar species numbers in any one large region from temperate to tropical regions, and comprise representatives of three major phyla, which, though divergent phylogenetically, have a series of similar functional forms. The tropical Indo-West Pacific is the largest coastal biogeographic region on earth and also has the most sponges recorded for any one region, with approximately 250 sponge species for the Indian Ocean alone. An analysis of the large scale patterns of sponge species richness has, however, never been performed in the WIO. Our analysis revealed the following patterns: 1) species turnover is lowest within and between the (North Red Sea, South Red Sea and Arab Bassin) and the (Mascarene Plateau, Somali Bassin and Mozambique Channel) branches. On the other hand, species turnover is at its largest at the southern extreme. i.e. at the boundary between Cape Point and Natal-Delagoa bioregion. The positioning of Delagoa bioregions with Mozambique, demonstrates that this bioregion acts as a bleeding zone between the Indo-Pacific and the South African east coast. The analysis revealed that the WIO can be split into at least three biogeographical realms: 1) the red sea and associated Arab Basin, 2) the asymmetrical circumtropical region stretching from the horn of Africa to southern Mozambique including the Delagoa bioregions of South Africa, and 3) Southern Africa excluding the Delagoa bioregion. Given the preliminary patterns revealed here, it is becoming clear that important taxonomic turnovers occur within the latitudinal and longitudinal gradients of the WIO,

which is not all that homogeneous an area as has long been thought. The biogeography of the WIO can be explained by 1) dispersion ability, 2) current patterns, and 3) recent geological history. We also found that Rapoport's rule cannot be upheld across the latitudinal gradient studies here. This pattern is contradictory to the rule that dictates that species' range sizes decrease towards lower latitudes, i.e. Rapoport's rule.

The variability and dynamics of the Antarctic Circumpolar Current using altimetry-applied proxy techniques

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The African choke point of the Antarctic Circumpolar Current (ACC) constitutes the most variable of the Southern Ocean. Interactions with the Agulhas Current and its Retroflexion to the north and the Weddell Sea in the south produce transport and thermohaline variability unlike any other sector of the ACC. Sustained, high resolution hydrographic sections at the GoodHope line have allowed us to develop proxy techniques between sea surface height and the baroclinic structure of the ocean, to investigate the dynamic nature of the ACC at an improved spatial and temporal resolution. Firstly, robust weekly transport estimates of the ACC, made using empirical relationships and applying satellite altimetry data, have revealed that the Subantarctic Front is responsible for the majority of the transport variability (>50%) even though its net transport is 10% less than that of the Antarctic Polar Front (APF). The presence of Agulhas Rings at the northern edge of the ACC cause intense transport reversals and likely allow for the quasi-permanent presence of the Subtropical Front (STF). Next, we examine the synoptic variability of heat and salt content by combining altimetry data to the gravest empirical mode (GEM) mapping technique. The GEM exploits the relationship between subsurface density profiles and sea surface height to produce vertical thermohaline structure across the ACC. The results show that Agulhas Rings invade the Subantarctic Zone on average 2.7 occasions per annum and are responsible for possibly the longest and highest scales of observed variability in the whole Southern Ocean. These events have been observed to interact with eddies originating at the STF resulting in heat and salt anomalies that last more than one year at a single geographical location. Further south, the GEM thermohaline fields reveal that the variability of the ACC fronts is strongly determined by the regional topography, with the APF's flow over the Mid-Ocean Ridge providing a source for ACC mesoscale

perturbations in the form of meanders and eddies. By applying altimetry data to these proxy relationships provide a valuable tool by which to describe the regional dynamics of the ACC in this data sparse and remote expanse of the world's ocean.

An implementation model for integrated coastal management in South Africa - from legislation to practice

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Since the 1970s much attention has been given to implementation models and frameworks for integrated coastal management (ICM). Many of the earlier models followed results-based approaches, where the primary focus was to identify coastal issues and implementation occurred through specific projects or programmes. While the importance of cooperative governance were emphasised from early on, governance systems remain largely sector-based, a legacy of the traditional approach to management. In this paper we explore the implementation of ICM within a sector-based governance system as in South Africa by first proposing a prototype implementation model design, using international best practice guides and own experience and intuition grounded in the South African context.

Thereafter the workability in and compatibility with South Africa's sector-based governance system is assessed, using empirical information from South Africa's national programme of action to protect the marine environment from land-based activities as case study (i.e. a practical validation). Next the contextually-derived implementation model is subjected to theoretical scrutiny to validate its scientific credibility (i.e. a theoretical validation). From this validation process a refined implementation model emerged, comprising two interdependent but distinctive adaptive cycles coined the resource cycle and the actor cycles. The resource cycle primarily identifies distinct actions that are relevant to the resource (i.e. coastal marine environment) and activities in and around that resource. An actor cycle is depicted as a separate, adaptive cycle to emphasis its importance in a governance system of ICM and to show that involvement may change over time, as actors are influenced by non-static political and socio-economic conditions.

Drought at St Lucia Estuary: expected, unexpected and spectacular ecosystem responses

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St Lucia, a World Heritage Site and the largest estuarine system in southern Africa, has experienced a severe and prolonged drought. The estuary mouth closed in 2002 and, except for a six-month period in 2007, has remained closed since then. This presentation describes the resulting ecosystem responses. There are the hydrological and biotic changes resulting from loss of linkage to the sea. Loss of tidal action; the drying of much of the system; changes in salinity gradients and the compartmentalisation into several discrete water-bodies; a concentration of nutrients and salts and resulting algal blooms. There were sequential die-offs of species caused by salinity and exposure, and a slow reduction in populations of obligate marine-breeders. *Oreochromis mossambicus* became very abundant. Groundwater seepage along the margin of the lake promoted shoreline vegetation and created refugia for hippopotamuses. Fish-eagle numbers declined - a result of their inflexible lifestyle - and at times many more pelicans than had been previously recorded used St Lucia. During this drought previously unrecorded species became evident, including some alien invasive ones. Drought-induced changes have altered tourism patterns and have been the stimulus to develop new management approaches. Ecologically it has been an exciting period in which we have learnt a lot. Over the past 60 years there has been a lot of research into St Lucia; but were we prepared for this drought? There have been many unexpected system responses - some, very obvious and with hindsight, are responses we should have foreseen; others are stochastic manifestations that we could not have predicted. Are we now better able to predict future ecological responses to extreme conditions? We have the building blocks to do develop a greater degree of conceptual understanding - but often tend not to think enough or apply existing knowledge to predict possible system responses.

Ballast water management technology testing

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Ballast water is one of the major vectors in the spread of alien invasive species around the world's oceans. The International Maritime Organisation's (IMO) International Convention for the Control and Management of Ships Ballast Water and Sediments (D-2) will soon come into place resulting in at least 50 000 vessels worldwide having to install a ballast water management system (BWMS). Resource Ballast Technologies (RBT) has developed a BWMS which combines cavitation, chlorination, ozonation and filtration. Acute and chronic toxicology and efficacy was conducted by Anchor Environmental Consultants. Whole effluent toxicity testing (WETT) was performed to test for chronic and acute toxicity. Six species were exposed to five concentrations of treated ballast water (TBW). Growth of *Gracilaria verrucosa* was inhibited in 100% TBW. No adverse effects were detected for any of the invertebrates. Both species of fish suffered 100% mortality in the 100% TBW. 50% TBW caused 100% mortality for *Psammogobius knysnaensis* but had no effect on *Liza richardsonii*. A 28 day fish juvenile growth test, a 72-hour algal growth inhibition test and a sea urchin fertilisation test (1 hour 10 min) were conducted. Fish and phytoplankton were not affected. Sea urchins showed an adverse effect at 100%TBW. For efficacy testing five seawater and five brackish water land-based test 5 day test cycles were conducted and demonstrated consistent compliance with the D-2 standard. Three shipboard tests were completed successfully between November 2009 and June 2010 onboard the *M/V Toronto*. Type Approval for the RBT BWMS was awarded in October 2010. Other applications of the technology are currently being investigated. Possible future applications are water treatment in mariculture, for example abalone farms to constrain the spread of pathogens, large scale water transfer schemes and wastewater management applications.

Analysing fishing patterns of purse-seiners in the southern Benguela using Vessel Monitoring Systems (VMS)

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Vessel monitoring systems (VMS) have been implemented to track vessel movements in South Africa's pelagic and demersal fisheries since 2000. However, this information has not yet been analysed, unlike in other regions of the world such as off Peru or in the English Channel, where VMS data were used to investigate fisheries activity at small scale (<10km). In contrast to data derived from fishery logbooks and acoustic surveys typical of larger scale studies, VMS data allows investigations at meso- and submeso-scales, with a focus on the local behaviour of fishery vessels. This allows detailed analyses of relationships between characteristics of the displacement of fisheries and the spatio-temporal abundance of prey at small scales. We explored the fishing patterns of South African purse-seine vessels targeting anchovy, sardine and round herring in 2002 and 2005 using VMS and a state-space model developed to detect the different types of vessel movement (stillness, tracking, and cruising). The analysis aimed at qualifying vessel trajectories, segment by segment, with the objective of identifying fishing sets and prospecting phases and distinguishing these from cruising and tracking. We then related the positions of fishing sets to fishery logbook information and results from scientific acoustic surveys used to map the spatial distribution of small pelagic fish in the south Benguela and estimate their abundance. This work underlines the utility of VMS information as a near real-time, small-scale monitoring tool, and one that will likely be useful in contributing to the application of ecosystem-based fishery management in South Africa.

(Poster 107) Killer whale predatory events in False Bay, South Africa: who's who and what are they doing?

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Apart from regular annual aerial surveys for southern right whale cow-calf pairs, there is currently no research programme focusing on cetaceans in False Bay, Western Cape. Opportunistic recordings of unusual cetacean sightings have been collated from white shark cage-diving operators, researchers and a boat-based whale watching operator who use the western half of the bay throughout the year. Historically, verified sightings of killer whales in False Bay have been rare; however, during 2009 and 2010, eight incidental encounters with killer whales were documented. Encounters showed strong seasonality, all

occurring between April and August, and were usually associated with large numbers of common dolphins and Cape fur seals feeding on sardines and anchovy. Nine predatory events (six successful and three unsuccessful) on common dolphins were observed. Three different techniques were used to immobilise the prey: horizontal lunge, breach attack from below and breaching on top of the dolphin, which was the most commonly observed technique. Two successful, apparently arbitrary fatal attacks on seals were observed on one occasion when no dolphins were present, but the seals were not consumed. Photographs of the dorsal fins and saddle patches were collected during all encounters and used to build a catalogue of individually recognisable animals and to investigate group composition and sighting frequency. Mean group size was 5.6 (range 4-12) and preliminary analysis shows several resightings of marked individuals, with at least 4-5 different groups visiting the bay. The increase in the number of sightings of killer whales in recent years may indicate a shift in behaviour, range or diet associated with environmental changes and bears further investigation.

(Poster 108) Observations on the behavioural responses of the gammarid amphipod, *Melita zeylanica* Stebbing exposed to different combinations of salinity and temperature

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The gammarid amphipod *Melita zeylanica* Stebbing is a common epibenthic estuarine species in South African estuaries particularly on the east coast of South Africa. Its geographical distribution extends as far as the south coast and north to Mocimboa do Castelo. In the Mngazi estuary, *M. zeylanica* is recorded at the upper reaches showing high temporal fluctuations in abundance. When water volumes are high during closed mouth conditions, its spatial distribution in this estuary shows a longitudinal extension to the previously riverine areas. When the freshwater conditions return, the amphipods persist and survive under these conditions. In order to understand the observed patterns of distribution and abundance, the behavioural response of *M. zeylanica* to combined effects of salinity and temperature was assessed using a multifactorial experimental design. The amphipods were exposed to 36 combinations of salinity (7, 21 and 35‰) and temperature (19, 24, 29 °C). Level of activity and choice were recorded per combination. Level of activity showed clear trends where the level of activity increased with increasing salinity and temperature. In general, the intermediate temperature was preferred at the different salinity levels when presented as a choice against combinations involving

the two extreme temperatures. The results were used to explain spatial and temporal distributions under field conditions. The implications of the observed behavioural responses of *M. zeylanica* on the susceptibility to predation and hence on the observed fluctuations in abundance of the amphipod are also discussed.

Light availability for primary producers in a large estuarine lake (Lake St. Lucia) experiencing highly variable water levels and turbidities

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Lake St. Lucia is a large, shallow estuarine lake located in northern KwaZulu-Natal, South Africa. During an extended drought water levels have decreased dramatically, reaching less than 0.5 m over large regions of the lake. At the same time, there are many windy days in the area and even a light wind can cause strong mixing and wave action over the large, shallow water surface of the estuary. This results in strong resuspension of the sediment and thus in a very high turbidity, and very high light attenuation factors, i.e. strongly reduced water transparency which may cause light limitation for primary production. On the other hand, high irradiance particularly in summer, may lead to light inhibition. This study considers the light availability for the benthic (micro-phytobenthos) and planktonic primary producers (phytoplankton) in dependence of different water depths and turbidities from a theoretical perspective. A mathematical model is used to estimate the primary production dependent on global irradiance, water levels, and light attenuation coefficients. The latter is directly linked to turbidity. Turbidity itself was found to depend on wind speed and water depth, with a higher water depth decreasing turbidity. That is, low ratios of photic to mixing depth may occur even in very shallow parts of the lake. The model is linked to field data from Lake St. Lucia to investigate to what extent light limitation or light inhibition are important for the dynamics of micro-phytobenthos and phytoplankton in this estuary.

(Poster 109) A study linking foraminiferal communities to their environment in St Helena Bay on the west coast of South Africa

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Sediment samples from a total of 70 cores around a fish factory pipeline in St Helena Bay were examined for foraminifera as well as for a suite of environmental factors. Sediment samples were dominated by a large mean grain size, high trace metals and high percentage nitrogen. A total of 28 morpho species were identified. The species diversity was lowest at the pipeline stations of St Helena Bay. Species accumulation curves reached asymptote, indicating that the sampling effort was sufficient. Diversity indices estimates were also close to those which were observed.

Species diversity, richness and abundance were negatively correlated with trace metals. The percentage nitrogen was negatively correlated with diversity. The mean grain size was negatively correlated with richness, diversity and abundance, although these correlations were low. Samples were dominated by small foraminifera and there was no correlation between the size of the foraminifera and the mean grain size of the sediments, though the small foraminifera could be indicative of a polluted environment or the cold temperate waters of both locations.

The relate statistic between the generic data and the species data was significant, an indication that genera could be used in monitoring. The dominant genera in St Helena Bay *Ammonia*, *Bolivina*, *Elphidium*, *Cibicides* and *Rosalina* were negatively correlated with trace metals and percentage nitrogen.

(Poster 110) What variables affect the numbers of Great White Sharks *Carcharodon carcharias* in Gansbaai?

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Boat based observations of *Carcharodon carcharias* have shown that there are seasonal patterns of occurrence of males and females at Gansbaai, Western Cape, South Africa. Observations of sharks and environmental variables were made between 2007 and 2010 from a cage diving vessel. Numbers of sharks observed were related to the explanatory variables using a generalized linear model, and sea surface temperature and season were the variables, which had

the most significant effects on numbers of sharks. Male sharks were more abundant in the bay during winter months from May to August, with females more abundant in spring, from July to November. The influence of environmental parameters on white shark presence has stimulated hypotheses for further studies in the area using telemetry to determine the effects of water properties on the inshore movements of great white sharks, specifically during the summer months.

Long-term environmental monitoring in Saldanha Bay and Langebaan Lagoon

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Saldanha Bay and Langebaan have been the centres of significant industrial, commercial and tourism growth along the West Coast since the early 20th century. Major developments within the Bay include the construction of the Marcus Island causeway and the iron ore jetty, and the establishment of a small craft harbour, desalination plant, mariculture farms and several fish processing factories. Anthropogenic pollutants and wastes are introduced to the area through dredging and port expansion, port activities, shipping, ballast water discharges and oil spills, municipal (sewage) and household discharges, discharge from fish processing factories, biological waste associated with mariculture, and storm water runoff. The development of the Saldanha Bay port has significantly altered the physical structure and hydrodynamics of the Bay, whilst all developments within the area have the potential to negatively impact on ecosystem health. This talk presents results of a comprehensive bay-wide environmental monitoring programme which commenced in 2004, but covers the period from the 1970's to the present day. Data have been collected on physical parameters (water temperature, salinity, oxygen levels, circulation patterns, and sediment particle size composition), faecal coliforms, trace metal contaminants in the water column and sediments, benthic macrofauna, intertidal invertebrates, fish communities and birds. The most recent 2010 report in the series of four "State of the Bay: Saldanha Bay and Langebaan Lagoon" reports examines long-term trends in the measurements of these physical parameters, pollutants and biological components of the ecosystem.

(Poster 111) The value of protecting the Kogelberg coast

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A valuation study was undertaken of the Kogelberg coast, based on existing data on fisheries and a survey of recreational users and property owners. Commercial fisheries are currently worth in the order of R20.1 million, of which R16.1 million is the value of the West Coast rock lobster fishery and the balance is the value of the line fishery. If recovered, the abalone fishery could potentially yield about R22.5 million, and the kelp fishery some R0.75 million. Subsistence fisheries around the Hawston/Kleinmond area are worth about R4 million. In addition to the permanent population of about 13 000, there are an estimated 4.3 to 5.3 million visitor days per year. Visitors spend an average of 70% of their leisure time at the coast. Two-thirds of visitors in summer were beach-oriented visitors and the remainder were fishing and water sport-oriented. Based on travel expenditure attributed to the area, the tourism value of the coast was estimated to be R191 to R235 million per annum. Coastal property in the area is estimated to be worth approximately R7.3 billion. Of this, the coastal premium was estimated to be just over R1 billion, translating to an annual value attributed to the coast of R59 million. Thus the recreational value of the coast is estimated to be in the order of R272 million. These values were mapped based on aerial surveys of users and the distribution of coastal property. In addition, the effect of changes such as reduced crime, MPA expansion, increased litter and changes in fish and cetacean numbers on future value of this stretch of coast was estimated based on a conjoint analysis.

Development and application of the Estuary Health Index in South Africa in the context of setting freshwater flow requirements

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In South Africa, aquatic ecosystem health is categorized on a scale of A to F (Ecological Category). The determination of the freshwater Reserve for estuaries involves deciding on the future Ecological Category for a system and determining the quantity and quality of flows required to achieve this. The method for determining the Reserve is thus dependent on the reliable determination of estuarine health, as well as understanding the relationship between freshwater

flows and health. Based on a critique of preceding methods for describing river and estuary health in South Africa, the Estuary Health Index was developed in 1999, and has since been tested in 26 Reserve determination studies of different levels of rigour. The results of these studies were analysed to examine the strengths and weaknesses of the index, as well as to find trends in the relationship between freshwater inflows and health. The results were correlated with earlier rapid assessments of estuary health. Confidence of the studies was primarily determined by the amount of historical data available rather than rigour of the fieldwork undertaken for the study. There were consistent trends between health and percentage of natural Mean Annual Runoff reaching the estuary, the slope of the relationship varying with estuary type and size. Weaknesses of the index are discussed in the light of the recent overhaul of the method in 2011.

Towards acoustic discrimination between finfish and jellyfish in the southern Benguela system

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Jellyfish abundance appears to have increased in recent years in several pelagic ecosystems worldwide. It has been suggested that these increases are in some cases symptoms of “regime shifts” that have followed either climate change or increased commercial exploitation of pelagic finfish, or both. Biomass estimates from routine acoustic surveys of pelagic fish discount the effect of energy backscatter from medusae and other organisms. The impact that dominant jellyfish have on the accuracy of acoustic biomass estimates of small pelagic fish was investigated and quantified using a multifrequency species identification method. To discriminate between jellyfish and finfish, we used multi-frequency acoustic data and ground-truthed trawl information from 14 trawls that were positive for *Aequorea aequorea* collected in daylight during an experimental survey. Preliminary results indicate that *A. aequorea* could be easily distinguished from fish. Numeric densities obtained from catch data reached a maximum of 0.00095 *Aequorea* per m⁻³, whilst integrated densities reached a maximum of 0.4 Ind.m⁻³. Results suggest that previously constructed acoustic data filters are functioning and therefore make it possible to separate the echograms into pure jellyfish and pure fish, but need some improvement. This analysis is important to evaluate the impact of jellyfish on acoustic estimates of pelagic fish biomass and improve the accuracy of acoustic estimates of fish abundance. Furthermore, it potentially facilitates future biomass estimation of jellyfish in the region.

(Poster 112) Updates of spawning habitat characterization of anchovy (*Engraulis encrasicolus*) and sardine (*Sardinops sagax*) in the southern Benguela using modified single parameter quotient analysis

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We analysed data on the occurrence of anchovy and sardine eggs collected during annual pelagic spawner biomass surveys conducted along the South African coast from 2000 to 2006. Egg samples were collected concurrently with oceanographic data in order to describe the environmental characteristics of the spawning habitats of each species over this period using a modified single parameter quotient (SPQ) analysis. We compare these recent spawning habitat characterizations with those derived using data collected over the period 1984 to 1999 and reanalysed using the modified SPQ. Sea surface temperature (SST) of preferred spawning habitat has increased over time for both species; anchovy preferred spawning habitat SST changed from around 17.5-19.5°C to 18.5-20.5°C over the past 23 years whereas that of sardine changed from around 16.0-18.5°C to 20-21°C. Changes in preferred ranges of other environmental variables distribution is shown by both species. No effect of different biomass levels on spawning habitat characteristics was found for either species. A newly developed method to compare the probability of egg presence across the surveyed area derived from oceanographic variables and spawning stock biomass was applied to ascertain whether there have been changes in the proportion of potential spawning habitat utilised, and whether this shows a relationship with spawning stock biomass. The significance and shape of the relationship between utilised spawning area and stock biomass can provide indications on the mode of habitat utilisation and can be used to link spawning strategies with ecosystem productivity. These analyses will assist in identifying possible impacts of environmental variability and climate change on anchovy and sardine spawning habitats.

Relationships between fish and benthic macroinvertebrate faunas and habitat types in a seasonally-open Australian estuary

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Critical to the understanding of estuarine ecosystems is a rigorous classification of their habitats and an assessment of the extent to which the distribution of key faunal assemblages are related to those habitats. This study relates a fully quantitative abiotic classification of the nearshore habitats within Broke Inlet, a 'near pristine' seasonally-open estuary in south-western Australia, to the fish and benthic macroinvertebrate communities present at those habitat types in each season for two years and one year, respectively. The eleven habitat types, which differed in their suite of enduring abiotic variables, including those reflecting the vicinity of marine and freshwater sources, exposure to wave activity and substratum type, were found to contain significantly different fish faunas in seven of the eight seasons sampled. Furthermore, the pattern of relative differences among habitat types, as exhibited by the ichthyofauna, statistically matched that among the suite of enduring abiotic variables used to distinguish those habitats in almost all seasons. However, while the benthic macroinvertebrate faunal composition differed among habitats in all four seasons, those differences were only significantly correlated with those among the abiotic characteristics of habitat types in one of those seasons. These results therefore demonstrate that the enduring abiotic classification scheme produced for Broke Inlet provides a sound basis for predicting the ichthyofauna, but not the benthic macroinvertebrate fauna, likely to be found at any location within the estuary.

(Poster 113) Phenotypic diversity of goatfishes (Mullidae)

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That the diversity of goatfishes is still insufficiently explored becomes immediately evident when looking at the impressive increase of species number in the Western Indian Ocean (WIO) from 21 reported in 1984 to 41 species known today. Eleven of the 20 WIO species that were added since have been described during the last three years only, due to recently enhanced taxonomic efforts stimulated by the South African Institute of Aquatic Biodiversity. The need for further comparative phenotypic studies of goatfishes from several still largely unexplored areas in the Indo-Pacific became apparent during a recent screening of museum collections in Europe, South Africa, the US and Australia. The genera *Upeneus* and *Mulloidichthys* deserve enhanced attention in particular, as they show considerable intraspecific variation in colour and body form that needs to be disentangled from characters allowing robust species diagnosis. Detailed studies of meristic, morphometric and colour characters provide also important information about adaptive traits involved in diversification and evolution of goatfishes.

Good examples are the tail-fin markings and lateral body stripes in *Upeneus* that should facilitate the co-existence of otherwise ecologically rather similar species. Colour patterns alone however do not always warrant reliable species distinction. For instance, the characteristic dark lateral spot of *Mulloidichthys flavolineatus* can be switched "on" or "off" depending on context. To overcome taxonomic challenges deriving from a rather high variability in colour and a rather low variability in meristic characters, a large set of morphometric characters has been used successfully in inter- and intraspecific comparisons of both genera. This comparative phenotypic approach towards a more thorough understanding of goatfish diversity has the added advantages of being applicable to formalin-fixed samples and permitting simple field-identification keys to be prepared. However, this approach aims also at integrating molecular studies towards a deeper understanding of evolutionary processes and patterns.

Sediment and heavy mineral distribution within the KwaZulu-Natal Bight

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Bottom sediments were sampled from within the KZN Bight with an average sample spacing of between 500 and 1000m. Grain size characteristics, mineralogy, total organic content and carbonate content were established for each sample. The KZN Bight is dominated by medium grained sands (0.5mm to 0.25mm) with two mud banks situated off the Thukela River mouth. Very coarse and coarse sizes (2mm - 0.5mm) are due to a high bioclastic component, mimicking the carbonate content distribution and are derived from reef systems. High organic contents are centered on the two Thukela mud banks. The magnetic component of the sediments, a function of the magnetite content, revealed a large northerly directed plume emanating from the Thukela mouth. The magnetite plume is interpreted as a submerged palimpsest strand line that existed during the last glaciation. This remarkable feature provides clear evidence that the Thukela drainage and the long-lived northerly longshore drift and KZN gyre were instrumental in generating the economically important heavy minerals deposits concentrated in the coastal dune cordon northwards.

(Poster 114) Estimating flushing time-scales for Plymouth Sound and its coastal zone using the three-dimensional model FVCOM

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Flushing time-scales and residence time-scales are useful indicators of the times required for the removal of fresh waters and solutes from a coastal and estuarine system and of the system's robustness to ecological disturbances. We present salinity measurements and modelled tracer distributions that are used to compute flushing time-scales in the Plymouth coastal zone. The FVCOM state-of-the-art coastal and estuarine model is used in its full, three-dimensional application. Flushing time-scales are initially computed for fresh water in the Plymouth Coastal Zone using measured salinity data and subsequently using FVCOM. There is close agreement for freshwater flushing time-scales: four to six days. The complexity of modelled tracer distributions is largely a consequence of the spatial complexity of tidal current patterns and their temporal fluctuations. Topographic steering of currents and the formation of recirculation patterns are an important component of this hydrodynamic complexity. Flushing time-scales depend on location and the sea volume considered, but they are approximately four to nine days if the source is located in Plymouth Sound or in the lower Tamar Estuary.

(Poster 115) The influence of the Thukela River on macrobenthic trophic guild communities in the central Natal Bight

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The Natal Bight off the east coast of South Africa is a unique shelf habitat, exhibiting high secondary productivity and supporting high diversity. Ecosystem attributes are influenced by local oceanographic features and outwelling via one of the largest rivers in the country. Our study forms part of a larger, multi-institutional, multi-disciplinary study under the African Coelacanth Ecosystem Programme (ACEP) investigating how material sources, posited to be derived from these features, shape the ecological structure and functioning of the Bight. This study describes trophic guild structure of macrobenthos influenced by the Thukela River, in relation to measurable environmental parameters such as sediment characteristics, depth strata, and other physico-

chemical and oceanographic variables. Transects set along different sediment distribution and depth related gradients were sampled during a wet (February 2010) and dry (August 2010) season. Quantitative data (abundance. m²) from the wet season are subject to multivariate classification and ordination analyses in order to elucidate spatial changes in trophic guilds. Preliminary results indicate that, contrary to many other shelf environments, inner shelf sediments off the Thukela are characterised by mud while the outer shelf is composed of coarser gravels. With the high mud and concomitant organic (POM) content of sediment, it is intuitive that this area is dominated by deposit feeders. Initial findings indicate that this is true and that the highest proportion of this feeding mode belongs to the Polychaeta, from family Spionidae. The latter are important structural and functional components of benthic infaunal assemblages. A first look at the macrobenthos indicates that this area is characterised by a high taxonomic diversity with many species poorly documented and described for the east coast. Our research will contribute to the principle aim of ACEP: to document and identify key nutrient sources of the Natal Bight and better understand the ecology of this region.

Classifying estuarine habitats and predicting their fish faunas

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This presentation will focus on a quantitative scheme for classifying nearshore habitat types and predicting their fish faunas, which has been developed for a range of estuaries in south-western Australia that differ widely in their geographical and geomorphological characteristics. This scheme provides a reliable framework for managers and ecologists to (i) investigate relationships between habitat types and faunal composition at local to regional scales and under different geographic and estuary-type scenarios, (ii) establish benchmarks against which the impact of future environmental change can be assessed and (iii) predict the habitat type and characteristic fauna of any nearshore site of interest within those systems. The habitat classification scheme has been based on the use of enduring environmental criteria that can be easily measured in GIS from mapped data sources such as satellite imagery and bathymetric charts, and has employed novel applications of relatively new multivariate routines. The results of this classification scheme, and the relationships between the derived habitat types and their fish assemblages, will be presented for five estuaries across south-western Australia, namely the permanently open Swan-Canning and Peel-Harvey estuaries, the seasonally-open Broke

and Wilson inlets and the normally-closed Wellstead Estuary. Questions regarding the importance of geographical location and estuary type in structuring habitat types and their fish faunas will also be addressed.

Temporal variability of nutrient fluxes onto the northern Natal Bight offshore of Richards Bay and from adjacent catchments

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The Natal Bight is one of a number of wider continental shelf regions along the east coast of Africa that are unusually productive. Key to this productivity is the supply of nutrients to these regions and their characteristic long retention times. For many bights to the north, nutrient fluxes from adjacent catchments play a significant role in the functioning of these ecosystems. The situation in the Natal Bight is more nuanced in that there is a significant additional source of nutrients onto the Bight from the adjacent ocean, driven by the close proximity of the Agulhas Current to the shelf edge. The two major oceanic sources of nutrients to the Natal Bight are considered to be due to shelf-edge upwelling occurring between St Lucia and Richards Bay and a recurrent lee eddy off the southern termination of the Natal Bight. Presently there is little clear evidence of significant nutrient inputs along the outer edge of the Natal Bight between its northern and southern extremities. While these sources of nutrients and to a more limited extent their distribution over the shelf have been described, very little is known of the temporal variability of nutrient fluxes onto the Natal Bight. This paper provides a preliminary characterisation of the temporal variability of the flux of nutrients onto the northern Natal Bight based on a combination of a time series measurements of currents and temperatures off Richards Bay undertaken as part of the African Coelecanth Ecosystem Programme II and historical nutrient data. These estimates, together with similar estimates of the nutrient fluxes onto the southern Natal Bight (yet to be undertaken), provide the necessary context for a preliminary assessment of the relative importance of nutrient fluxes from the adjacent catchments and other sources on the Natal Bight ecosystem.

Calibrating ecosystem models of the southern Benguela with stable isotope data

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Ecosystem models that link ecologically important species through their trophic interactions have been developed to investigate food web structure and functioning in marine ecosystems. In these models trophic linkages are usually based on studies of dietary composition, which is poorly known in many instances and may be biased because of incomplete spatial and/or temporal coverage. The analysis of stable isotopes of nitrogen and carbon in animal tissues can assist in elucidating food web structure, because a consumer is slightly more enriched in these isotopes than is its diet. In addition, isotopes integrate the relative contributions of isotopically distinct dietary components over a period of time, providing an average estimate of an organism's diet that is less subject to temporal or spatial bias than stomach content analyses. We measured the nitrogen stable isotope ratios ($\delta^{15}\text{N}$) of a large number (approximately 1 000) of samples from important species in the pelagic foodweb of the southern Benguela ecosystem, spanning primary consumers to top predators. Taxa analysed include copepods, euphausiids, small pelagic fish, mackerels, squid, hakes, large pelagic fish and sharks, and samples had wide spatial and temporal coverage. Species-specific observed mean $\delta^{15}\text{N}$ ratios were compared with $\delta^{15}\text{N}$ ratios predicted from their trophic level derived in recent Ecopath models of the southern Benguela. Predicted $\delta^{15}\text{N}$ was calculated using copepods as the isotopic baseline and equating their observed mean $\delta^{15}\text{N}$ value to the model-derived trophic level for mesozooplankton, and assuming a 3.4 ‰ increase in $\delta^{15}\text{N}$ per trophic level. Observed $\delta^{15}\text{N}$ values were higher than predicted values for almost all other species, with the difference between the two increasing with increasing trophic level. Possible reasons for differences between model and observations are discussed, and the utility of using stable isotope data to calibrate trophic models is assessed.

(Poster 116) Documenting the non-geniculate coralline algal flora of the South African south coast

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Non-geniculate coralline red algae are common in all of the world's oceans, where they often occupy close to 100% of the primary rocky substratum. The South African (SA) rocky subtidal and intertidal habitats in particular, are rich in diversity and abundance of these algae. Despite their ubiquity, they are a poorly known and poorly understood group of marine organisms. Few scattered records of non-geniculate coralline red algae were published prior to 1993, but these should be treated with caution since many taxa have undergone major taxonomic review since then. A series of taxonomic studies, based mainly on the Western Cape Province, published particularly between 1993 and 2000, has significantly extended our knowledge of these algae from southern Africa. In 2008, references to these latter papers and the older records were gathered in a single publication providing a catalogue with keys to the various non-geniculate coralline algal taxonomic categories. However, ongoing global taxonomic changes to the subclass Corallinophycidae, as well as the lack of complete records for the entire SA coastline, have meant that the inventory of non-geniculate coralline algal flora of SA is incomplete. This study is aimed at documenting the intertidal and shallow subtidal species of non-geniculate coralline alga from the SA south coast. Here we present our preliminary findings, reporting on the current biodiversity status of the group after three years of active sampling along the SA south coast.

The use of learning support materials in the rural schools of Maputaland, KwaZulu-Natal, South Africa

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The African Coelacanth Ecosystem Programme (ACEP) was established in 2002 after the discovery of a colony of coelacanths off the Maputaland coast at Sodwana Bay, KwaZulu-Natal. The environmental education and awareness sub-programme developed learning support materials (LSM's) for use in schools and the materials were disseminated annually through teacher education workshops.

This study aimed to uncover the use of these LSM's in the rural schools of Maputaland. The active learning framework was used to analyse the materials. Collectively, the ACEP materials cover a range of active learning aspects; however alignment with the curriculum has resulted in an increased focus on experiments, accompanied by a loss of environmental content and a narrowing scope for active environmental learning.

Workshop questionnaires and four school case studies revealed the patterns of practice of use of materials in schools. The stated use of materials by teachers is not

fully realized in the actual classroom practice which centres on learning content and concept definitions. There is no culture of use of materials in the schools following the annual introduction of ACEP materials. It was also found that the marine and coastal knowledge holding power is outside the realm of the teachers' practice and control.

The findings of this study come at a time when there is uncertainty over the future of South African education and the curriculum. This research may inform the environmental education and coastal and marine education field as to their role in education and more specifically the development of learning support materials.

(Poster 117) Microphytoplankton diversity and distribution of the Natal Bight, South Africa

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The microphytoplankton diversity and distribution on the Natal Bight continental shelf (30.3S, 30.8E - 28.9S - 32.0E) was studied during two cruises in 2010 as part of ACEP II. Samples were collected from several depths in the photic zone with a rosette bottle sampler on 8 transects totalling 24 stations. The nutrient profiles of the water column showed very low nutrient concentrations with especially silicate being below the detection limit in many instances. A potential source of silicate was the Tugela river in summer. Close to the mouth, slightly elevated levels of the nutrient and of phytoplankton biomass (chl_a), were measured. Initial results indicate that the dominant microphytoplankton group in the Bight was the Bacillariophyta (diatoms), followed by Dinophyta, Haptophyta (coccolithophorids), Cyanophyta and Chlorophyta. The southern regions of the Bight were dominated by *Pseudonitzschia* and *Thalassionema*. Some of the Diatom taxa that were recorded on the southern end of the Bight during the present study, have previously only been reported from the Southern Ocean. The information on the distribution of taxa will in future serve to better explain pigment analyses data and ground truth ocean colour (remote sensing) data. The latter would enable an assessment of phytoplankton distribution on larger spatial and temporal scales.

African penguin foraging ecology in relation to fine-scale oceanographic processes in Nelson Mandela Bay, South Africa

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The African Penguin (*Spheniscus demersus*) is a marine predator that is struggling to cope with environmental change and has recently had its species status elevated to Endangered by the IUCN. Its population has decreased by 60% over the last decade, largely due to localised over fishing and a recent eastward shift in pelagic fish, possibly due to climate change. Over the last two years, African Penguins have responded to environmental change and food shortages by extending the amount of time they spend at sea searching for prey and by increasing the length of their foraging tracks. These findings highlight the need to fully understand the foraging ecology of African Penguins. We assess how African Penguins breeding on Bird Island, Nelson Mandela Bay, South Africa, forage in relation to the oceans thermal and circulatory patterns around the island on a fine temporal and spatial scale. We implement miniature GPS loggers coupled with a temperature-depth recorder attached to the birds in addition to a network of twelve under water temperature recorders and two acoustic doppler current profilers distributed throughout the bay to determine the bays oceanography. Birds foraged preferentially in coastal waters up to 100 metres deep where they mostly utilised the first 30 metres of the water column and targeted a narrow range of temperatures. Dives were directed towards a weak winter thermocline, suggesting that the winter thermocline may play an important role in the foraging strategy of the African Penguin. If the penguins use fine-scale oceanographic features such as temperature gradients, thermoclines and currents to locate areas that are most likely to host their prey, climate change may further disrupt their ability to successfully locate what little prey is available to them, further adding to their plight.

Climate change and South Africa's estuaries

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The impacts of climate change on estuaries include: 1) Changes in precipitation and runoff influencing seawater intrusion, mouth closure, nutrients fluxes and sediment deposition/erosion, 2) Rising temperatures, 3)

Sea level rise, 4) Changes in ocean circulation patterns, and 5) Increase coastal storminess. An analysis shows that the KwaZulu-Natal and West Coast estuaries will be the most effected by climate change from a structural and functional perspective. In KwaZulu-Natal the major driver of change is increased runoff into the numerous small, perched, temporarily open/closed estuaries (TOCEs), which will result in more open mouth conditions, a decrease in retention time, and a related decrease in primary productivity and nursery function. In contrast, the West Coast estuaries will be negatively affected as a result of reduction in runoff - with a related decrease in nutrient supply- and sea level rise. This in turn will increase salinity penetration in the permanently open systems and increase mouth closure in the TOCEs. Similar to KwaZulu-Natal, the West Coast estuaries will display a decrease in primary production and a loss of nursery function. Although the Transkei, Eastern and Southern Cape estuaries will also show some shifts in mouth states, nutrient supply, salinity distribution and ultimately production (e.g. fisheries), the most obvious impacts of climate change along these coastal regions will be the change in temperature (nearshore and land) and the associated range extensions of species and community composition changes. In summary, contrary to the current monitoring programmes which are focussing on biotic responses in the biogeographic transition zones (e.g. Transkei and Southern Cape) the most significant structural and functional changes will be in the estuaries of KwaZulu-Natal (subtropical) and the Western Cape (cool-temperate). Monitoring programmes should be designed to address this.

(Poster 118) A review of apparent cosmopolitan shell infesting spionids on the South African coastline

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The oyster industry in South Africa is maintained by the importation of oyster spat which may be large enough to carry shell-infesting *Polydora*-type worms, potentially spreading them beyond their natural distribution. Locally, fifteen species were found on molluscs including oysters and abalone; one is invasive while seven more are considered to be cosmopolitan (species found over a wide geographic range) based on morphological techniques. The prevalence of sibling-species complexes within this family suggests that many of these so called cosmopolitan species may in fact be sibling species. We propose to use morphological and molecular techniques to describe and compare members of the *Polydora* complex which infest the shells of commercially important mollusc species such as oysters and abalone on the South

African coastline. Here we present preliminary results on the cosmopolitan status of one of these species, *Dipolydora cf giardi* which show major differences in the morphology of the modified spines between South African and Italian material. This suggests the presence of sibling species, but needs to be confirmed with molecular analysis. A review of the rest of the 'cosmopolitan' species will be presented.

Long-term changes in autumn abundance, species composition and size structure of the copepod community in St Helena Bay over the past six decades

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Zooplankton samples collected in St Helena Bay during austral autumn since 1951 were analysed in terms of abundance, species composition and size structure of copepods, usually the most abundant members of zooplankton communities worldwide, which form the dominant link between primary producers and higher trophic levels. There was an initial multi-decadal phase of increase in total copepod abundance, reversing in the mid-1990s and declining thereafter. Marked changes in species composition accompanied this long-term shift in abundance, with typical upwelling species (*Calanoides carinatus* and *Centropages brachiatus*) becoming less prominent during the decline phase compared with the increase phase. Tracking changes through time of zooplankton communities using average copepod community size (ACCS) enables detection of major changes in community structure as a consequence of shifts in environmental conditions. Analysis of annual ACCS versus annual anomalies of Extended Reconstructed Sea Surface Temperature (ERSST - here used as a proxy for decade-scale environmental change) in St Helena Bay since 1951 reveals that comparatively large species were predominant during the period 1951-1978, when cool temperatures prevailed in the area. Conversely, smaller species dominated the community during the period 1984-present, when ocean warming of the area was evident. The latter pattern was, however, disrupted when coincident with a prolonged El Niño during the early 1990s, large species such as *Rhincalanus nasutus* and *Calanus agulhensis* made a brief but prominent re-appearance in the samples of 1990-1994; the underlying mechanisms behind this behaviour are not fully understood. Because cold-water copepods are often larger in size than their warm-water counterparts, a shift to a smaller average size – presumably since the early 1980s - is indicative of warming of the ecosystem. This has, as a consequence,

a fundamental effect not only on zooplankton rate processes (e.g. growth and production) but also on, for instance, predation by and recruitment of higher trophic levels that feed size-selectively.

(Poster 119) Spatial patterns and seasonal trends of whales and dolphins in the Greater Dyer Island area based on data from a commercial whale watching vessel

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In South Africa, licensed whale watching vessels are required to collect data on trip statistics and the species, number and behaviour of animals encountered. Although trips are restricted in range, these vessels can act as platforms of opportunity for the collection of photographic, behavioural and spatial data. This information is valuable in otherwise data-poor areas. Here we analyse 11 years of opportunistic data (2000-2010) collected by biologists aboard the whale watching boat operating between Danger Point and Quoin Point, Western Cape. We investigate seasonal and spatial patterns in cetacean presence and behaviour in the area, using trip statistics to account for survey effort. Six species of whale and dolphin were regularly observed. Seasonal trends in abundance are clear for: southern right whales (peak: Jun-Dec with mating observed Aug-Nov), humpback whale (peak: Jun-Dec), Bryde's whale (peak: Jan-Jun). Common, Indo-Pacific bottlenose and Indo-Pacific humpback dolphins showed no seasonal trends and were seen throughout the year. Habitat segregation between species was clear. Humpback dolphin distribution was restricted to very shallow water (<7m), and two main areas, one in the vicinity of a river mouth. Bottlenose dolphins used a wider range of inshore habitat including around Dyer Island. Common dolphins, were mainly seen in offshore waters (majority >15 km). Right whale distribution was restricted to nearshore waters (<2km from shore). Bryde's whales and humpback whales were observed throughout the surveyed area. Data collected from whale watching boats have several limitations including variation in observer training and reporting, bias in effort towards areas and periods of high whale density, non-random surveys and short periods of observation. We discuss the relative benefits of this type of data and its importance for local conservation initiatives in data poor areas.

Food web structure in Mediterranean coastal lagoons under different trophic conditions

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The analysis of stable carbon and nitrogen isotopes is a method that has been widely used in past decades to establish the origin and flow of organic matter within food webs in natural ecosystems. The transfer of isotopes throughout the food web undergoes expected variations as a consequence of predictable patterns in metabolic isotopic fractionation. Accordingly, the carbon isotope ratios of animals reflect those of their food sources plus a slight enrichment, whereas nitrogen undergoes a greater fractionation.

While a number of stable isotope studies have been carried out on typical estuarine environments, only a few relate to coastal lakes and lagoons. Here we present the results of isotopic investigations of several Mediterranean coastal lagoons with the aim of showing how stable isotope measurements can provide crucial information for the analysis of complex ecosystems.

We used stable isotopes to describe organic matter transfer from primary producers to top level consumers, to elucidate the contribution of autochthonous and allochthonous organic matter, to discern benthic-pelagic coupling and to investigate inter-basin differences in food web structure.

The main findings of this study suggest site-specific features for the trophic contribution of primary organic matter sources. However, some correspondence exists between the role of basal sources, their isotopic signatures and environmental features (trophic state, exchange with the open-sea, residence time).

How many species of southern African marine fishes?

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Globally it is well recognised that biodiversity inventories are not yet complete, with potentially thousands of species unknown to science. Generally, marine systems lag behind terrestrial systems in terms of species discoveries. In southern Africa, a number of novel marine fishes have recently been described, which include larger fishes such as skates and sharks, so it is likely the fish biodiversity in the region is undersampled. This paper uses species discovery curves and a maximum likelihood model to estimate the unknown portion of endemic, southern African fishes. The results suggest that at least 25% of the total

endemic marine fish fauna is as yet undescribed. By analysing total maximum length (TL) and depth, results indicate that most undiscovered species will be small (<10cm TL) and inhabit shallow environments (<10m), probably inhabiting the sub-tropical/tropical waters of the east coast. At the current rate of fish discovery it will take at least 50 years to describe the total endemic fish fauna. Globally and regionally, gobies have by far the most undescribed species. Overall, size is the greatest predictor of whether a marine fish has been described, with smaller sized fishes and those inhabiting shallow areas most likely to be undersampled. It is likely that estimates of unknown biodiversity are probably higher still due to cryptic species and hybridisation within and between currently recognised species. The importance of molecular tools in delineating species is highlighted. Further, climate change may also contribute to range expansions of marine species, thus complicating the status of endemism in southern African marine fishes.

Settlement intensification and the interpretation of topography-related intertidal abundance patterns

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Within the suite of factors that influence settlement of intertidal invertebrates on rocky shores, habitat availability has a direct effect on potential settlement per unit area. Consequently, the amount of habitable free space may also influence recruitment dynamics through density and competition-related mechanisms, making it relevant to explanations of intertidal distributions and abundance. Results concerning the direction of the relationship between habitable free space and settlement have, however, been contradictory. Several studies conclude that settlement is positively correlated with free space, while others have identified inverse relationships. The most recent of these convincingly model and document an intensification effect whereby barnacle settlement is inversely correlated with free rocky habitat. Combining a simple method of measuring alongshore habitat availability with intertidal mussel settlement data from 20 sites, we examine the relationship between these two factors at three spatial scales (10m, 100m, 1000m) to test for any such intensification effect and to identify the scale(s) at which it may take place. With little difference in habitat availability among sites at the 10m scale, no correlation was found. Significant negative correlations were, however, identified at the 100 and 1000m scales, confirming an intensification effect. The strongest of these correlations was found at the 1000m scale. The findings are discussed in the context of large-scale mussel abundance patterns and how these

relate to the effects of coastline topography, with particular focus on the implications for explanations of patterns of distribution.

Toward an effective management and governance approach within Large Marine Ecosystems based on predictive monitoring and early warning systems

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There is a strong general agreement on the necessity for assistance to be targeted at the more vulnerable countries to take appropriate adaptation measures for climate change and ecosystem variability, but there is a missing link in terms of how to identify, at the regional and national level, what such measures would need to address and at what scale, in relation to the predicted and actual measurable inputs. Little attention has been given to the need for monitoring and measurement mechanisms at the regional and local level that can A. provide accurate indications of specific changes related to climate change at the ecosystem level whilst B. identifying the scale and distribution of expected impacts, and C. translating these into reliable predictions and policy guidelines which countries can act upon so as to adapt and mitigate/avert the negative impacts. Yet this must have inevitable and significant implications in terms of prioritisation of actions and targeting of available funding. Although there is much discussion about mitigation and adaptation, there has been little focus on continuous and sustainable monitoring of changes in many of the world's more vulnerable areas, the data and information from which are essential in justifying and prioritising management and governance actions, and to provide credibility for policy decisions. An additional hurdle is translating the needs, priorities and language of science and scientists to managers, politicians and governance structures, and *vice versa*.

It is concluded that there is an urgent need to develop focused early warning and continuous long-term monitoring networks, particularly in relation to critically vulnerable ecosystems and communities. These need to be sustainable and sufficiently credible in their data and information outputs to be able to drive reliable predictive mechanisms for adaptive management and governance, driven not only by sound science, but fully aware of and reactive to the socio-political needs and impacts of such vital research and monitoring. The Large Marine Ecosystems of the world are seen to be directly related to major global physical phenomena with a particularly close linkage to climate in terms of ocean-atmosphere interactions.

Specific indicators need to be selected that will act as early warnings of ecosystem variability and climate change at a global, regional and local level.

The steps taken to date by the UNDP/GEF ASCLME Project and its partners to address these challenges and facilitate the creation of robust and effective transboundary management mechanisms that bridge the gap between "science" and "governance" and plans for the creation of a region wide indicator monitoring network and early warning system are presented.

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(Poster 120) Macrophyte phenology in a temporarily open/closed estuary compared with a permanently open estuary

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Macrophyte phenology in response to environmental conditions was investigated in the East Kleinemonde Estuary, a temporarily open/closed estuary (TOCE), and the Kowie Estuary, a permanently open estuary (POE), along the eastern coastline of South Africa. The lack of freshwater flooding due to low rainfall coupled with several over-wash events resulted in prolonged mouth closure. This caused habitat inundation, high water level and high salinity in the TOCE. These conditions, including reduced sediments, were the most significant environmental factors affecting macrophyte phenology. Macrophyte phenology in the POE was driven by temperature, sediment redox potential and salinity. Conditions in the TOCE significantly reduced macrophyte cover whereas macrophytes in the POE maintained high cover abundance due to seasonal re-growth. Subsequent to water level dropping in the TOCE, *Sarcocornia tegetaria* and *Salicornia meyeriana* completed their life-cycles producing viable seed within four and three months respectively. In contrast, the *Sarcocornia* hybrid and *S. meyeriana* in the POE took seven and nine months respectively. *S. tegetaria* did not germinate in-situ but reproduced vegetatively despite producing seed. In the TOCE, *Ruppia cirrhosa* and *Chara vulgaris* completed their life-cycles within five and three months respectively. The reproductive periods for the intertidal and reed and sedge macrophytes were shorter in the TOCE. *Sarcocornia decumbens* and *S. tegetaria* produced substantially higher seed quantities, while *S. tegetaria* produced significantly higher seed quantities during the second reproduction period despite significantly lower cover in the TOCE. Seed production in *S. meyeriana* was significantly higher in the POE due to higher cover compared to the TOCE. The research suggests that

macrophyte phenology in the TOCE was event driven compared with the POE where macrophyte phenology was more stable and cyclically predictable. TOCEs should be managed to prevent inundation of the intertidal and supratidal habitats during peak flowering and seed production i.e. spring/summer.

(Poster 121) Microbial diversity associated with marine sponges - a useful tool for taxonomic classification of marine sponge species?

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The Southern African coast is a rich source of sponge species belonging to the Family *Latrunculiidae*, many of which produce biologically active natural products. In particular, we are interested in the Genus *Tsitsikamma*, currently comprising three species namely *T. favus*, *T. scurra* and *T. pedunculata*, which have been shown to produce discorhabdin and pyrroloiminoquinone type compounds which are of interest as cytotoxic agents. The aim of this research was to develop a reliable molecular identification protocol to distinguish between these and other potentially new species belonging to the genus *Tsitsikamma* and Family *Latrunculiidae*. Our first approach was to examine the nucleotide sequence of the mitochondrial CO1 region as well as the cytoplasmic 28S rRNA region for *T. favus* and *T. scurra* as well as two additional, unidentified *latrunculiid* specimens sampled in close proximity to the *Tsitsikamma* specimens in Algoa Bay. We observed sufficient levels of sequence divergence to distinguish between species belonging to different genera, but were unable to distinguish between members belonging to the genus *Tsitsikamma*. Our second approach was to characterise the microbial diversity associated with the different sponge species using denaturing gradient gel electrophoresis (DGGE) and pyrosequencing analysis of the 16S rRNA genes. The results show that sponge specimens belonging to the same species are associated with a distinct and conserved population of microbial species, while there are significant differences in the microbial diversity associated with sponge specimens belonging to different species within the genus *Tsitsikamma*. We propose that differences in the microbial diversity might prove to be a useful tool for distinguishing between closely-related marine sponge species.

(Poster 122) Comparing three underwater transect techniques for surveying reef fishes at Sodwana Bay, South Africa

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The iSimangaliso Wetland Park is comprised of the Maputaland and St Lucia Marine Protected Areas. The Park has been protected since the mid 1980's and was declared a world heritage site in 1999. To date, however, there have been few fish-specific investigations. The primary aim of this study was to determine which of three underwater transect techniques; slate-, photographic-, or video-transects, would be best suited to investigating the community structure and dynamics of coral reef fishes on one of the largest patch reefs in the area - Two-Mile Reef. Transect length was standardised to 50 m and a stratified, random sampling design implemented. A total of 45 transects were conducted with 15 replicates per transect technique. Results show that across all three transect types, 12708 fishes consisting of 189 species from 36 families were positively identified. Visual transects provided the lowest overall abundance of 3880 fishes but the highest species count of 146 species. For photographic and video transects two analyses types were implemented - Standard counts and *MaxN*. Standard counts showed abundances of 4492 and 4336 fishes for photographic and video transects respectively. *MaxN* have showed abundances of 2027 and 1667 respectively. Both analyses types provided species counts of 118 for photographic- and 138 for video-transects. Total analysis time for photographic and video transects was 234 hours with each transect type taking 106 and 128 hours respectively. The optimal transect technique will be used in a seasonal comparison of the depth related community structure of coral reef fishes in the area. The results of this research will provide essential baseline information for the development of a long term monitoring program within the iSimangaliso Wetland Park, essential for marine and coastal conservation.

(Poster 123) The importance of estuarine head waters for young marine fishes with particular emphasis on freshwater inflow, migration barriers and non-native predators

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The utilisation of estuary headwater environments by young estuary- and marine-spawned fish species was

investigated together with the effects of riverflow alteration, in-stream barrier effects and non-native ichthyofauna on the nursery function of these habitats. The distribution and abundance of young estuary- and marine-spawned fish were sampled using seine and fyke nets in the headwater environments of four permanently open Eastern Cape estuaries. Within the suite of study systems, the first of two case studies focussed on barrier effects of in-stream structures on fish migration. This was undertaken in the Sundays River. In the second case study, predation and competition dynamics of the non-native piscivorous *Micropterus salmoides* on estuary-dependent fish was investigated in the estuary headwater regions of the Kowie River system. In all four estuaries, young estuary-spawned fish species dominated the ichthyofaunal community followed by marine-spawned species, despite varied freshwater inflow resulting in headwaters varying in salinity from fresh to hypersaline. Fish community structure however, differed largely between estuaries, with both freshwater abstraction and unnatural elevation of freshwater into estuaries, as a result of inter-basin transfers, affecting these communities. In-stream structures were found to effect upstream movement of fish in two ways, dependent on the type of barrier. Partial (size-dependent) and complete (species-dependent) restriction to upstream migration of fish by causeway-type in-stream structures were observed. Weir-type in-stream structures acted as a complete barrier to most species, regardless of fish size. Predation of estuary- and marine-spawned fish species by large sized *M. salmoides* was recorded, although these fish did not contribute significantly to their diet during this study. However, the main dietary components found in smaller sized *M. salmoides* stomachs overlap with those of juvenile estuary- and marine-spawned fish species, suggesting feeding competition between the juveniles of indigenous and non-native fish species.

Assessing long-term distributional changes of key commercial fishes in the southern Benguela using spatialised indicators

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Several commercially and ecologically important species in the southern Benguela have undergone southward/eastward shifts in their distributions over previous decades. Understanding these changes and their implications is essential when attempting to appreciate the possible impacts of future environmental change. Distribution maps were constructed for three different time periods since 1985 for key species in the

southern Benguela: anchovy *Engraulis encrasicolus*; sardine *Sardinops sagax*; round herring *Etrumeus whiteheadi*; Cape hakes *Merluccius capensis* and *M. paradoxus*; horse mackerel *Trachurus trachurus capensis*; chub mackerel *Scomber japonicus*; kingklip *Genypterus capensis*; chokka squid *Loligo vulgaris reynaudii*; snoek *Thyrsites atun*; kob *Argyrosomus sp*; yellowfin tuna *Thunnus albacares*; yellowtail *Seriola lalandi* and geelbek *Atractoscion aequidens*. To identify possible changes in the level of interspecific interaction over time, maps were used to calculate proportions east and west of Cape Agulhas, overlap in area and biomass, system connectivity, and a measure of spatial biodiversity. Interactions on the east and west coasts were also compared. In many cases distribution and patterns of interaction appear to have changed over time. Particularly when considering regional differences there are notable shifts in species distributions and the potential interactions between species (predators, prey and competition for common prey) on the east and west coasts. Overlap with small pelagics increased over time for several species (chokka, horse mackerel and chub mackerel). System connectivity was lowest in the intermediate period, during which the Benguela was changing from one spatially-distinct state to another (1997-2000), and declined over time on the west coast while increasing on the east coast.

Studying squid spawning behaviour using Acoustic Telemetry Techniques

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Measurements of animal movements, activity, and energetics in nature, have always been technologically challenging. The evolution and improvement of novel acoustic telemetry technology is driven mainly by the need to address more complex behavioural, ecological and physiological questions.

The South African squid, *Loligo reynaudii*, is known to have a complex mating and egg laying behaviour, including pairing, competition for mates, different methods of mating, and different sperm deposition sites. Here we present the results of a study conducted over three spawning seasons of the spawning behaviour of *Loligo reynaudii* in St. Francis Bay, South Africa using a traditional three and four array wireless

acoustic positioning system coupled with presence/absence passive receivers.

Also, we introduce a novel telemetry approach using Vemco VR2-W acoustic presence/absence receivers and synchronizing transmitters to provide long-term, fine-scale positional data on animals fitted with coded acoustic transmitters. We introduce a new accelerometer transmitter that when combined with VR2W VPS positioning provides more accurate activity and energetic estimates for aquatic animals.

Impact of effluent discharge on the receiving environment off Durban

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Large volumes of sanitary and industrial effluent are discharged into the marine environment off Durban on a daily basis through outfalls that serve the Central and Southern wastewater treatment facilities. The impact of the discharges on the receiving marine environment is monitored annually and has provided important information for managing the discharges. In 2009 the sampling design for the monitoring programme was radically altered and has revealed impacts that were previously not (clearly) discernible. There is evidence that sediment in the vicinities of the diffuser sections of both outfalls is contaminated by metals and organic chemicals (e.g. polycyclic aromatic hydrocarbons). However, the level of contamination is so low that there is little probability the contaminants are directly toxic to benthic invertebrate communities. There is, however, evidence for the enrichment of sediment near both outfalls with organic matter, which in turn has led to an increase in the chemical oxygen demand in sediment. The accumulation of organic matter and the elevated oxygen demand in sediment in the vicinity of the Southern wastewater facility outfall has reached a state that the sediment is now anoxic. This has substantially impacted the benthic invertebrate community near the outfall, which is showing ever increasing evidence of becoming dominated by polychaete worms that are tolerant of high organic loads in sediment. The impact is however restricted to a relatively small area in the vicinity of the outfalls. The implications of these findings on receiving water quality impairment are discussed in the context of the need for and problems associated with effluent discharge in South Africa.

The influence of mouth condition in temporary open closed estuaries on populations of estuarine fishes with different recruitment strategies

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Estuaries are important for many reasons, most notably because they act as nurseries for marine fish and shellfish resources. In dictating how larvae and juveniles of marine spawned species recruit into estuaries, the physical nature of the connection between estuarine and marine systems is crucial in facilitating this nursery role. Mouth condition therefore plays an important part in influencing populations of marine spawned fishes in estuaries and the structure of estuarine fish communities. In South Africa, where estuaries are numerically dominated by temporary open-closed systems (TOCEs), this becomes an important consideration. This study explored this aspect of estuarine ichthyology by investigating the occurrence and abundance of closely related marine fish in subtropical temporary open-closed estuaries. Concentrating on similar species from a single geographic region removed the potentially confounding influences of biogeography and major physiological differences in species involved. Different recruitment strategies can explain the success of the Cape Stumpnose *Rhabdosargus holubi* in utilising predominantly closed TOCEs compared to the congeneric Tropical Stumpnose *R. sarba*. Connectivity in these small TOCEs, as a function of frequency of mouth open phase, affects fish species differently depending on their life history strategies and estuarine dependence. Alterations in freshwater flows into estuaries and consequently changed mouth dynamics will clearly influence estuarine populations of the study species, and this has implications for marine populations of these fishes. Estuarine populations of *R. sarba* appear to be sensitive to relatively small changes in mouth open frequency. Increases in mouth closure that result in TOCEs changing from predominantly open to predominantly closed are likely to lead to reductions in marine populations of this species.

(Poster 124) Do sardine around southern Africa look alike? Meristic and morphometric variation amongst sardine (*Sardinops sagax*)

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Spatial variability in meristics (vertebral count) and morphometrics (body shape) was investigated for 1048

sardine *Sardinops sagax* from 43 samples collected from three southern African regions: Namibia, west coast and south-east coast of South Africa. There were differences in vertebral counts (Kruskal-Wallis $H = 23.135$, $n_N = 217$, $n_W = 329$, $n_{SE} = 320$, $P < 0.001$), with Namibian sardine tending to have more vertebrae than South African sardine, but with no difference between South African west and south-east coast sardine. Principal component analysis indicated regional differences in body shapes and discriminant function group centroids for the three regions differed significantly ($F^{NvsW}_{16,10} = 29.49$, $F^{NvsSE}_{16,10} = 27.16$ and $F^{WvsSE}_{16,10} = 18.00$, $P < 0.001$). Namibian sardine have thicker bodies, bigger heads and smaller tails than South African sardine. Off South Africa, sardine on the south-east coast tend to have thinner bodies and smaller heads than those on the west coast. Significant meristic and morphometric differences between sardine from Namibia and South Africa provide further evidence of the separation of these sardine stocks, and differences in body shape between South African west and south-east coast sardine support the hypothesis of these being two discrete stocks.

(Poster 125) Temporal and spatial variations in shore angler CPUE in the Western and Eastern Cape, South Africa

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The monitoring of recreational shore angling provides insight in to the extent of the impact that this sector has on inshore coastal resources. Collection of effort, catch, and catch-per-unit-effort (CPUE) for recreational shore anglers through roving creel surveys was initiated at five sites (Kogelberg, Stilbaai, Mossel Bay, Plettenberg Bay, East London) on the southern and Eastern Cape coasts of South Africa in January 2010. Surveys have been conducted on the coast and in estuaries at each site. Sites were chosen in areas where surveys have been conducted previously; where MPAs are inclusive, adjacent or in close proximity; or where there is a deficiency of data in what are otherwise heavily fished areas. Estimates of effort (angler hours.km⁻¹.day⁻¹) and catch per unit effort (CPUE) (fish.angler hour⁻¹) will be used to make comparisons on 1) a temporal scale with data from previous studies and on 2) a spatial scale across geographic scales, between MPA and non-MPA areas, and between estuaries and the coast. Changes and differences in catch composition and size frequencies of catches will also be analysed across these scales. A year's complement of data can give insight into changes in each areas coastal environment and it potentially seeks to highlight the benefits of MPAs in the adjacent areas,

though longer-term monitoring is required to draw conclusions with certainty.

Conservation of fishes in South African estuaries at a crossroad

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The conservation of fishes in estuaries on the subcontinent is threatened by a number of factors, including habitat degradation, disruption of essential ecological processes, hydrological manipulations, environmental pollution, overexploitation and, more recently, climate change and the impacts of introduced aquatic animals. Although major threats to fishes are usually linked to environmental degradation, there is increasing evidence that the stocks of heavily targeted species are collapsed. Fish conservation and fisheries management does not depend on the implementation of a single action but rather the co-ordination of a detailed plan, often in a multidisciplinary context. Some examples of innovative means of contributing to estuarine fish conservation in a South African context include the determination and implementation of the ecological freshwater requirements for estuaries, the zoning of estuaries for different uses, and the recognition that the maintenance of ecological processes are vital to aquatic ecosystem health. Apart from the designation of protected areas, the main direct means of conserving fish species and stocks include habitat conservation, controls over fishing methods, effort, efficiency and seasonality, pollution control and the prevention of artificial manipulation of estuary mouths. Since becoming a democracy in 1994, environmental legislation, policy and institutional arrangements in South Africa have undergone some major changes which, if fully implemented, will be very positive for environmental and fish conservation in estuaries on the subcontinent. Unfortunately the current situation is one of increasing estuarine pollution and habitat degradation (especially of those systems in urban areas), disregard for environmental legislation (e.g. sand extraction from the headwaters of estuaries), lack of compliance to fisheries control measures (e.g. size and bag limits), widespread poaching using nets of various types (e.g. gill nets), targeted exploitation of the spawning stock of certain species (e.g. dusky kob and white steenbras), legal and illegal fishing in estuarine protected areas (e.g. in Lake St Lucia and Kosi), slow implementation by government authorities of the ecological flow requirements for estuaries, poor implementation of existing environmental and fisheries related legislation by law-enforcement officials, and the undermining of broad-based estuary management plans by minority groups. All the above situations need to be addressed and turned around as a matter of

urgency if we are to avoid a complete collapse of estuarine fish stocks in the near future.

(Poster 126) Timing and periodicity of hyaline band formation in Namibian *Merluccius capensis* otoliths

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We validate the seasonal formation of hyaline (translucent) bands on 3955 Namibian hake, *Merluccius capensis* otoliths of consecutive samples from five cohorts; born in (winter of) 1996, 1998, 2002, 2005 and 2006. Cohorts were identified by tracing growth rates of otoliths obtained from fur seal scats sampled at least once a month at the main fur seal colonies along the Namibian coast as well as from consecutive demersal surveys and some commercial samples. Logistic ogives fitted to proportions of otoliths showing (one to nine) hyaline bands revealed that bands were deposited at least twice per annum, spanning long periods, with the 50% deposition dates occurring in summer-autumn and winter-late spring. The second, fifth and seventh bands were the true annuli formed in winter-spring. Band deposition periods spanned high ranges of bottom temperatures, salinities and oxygen concentrations. Effects of all available environmental and fish condition data on band deposition rates were tested using Generalized Additive Models. Results suggest that the main periodic hyaline bands in hake otoliths are deposited at regular intervals following internal stimuli, with some additional bands deposited in response to external cues.

(Poster 127) The effect of barotrauma on five species of South African linefishes

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Management measures for South African line-caught fishes include output controls such as closed seasons, bag and size limits and no-take moratoria. The main condition for these measures to be effective is that undesirable catches can be successfully released. However, most of the linefish species are susceptible to barotrauma, a condition caused by the rapid reduction of hydrostatic pressure during the ascent to the surface during capture. We investigated the effects of

barotrauma on five commercially important species, roman, *Chrysoblephus laticeps*, silver kob, *Argyrosomus inodorus*, hottentot, *Pachymetopon blochii*, santer, *Cheimerius nufar* and carpenter, *Argyrozona argyrozona*. A classification of the signs of barotrauma was developed and internal and external signs of barotrauma across fishing depths and species were compared. Immediate post-release survival was investigated during a catch and release experiment. Medium-term survival (two to three days) data have been collected by returning fish to depth in cages and subsequent monitoring on SCUBA. Our results indicate that most of the fishes experience barotrauma even when caught at relatively shallow depths. External signs include extension of the inflated, inverted stomach through the mouth, extended eyes, protrusion of the hind-gut and other organs through the cloaca and gas bubbles in the dermal tissue between the fin rays. The absence of any obvious external signs of barotrauma can be misleading as dissections of non-symptomatic fish revealed ruptures of the swim bladder and other internal injuries consistent with barotrauma. The results of this study indicate that there might be significant post-release mortality, which needs to be taken into account during stock assessment predictions and during the implementation of catch restrictions.

Recognising the customary rights of traditional fishers in conservation planning and management: Lessons from Covie and Ebenhaeser-Papendorp

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Following the democratic elections of 1994, South Africa embarked on a radical law reform process to address past injustices, and chart a new development pathway - one based on respect for and protection of human rights and the principles of sustainability. Within the land and natural resource management arena, the restitution of land rights and equitable access to resources were seen as key mechanisms to give effect to these Constitutional imperatives. However, restoration of land and resource rights has been fraught with difficulties especially in areas that are considered to be of high conservation value. This has resulted in conflicts between conservation authorities and land and resource beneficiaries, leading to significant delays in settling claims. In this paper, we examine how the customary fishing rights of two coastal communities have been ignored in favour of conservation interests and how failure to address these rights potentially undermines conservation objectives. The historic fishing practices as well as the customary rules

governing the two fishery systems are documented based on oral histories conducted with 30 fishers and other key informants in both communities. The food, livelihood and socio-cultural values associated with harvesting marine resources are explored as well as the perceptions of resource users to conservation initiatives in the area. Failure to recognise and respect fisher's customary rights has led to high levels of frustration amongst fishers and both communities are now seeking legal assistance to have these resource rights recognised and secured. Such conflicts suggest that despite progressive legislation in South Africa, approaches to conservation still reflect a technocratic, resource-centred and science-driven approach.

A probabilistic modelling approach for estimating primary production from satellite remote sensing

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Phytoplankton form the base of marine food webs, yet few models of primary production directly incorporate information on the vertical distribution of phytoplankton. We introduce probabilistic models to estimate depth-integrated distributions of chlorophyll from archives of data from ships and remotely sensed data of sea surface temperature (SST), surface chlorophyll (Chl) and wind (U and V vectors) from satellites. Our area of study has contrasting hydrographic regimes, which include the dynamic Southern Benguela upwelling system and the stratified waters of the Agulhas Bank. A conditional random field (CRF) model is used to label sequences of daily satellite-derived SST and Chl that frequently contain missing data, in terms of the degree of variability. The strength of this method is its flexibility to incorporate a variety of arbitrary, non-independent features extracted from expert knowledge. These sequences are combined with sequences of remotely sensed wind data as well as sub-region, season, and water-depth (a proxy for distance offshore) and related to characteristic chlorophyll and temperature profiles in a dynamic Bayesian network. Dynamic Bayesian networks are used to model causal relationships that evolve over time and yield a probability distribution over a final event. Cluster analysis is used to identify "typical" chlorophyll and temperature profiles that rely on no assumptions concerning their shape. Each cluster represents a potential event for the sequence of the observed variables. Over 7300 chlorophyll and temperature profiles recorded during research surveys from the southern Benguela region are used in the

cluster analysis. The model will be used to predict the type of profile most likely for each pixel of a remote sensing image given a sequence of daily information. The phytoplankton biomass profile can then be combined with subsurface light algorithms to estimate daily integrated primary production for a given region of interest.

Evaluation of delta-models for the standardization of CPUE time series: evidence for spill-over effect from a South African MPA?

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Catch and effort data are the most common source of fisheries information, where catch-per-unit-effort (CPUE) is usually assumed to be linearly proportional to abundance. Here we evaluate methods to standardize the CPUE time series of reef fish directed line-fishing around the Goukamma Marine Protected Area (MPA) to investigate changes in abundance of roman *Chrysoblephus laticeps* before and after the MPA implementation in 1990. For this purpose, area-specific commercial linefish catch and effort data for the period 1985-1999 were sourced from the National Marine Linefish System. The information includes daily catch in kilogram (kg) per species per fishing day per boat per area. To account for the multi-species nature of the fishery, we fitted generalized linear models to CPUE data with the aim to adjust for factors such as changes in effort, fishing behaviour and the spatial structure of the trends in CPUE. As the roman CPUE data were not normally distributed and contained a relatively large proportion of zero observations (24%), we compared delta-models, which involve modelling the probability of zero catches (Binomial model) and the positive CPUE observations (e.g. log-normal or gamma) separately, to Poisson and log-normal distributions. Results based on Monte-Carlo simulations and randomized quantile residual plots suggest that the delta-lognormal distribution performed best, with the most parsimonious delta-lognormal model explaining more than 30% of the total variation in the data. The standardized roman CPUE increased five years after the Goukamma MPA was established and was 65-160% higher during 1995-1999 compared to the period prior to the establishment of the MPA (1985-1990). Beneficial changes to the fishery became therefore

apparent five years after the MPA implementation, which approximates the age of first recruitment of roman into the fishery, indicating that the increase in relative abundance could have been a result of increased larval spill-over.

(Poster 128) The effect of dietary kelp and protein on abalone *Haliotis midae* growth and canning yield

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Diet has been found to affect the growth rate and canning yields of farmed South African abalone *Haliotis midae*. The aim of this project was to determine the effect of (a) the inclusion of kelp in the fishmeal/soya-based formulated diet on growth and canning yields and (b) the effect of reduced protein on the same. Two size classes of abalone (starting weight: 38 g and 78 g) were used and the experiments were run in duplicate on two abalone farms for 117 days. In experiment 1, both size classes of abalone were fed one of two isonitrogenous (26 % protein) diets, one with kelp included in the formulation and one without. In experiment 2, both size classes were fed one of three different diets with varying graded levels of dietary protein: 34 %, 26 % and 22 %. Each diet/size class treatment was represented in triplicate on each of the abalone farms.

The effect that dietary kelp and dietary protein level had on abalone growth (i.e. specific growth rate), mortality and canning yields will be discussed.

(Poster 129) Multi parameter probes vs Upgraded Universal Underwater Units (U4)

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The old U4 systems currently in use on all the Department of Environmental Affairs research vessels has become outdated and in urgent need of replacement to provide continuity with regard to the collection of excellent quality data and samples. These systems provide technicians and scientists with valuable data with respect to flow rates, temperature and depth all of which are critically important to the research (eg. biomass estimates) that is done onboard the Department research vessels. The replacement of these old U4 units is thus not only very crucial to our research but also to a costly one. These units are generally attached to various Plankton sampling

systems and used routinely all various research cruises. Newer multi parameter probes are currently being built by Hydro Bios Pty Ltd under request and technical instruction of Mr.M.Worship. These have more accurate and up to date sensors and numerous more advantages in comparison to the older underwater units. A comparison between the two units is currently being conducted onboard the Frs. Africana during the monthly St. Helena Bay Monitoring Line cruise in order to establish the accuracy of the older U4 systems and the way forward in terms of development of the newer multi parameter system. The test unit received from Hydro Bios and the old U4 unit have been fitted onto the same vertical bongo frame in order to achieve an accurate comparison. Once the results of the comparison have been analysed a decision will be taken whether or not proceed with the purchasing of the newer multi parameter probes.

(Poster 130) Preferred temperature range of demersal fish species: contribution towards understanding physiological optima

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Preferred temperature range, thermal tolerance, or physiological performance of different marine fishes has been the subject of various ecophysiological studies partly to understand physiology of the organisms involved and also to understand how temperature effects at organismic level translate to population, community, and ecosystem level response to important changes in temperature. Currently with the increase interest in understanding the consequence of global warming, the potential response of various marine organisms directly to warming and indirectly to thermally related oxygen demand and tolerance has become the topic of various laboratory and field studies. In this study temperature preference of demersal fishes off the west coast of South Africa was modelled using logistic regression. The results showed that the demersal fishes have wide temperature preference range. Furthermore the relative frequency distribution of species preferred temperature was compared to the frequency distribution of survey stations in the different temperature range (as a proxy for available environmental niche). This was done to assess if the number of species are evenly distributed along the preferred temperature range or most species preferred specific temperature range. Results from such kinds of studies can be used to identify indicator species and are also important in understanding the potential and the extent global warming related impacts on fish communities and marine ecosystems in general.

Demersal fish biodiversity pattern: West coast vs. South coast

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Biodiversity pattern and governing factors have been the topic of both applied and theoretical ecological studies. Pattern in the biodiversity of demersal fishes off the west and south coast of South African has been studied. It is generally known that the two coasts are characterized by different oceanographic conditions that dictate observed difference in productivity, and the west coast characterized by lower species richness than the south coast. But the pattern of biodiversity in relation to physical variables has never been cross compared between the two coasts. For this study three of the most commonly used diversity indices (Species

richness S , Shannon-weiner diversity index H' , Pielou's evenness index J') were employed. Generalized Additive Models (GAMs) were used to link diversity to the physical factors. The results showed that biodiversity pattern as a function of depth, and latitude was different between the west and south coast. To understand the observed patterns and search for explanatory mechanisms a systematic approach was followed where the biodiversity pattern was assessed at 2^0 interval from the north west (near the orange river) to the south east (Port Elizabeth). This study further explores competing models (Mid Domain Effect MDE, Rapoport's bathymetric rules, and other relevant null models) to explain the observed biodiversity pattern. This will be a contribution towards the ongoing study elsewhere on factors regulating and determining biodiversity of different ecosystems.

INDEX

A

Abram, 3
Achterberg, 53
Adams, 41, 84, 85, 88, 113
Agenbag, 11, 43
Albertelli, 66, 77
Allan, 3
Altwegg, 44
Ambrose, 3
Anders, 95
Anderson, 4, 12, 13, 29, 32, 96
Angel, 104
Ansorge, 24, 68, 100
Atkins, 46
Atkinson, 4
Attwood, 69, 77, 119
Auel, 92
Auerswald, 5, 49
Augustyn, 84
Ayers, 5

B

Bachoo, 71
Bailey D, 41
Bailey S, 5
Baird, 6
Balachandran, 76
Baldanzi, 6
Bali, 7, 39
Barkai, 7
Barker, 65
Barlow, 8, 51
Basson, 8, 45
Becker, 9
Beckley, 9
Bemanaja, 44
Benger, 23
Bennett, 10, 15, 19
Bernard, 5, 10
Best, 11, 78, 86
Bester E, 97
Bester MN, 40, 43, 63, 97, 111
Beukes, 94
Bez, 101
Bianchi, 66, 77
Biccard, 11
Bigot, 54
Blamey, 11
Bloomer, 10, 37, 74, 86
Bolton, 4, 12, 13, 20, 29, 32, 59, 92, 96
Bonadonna, 18
Bonnievie, 17
Booth, 76, 119
Borja, 1
Bornman, 24, 113
Bosman, 12

Bourjea, 13, 34, 70
Bowie, 69
Branch, 18, 79, 81, 83
Brandão, 11
Bridges, 49
Britz, 13, 90, 120
Browne, 13
Bundy, 94
Butterworth, 11

C

Cannicci, 30, 32, 33, 95
Carlton, 1
Carrasco, 14
Cawthra, 14
Celliers, 29
Chalmers, 74
Chetty, 15, 73
Childs, 10, 15, 19
Christison, 55
Ciccione, 13
Clark BM, 16, 42, 101, 104, 117
Clark G, 61
Cockcroft AC, 16, 84
Cockcroft VG, 78
Cocks, 58
Coetzee, 16, 68, 79, 101, 105
Cole, 17, 54, 55
Coleman, 61
Colenbrander, 49
Collins, 17
Connan, 17
Cook, 18
Cooper, 18, 22
Cowley, 9, 10, 15, 19, 28, 56, 68, 70, 94, 117
Craig, 70
Cramb, 19
Crawford, 44
Cuvillier, 54
Cyrus D, 19
Cyrus M, 20

D

da Silva, 20, 47
da Silva Neto, 4
Dagorn, 28
Darnaude, 15
Davids, 49
Davies-Coleman, 114
Dawson, 20
de Jonge, 21
de Lecea, 21, 22
de Moor, 31
de Wet, 20
Deborde, 65
Deyzel, 34

Dicken, 22
Dittmann, 22, 23, 25, 26
Dopolo, 23
Dorrington, 59, 114
Downey, 24, 115
du Plessis, 24
du Randt, 82
Dudley, 29
Duncan, 25
Dunlop, 25
Durholtz, 31
Dyers, 44

E

Earl, 25, 26
Ekau, 31, 35, 63
Elliott, 26
Ellis, 79
Elwen, 27, 63, 97, 111
Engelbrecht, 110

F

Fabiano, 66
Fallows, 102
Fennessy, 21, 27, 89
Field JG, 27, 119
Field R, 28
Filmalter, 28
Fisher, 79
Flohr, 28
Floros, 29
Foulis, 29
Fowler, 25, 26
Fox, 101
Francis, 29
Frantz, 43, 48
Frid, 3
Froneman, 3, 40, 59
Frouin, 54
Fusi, 30, 32, 33

G

Garlick, 35
Garnier, 13
Gatti, 66
Gebreselassie, 44
Geduld, 30
Geist, 31
Geja, 31
Gerow, 70
Gersun, 32
Gibberd, 32
Gibbons, 56, 103
Giomi, 30, 32, 33, 95
Githaiga-Mwicigi, 33
Glassom, 38

Godley, 13
Gold, 49
Goldschmidt, 23
Gon, 34, 98
Goodman, 53
Goschen, 34
Götz, 5, 10, 34, 47, 118, 119
Gouws, 10, 34, 49, 66, 70, 98
Greeff, 55
Green, 35
Grémillet, 18, 79, 101
Gridley, 27, 97
Griffiths, 1, 11, 50, 64, 72, 81
Groeneveld, 29, 64, 89
Grote, 35
Guastella, 36
Gulekana, 36, 37

H

Hagen, 35, 92
Hall, 37
Hamann, 18
Hammond, 78
Hampton, 37
Harington, 38
Harris, 38, 96
Hart, 38
Hayes, 27
Heene, 65
Hein, 39
Hendricks, 39
Henninger, 59
Henriques, 83
Hermes, 17
Heyns, 40
Hill E, 42, 44
Hill JM, 82, 94
Hoareau, 40, 86
Hoeksema, 105
Hoffmann, 79
Hofmeyr, 40
Holliday, 9
Holness, 74, 96
Hoppe-Speer, 41
Hubas, 41, 77
Huggett, 41, 72
Hughes, 13
Hurwitz, 102
Hutchings K, 42, 51, 101, 104
Hutchings L, 16, 42, 43, 115

I

Illert, 43
Ismael, 43
Ismail, 43

J

James BS, 43
James NC, 63, 110

Jaquemet, 44, 54
Järnegren, 9
Jarre, 11, 42, 43, 44, 45, 61, 70, 74,
81, 93, 115, 118, 119
Johnson, 45, 46
Johnston, 61
Jones CLW, 25, 28, 58, 80, 88, 90,
120
Jones S, 43

K

Kaehler, 44, 76, 81, 83
Kaiser H, 25, 28, 58, 80, 88
Kaiser S, 46
Karsmarski, 46
Kean, 46
Keith, 46
Kerwath, 10, 20, 34, 47, 57, 118, 119
Kiriakoulakis, 3
Kirkman, 40
Kisten, 47
Kiviets, 48
Knott, 61
Kobryn, 9
Kock, 49, 102
Kolasinski, 54
Koper, 48
Kotze, 95
Kovacs, 40
Kraft, 49
Kruger, 49
Kunnen, 50
Kyle, 50

L

Laird, 50
Lamberth, 20, 51, 63
Lamont, 8, 41, 51
Largier, 52, 79
Lawrence, 52
Lawrie, 53
Lebourges-Dhaussy, 72
Leeney, 27, 97
Leslie, 121
Lipinski, 35
Lobo-Petersen, 53
Lombard, 96
Lubarsky, 41
Lucas, 32, 33, 38, 46, 53
Ludford, 54
Ludynia, 44
Lutjeharms, 24, 89, 90
Lydersen, 40

M

Mablouke, 54
Macala, 55
Macey, 20, 55, 92
MacKay, 39, 55, 90, 98, 107

MacKenzie, 86
Maduray, 56
Maggs, 56
Majiedt, 57
Makhado, 44
Mäkinen, 57
Malauene, 57
Maliza, 58
Mandiwana-Neudani, 29
Maneveldt, 58, 75, 108
Mann BQ, 25, 56, 57, 74
Mann J, 58
Marais, 86
Marchand, 65
Markovina, 13
Marshall, 60
Matcher, 59, 114
Mathee, 62, 64, 69
Mattio, 59
Matumba, 60
Maxwell-Hafen, 32
Mazzola, 112
Mbande, 60
Mbatha, 60
McGregor, 45, 61
McIntyre, 43
McKinley, 61
McLachlan, 62
McQuaid, 1, 17, 19, 30, 37, 54, 55,
60, 65, 82, 83, 90, 95, 112
Mead, 1
Merkle, 62
Mertz, 63
Meyer A, 108, 110
Meyer B, 5
Meyer M, 20, 95
Meyer T, 97
Meziane, 65
Michalowski, 63
Midgley, 63
Miller, 108
Milne, 64
Miranda, 64
Miskiewicz, 61
Mkare, 64
Mkize, 106
Mmonwa, 65
Moens, 41
Mohrholz, 65, 67
Molnar, 65
Moloney, 37, 57, 70, 118
Montefalcone, 66, 77
Monteiro, 100
Montoya-Maya, 91
Moodley, 66
Moore M, 53
Moore SA, 9
Morallana, 66
Morri, 66, 77
Mortimer, 13
Mostert, 32
Mostovski, 75

Mtontsi, 67
Muir, 50
Muller, 67
Munnik, 68
Murray, 68
Mushanganyisi, 68
Mussgnug, 69
Muteveri, 69
Muths, 13, 34, 70
Mwale, 34, 57, 66, 70, 98
Mwaluma, 34, 70
Mwandya, 34, 70

N

Næsje, 9, 10, 15
Ndjaula, 70
Nel, 38, 71
Newman, 4, 71, 116
Ngoile, 113
Nieuwenhuys, 88, 108

O

Ockhuis, 41, 72
Odendaal, 96
Oelofse, 49
Okemwa, 13
Olbers, 15, 72, 73
Olds, 73
Olivier, 77
Omarjee, 22, 73
Oosthuizen A, 74
Oosthuizen CJ, 74
Oosthuizen H, 44, 95
Orr, 101, 104
Osman, 45, 74, 79
Ovechkina, 75

P

Padua, 75
Paimpillil, 76
Paoli, 66
Parker, 76
Parkinson, 76
Parravicini, 66, 77
Pasnin, 77
Passarelli, 77
Paterson AW, 34
Paterson B, 45
Paterson DM, 19, 41, 77
Patrick, 78
Penry, 78
Perissinotto, 14, 64
Petersen SL, 93
Petersen W, 49
Pfaff, 79
Phillips, 79
Pichegru, 18, 44, 79, 80, 110
Pieterse, 80
Pillay D, 18, 52, 81

Pillay K, 81
Pillay P, 81
Pistorius, 46
Pitcher, 82
Plön, 3, 46
Porri, 30, 33, 37, 54, 82, 83, 95, 112
Porter, 83
Potgieter, 119
Potier, 54
Potin, 54
Potter, 105
Potts, 49, 68, 83, 87
Poulton, 38
Pretorius, 84
Prinsloo, 81
Probyn, 82
Prochazka, 84

R

Rademan, 62
Raemaekers, 13
Rajkaran, 41, 84, 85
Read, 24
Reason, 17, 111
Reddy, 85
Reeb, 86
Reed, 86
Reid, 10, 79, 86
Richardson, 83, 87
Richoux, 3, 87
Riddin NA, 88
Riddin T, 88, 113
Rigaux, 41
Rius, 1
Rixen, 28
Roberts, 12, 24, 33, 36, 57, 88, 96,
108, 115
Robey, 89
Rolston, 23
Roman, 89
Ropert-Coudert, 18
Rossetti, 90
Roudat, 72
Roux, 118
Rowbotham, 44, 45
Ryan L, 61
Ryan PG, 18, 79, 110
Rybarczyk, 41

S

Sachidhanandam, 41
Samaai, 47, 56, 99
Samyn, 72
Sauer, 13, 24, 68, 83, 87, 115
Schapira, 90
Scharler, 5, 50, 90
Schell, 91
Schleyer, 29, 38, 91
Schmidt, 67
Schoeman, 38

Scholtz, 92
Schroeder, 92
Schukat, 92
Schumann, 34
Scott, 44
Shabangu, 93
Shannon, 11, 44, 45, 74, 93, 94, 115
Sharples, 3
Shaw, 83
Sheppard, 94
Sherley, 44
Shihepo, 27
Shillington, 36, 57, 119
Shin, 94
Sikweyiya, 49
Simon, 94, 110
Simoni, 33, 95
Singh, 95
Sink, 4, 57, 83, 96
Slabber, 96
Slinger, 100
Smale, 3, 46, 95, 103, 115
Smallwood, 9
Smit, 4, 12, 21, 22, 73, 85, 96
Smith AM, 12
Smith MD, 45
Smith MKS, 68, 73, 97
Snow, 109
Snyman L, 27, 97
Snyman R, 96
Somaai, 114
Somhlaba, 97
Sowman, 118
Sparks, 30, 53, 92, 98
Speich, 100
Springbok, 98
Steffani, 104
Stenevik, 35
Stow, 98
Strydom, 78, 99
Swart L, 99
Swart S, 100
Swartz, 57

T

Taljaard, 100, 108
Taylor M, 61
Taylor R, 101
Ternon, 44
Terörde, 101
Tessier, 70
Tew-Kai, 101
Theron, 110
Thompson, 9
Thornton, 102, 111
Thorstad, 15
Thwala, 102
Tirok, 103
Titley, 49
Toefy, 30, 92, 103
Torres, 107

Tosh, 43
Towner, 103
Tsotsobe, 49
Tunley, 42, 104
Turpie, 16, 104
Twatwa, 68, 79, 105
Tweedley, 105

U

Uiblein, 106
Uken, 12, 14, 75, 106
Uncles, 2, 107
Underhill, 44, 103
Untiedt, 107

V

Valesini, 105, 107
van Ballegooyen, 88, 108
van der Lingen, 7, 16, 31, 37, 61, 68,
70, 86, 101, 105, 108
van der Merwe E, 108
van der Merwe JH, 100
van der Merwe M, 109
van der Molen, 109
van der Westhuizen, 101

van Eeden, 79, 110
van Niekerk L, 110
van Niekerk SE, 110
van Zyl, 16
Vassallo, 66
Verheye, 35, 43, 72, 111
Villa, 77
Vinding, 111
Vivier, 19
Vizzini, 112
von der Heyden, 62, 64, 69, 112
von der Meden, 83, 112
Vousden, 113
Vromans, 113

W

Walker, 101
Waller, 44
Walmsley, 114
Wanless, 44, 79
Ward, 13
Wartenberg, 114
Wasserman, 114
Watermeyer, 115
Weisel, 111
Webber, 115

Weerts, 71, 116
Weller, 9
Welsh, 65
Wessels, 116
West, 117
Weyl, 73
Whitfield, 9, 26, 55, 63, 94, 117
Wilhelm, 118
Wilke, 10, 20, 47, 118
Wilkinson, 27
Williams C, 81
Williams S, 118
Williamson, 119
Wilson, 42
Winker, 119
Winkler, 120
Woelkerling, 58
Wolf, 96
Wolff, 3
Wooldridge, 102
Worship, 43, 72, 120
Wright, 43

Y

Ye, 25, 26
Yemane, 105, 120, 121