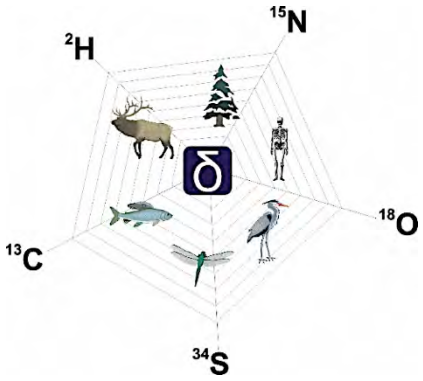
THE UNIVERSITY OF WESTERN AUSTRALIA



Applications of Stable Isotope Techniques to Ecological Studies

3rd-8th August 2014

9th International IsoEcol Conference

The University of Western Australia, Perth

THE UNIVERSITY OF WESTERN AUSTRALIA

West Australian Biogeochemistry Centre

www.wabc.uwa.edu.au

The centre is well equipped for stable isotope studies and offers a range of analytical and interpretive services.

We routinely provide analyses of $\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$, $\delta^{18}O$, $\delta^{2}H$ of solid materials, such as soils, carbonates, sediments, water and plant and animal tissues.

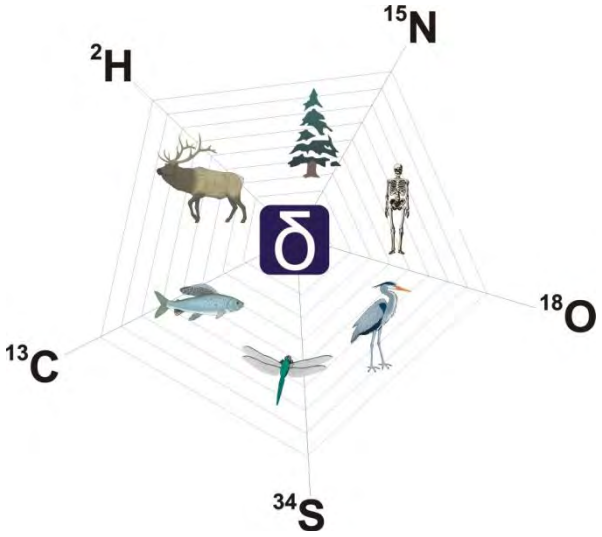
Our research is focused on the ecological sustainability of natural ecosystems and their response to disturbance and environmental change. We have extensive experience in the application of stable isotopes to research in both terrestrial and aquatic ecosystems; plant and animal ecology and physiology; soil and sediment chemistry; paleoclimates and groundwater-surface water interactions.

Contact us

The University of Western Australia
Crawley, Perth
Western Australia

grzegorz.skrzypek@uwa .edu.au
www.wabc.uwa.edu.au
(+61 (8) 6488 4584

9TH INTERNATIONAL ISOECOL CONFERENCE



3rd-8th August 2014
The University of Western Australia
Perth, Australia

Programme and Abstracts

THE UNIVERSITY OF WESTERN AUSTRALIA
Achieve International Excellence

CONFERENCE ORGANISING COMMITTEE

Dr Grzegorz Skrzypek, UWA
Dr Pauline Grierson, UWA
Dr Mat Vanderklift, CSIRO
Dr Shawan Dogramaci, RTIO

Volume designed, compiled and edited by: Kate Bowler, Sara Lock and Grzegorz Skrzypek. We gratefully acknowledge Ela Skrzypek and Alexandra Rouillard for Front Cover photography

THE UNIVERSITY OF WESTERN AUSTRALIA | A CENTURY OF ACHIEVEMENT 1913 - 2013
Achieve International Excellence

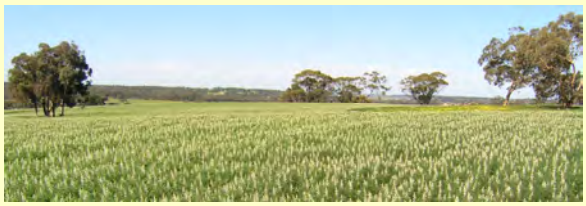
FACULTY OF SCIENCE

Postgraduate Research Opportunities in the School of Plant Biology

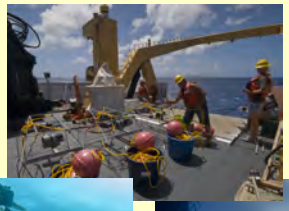
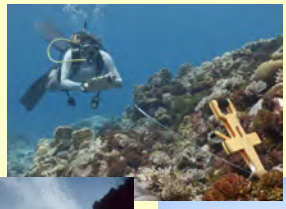
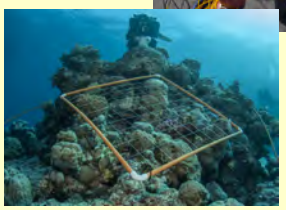
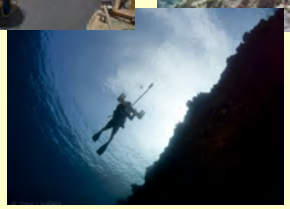
World-class researchers*
State-of-the-art facilities

Plant production systems

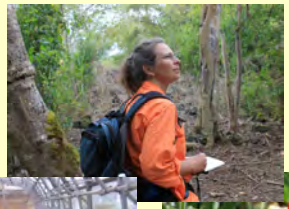


Marine systems


Natural terrestrial systems

130 postgraduate research students (50% international)

Postgraduates are active in, and valued by, the School community



ENQUIRIES
Associate Professor Megan Ryan, School Postgraduate Research Coordinator
grc-plants@uwa.edu.au

- Several ISI highly cited authors and prize-winning research scientists - www.plants.uwa.edu.au
- The University of Western Australia ranks 91st in the world in the highly respected Shanghai-Jiao Tong University's Academic Ranking of World Universities and in our key research areas of Life and Agricultural Sciences we are ranked 1st in Australia and 26th in the world.

ACHIEVE INTERNATIONAL EXCELLENCE

Oceans & Atmosphere Flagship

Understanding our oceans, coasts, climate and atmosphere is critical to Australia's future.

Key challenges

The ocean drives the climate system, provides food and transport, minerals, oil and gas resources, sustains biodiversity and regional economies, and offers recreational and lifestyle opportunities. The Flagship provides the science to inform environmentally, socially and economically sustainable outcomes across the broad range of users and uses of Australia's marine environment.

Our research programs

- *Ocean and climate dynamics*
- *Earth system assessment*
- *Coastal development and management*
- *Marine resources and industries*
- *Engineering and technology*

CSIRO

For more information visit www.csiro.au/OandA

Unlocking groundwater mysteries

From the creation of skyscrapers to automobiles, Rio Tinto's Iron Ore business plays a part.

Our business is the second largest supplier to the global iron ore market which makes steel for industrial and infrastructure use.

Most of our iron ore production is in the Pilbara region of Western Australia. Our network of 14 mines, three port terminals and largest privately owned railway in the world creates great flexibility, allowing us to respond rapidly to the changing market conditions.

Environmental responsibility is critical to the relationships we build with the community and other stakeholders.

To ensure water resource management at our mine sites is effective, we use a range of scientific tools including conceptual and mathematical modelling, aquifer testing and analysis, hydro-chemistry, natural isotopic tracers and geophysics.

Find out more at **www.riotintoironore.com**

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AINSE Funding Opportunities and Access to ANSTO Facilities

AINSE (the Australian Institute of Nuclear Science and Engineering) facilitates access to ANSTO's scientific facilities at Lucas Heights, some 30 km south of Sydney, and provides a focus for cooperation in the nuclear scientific and engineering fields. AINSE arranges for the training of scientific research students in matters associated with nuclear science and engineering. Staff and students from AINSE member institutions in Australia and New Zealand (http://www.ainse.edu.au/home2/members) are invited to apply for the following funding opportunities:

15 Feb

Honours scholarships

AINSE offers Honours scholarships of $5,000, and will also provide some costs for travel and accommodation at Lucas Heights. To be eligible, a student's supervisor must have an application for a Research Award in process. Applications for Honours scholarships close **15 February** each year.

15 Apr

Postgraduate top-up scholarships

AINSE offers awards for postgraduate students whose research projects are associated with nuclear science, or its applications, and who require access to the unique national facilities at the Lucas Heights Science & Technology Centre. The award consists of a top-up of $7,500 pa, as well as $10,000 pa for costs involved in using the facilities and services at Lucas Heights. Certain travel and accommodation costs to enable students to work at Lucas Heights are also provided. Applications for Postgraduate scholarships close **15 April** each year.
http://www.ainse.edu.au/grad_students2/postgraduate_awards

Mar & Aug

Research Awards

AINSE provides funds to assist researchers to gain access to the national facilities at ANSTO and other AINSE facilities. Funding is provided for one year commencing in January or July, and consists of costs associated with access to facilities as well as costs associated with travel and accommodation. Applications for Research Awards close **31 March and 31 August** each year.
http://www.ainse.edu.au/academic_researchers2/ainse_research_projects

Winter break

Undergraduate students Winter School

AINSE offers scholarships to enable a nominated undergraduate student from each member Institution to attend a Winter School at ANSTO on applications of nuclear techniques. The scholarship is open to all senior undergraduate students in which knowledge of nuclear techniques of analysis would be of interest. Such techniques have applications in areas ranging from agriculture to zoology; and include physics, chemistry, biology, environmental science, geography, geology, and archaeology. ANSTO provides for the costs of the experiments, and AINSE pays for travel, accommodation, all meals and social activities during the program. Interested students should contact their AINSE Councillor early in the year. http://www.ainse.edu.au/events2/winter_schools

@

Contact and further details

For further details, please contact AINSE on (02)9717 3376 or email us at ainse@ainse.edu.au
Visit our website to view opportunities available to AINSE members www.ainse.edu.au

sercon
The *Stable* Isotope Company

Sercon are dedicated to the design, manufacture and support of **Isotope Ratio Mass Spectrometers** and their associated **sample preparation systems**.

Backed by a wealth of experience in Isotope Ratio Instrumentation, we provide a full range of services specific to isotope ratio scientists and their applications.
Sercon continues the pioneering efforts of Europa Scientific. We are committed to the continuous development of our instrumentation and support services to ensure that ground breaking research needs are met.

To ensure that all Europa and Sercon instruments remain fully operational and productive, we offer a range of **upgrades** and **system refurbishments** from the Tracermass of the 1980s.

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In order to ensure the best possible performance at all times Sercon recommend an annual **service** of your instrument. Sercon are able to provide rapid on-site response from our team of specialist, experienced engineers. We can provide remote **support** via telephone and email. All of our users receive **training** as part of an installation programme. We can also provide further training on specific applications or tailor your course to your analytical needs.

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Sercon are the UK distributor for the complete range of **isotopically labelled compounds**. All products are of the highest possible chemical purity and are always supplied with the MSDS and Certificate of Analysis. We can supply products of a full range of enrichments and of a large variety of label positions in any quantity you would require.

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Welcome to the 9th IsoEcol!

On behalf of the conference organising committee, sponsors and supporters it is our great honour and pleasure to warmly welcome you to Perth and The University of Western Australia. We trust that you will find 9th IsoEcol conference stimulating and inspiring. We have more than 120 oral and poster presentations covering every single aspect of ecology, and encompassing ecosystems from the open ocean to the suburbs of cities. The field of stable isotope ecology, and the technology that underpins this research, has expanded tremendously and is now an essential part of the toolbox of each ecologist and environmental scientist. The tradition of IsoEcol, which we have continued, is to keep all sessions in one stream broadening the perspectives of the audience and facilitating cross-disciplinary discussion. We believe that keeping minds open to other fields, different models, various isotope tools or techniques will enhance our future research. We all want to learn from each other, and to understand how isotope techniques contribute to each other's successful research projects and sound ecological conclusions. Improving stable isotope techniques, in both the technology and the ways we analyse our data, will help in answering numerous ecological questions which need to be addressed urgently to understand our natural environment and keep it healthy on our changing planet.

We know that you will enjoy the conversations with the colleagues that you already know, and we also encourage you to forge conversations with new colleagues. To all the students, you will find that the established scientists in the field are invariably open to your questions, so don't be shy!

Traditionally IsoEcol includes a mid-conference field trip day. This will be great opportunity to discover more about Western Australia and enrich your ecological spirit on Rottnest beaches or in the Yanchep bush. We also hope that you can take some time to enjoy stroll across the beautiful UWA campus or along the Swan River. Please enjoy the conference and Western Australia, comeback home refreshed and full of new research ideas.

Dr Grzegorz Skrzypek, UWA
Dr Pauline Grierson, UWA
Dr Mat Vanderklift, CSIRO
Dr Shawan Dogramaci, RTIO

Conference Arrangements

University Club, UWA

The University Club is located on The University of Western Australia campus - Hackett Drive, Crawley (Hackett Entrance 1). See page 4 and 5 for transport information.

Registration and Welcome Mixer

The welcome mixer is on Sunday evening, 3rd of August at the UWA Watersports Complex from 5 to 7 pm (see UWA Campus Map below). This is a free event for all delegates. Registration will be available at the mixer and from 7.30 to 8.15 am on Monday the 4th of August.

Internet Access – there is wireless internet technology in all rooms. Individual internet access credentials (complimentary) will be provided to delegates on registration.

Meals

Morning tea, lunch and afternoon tea will be provided each day. If you have not already done so please notify the organising committee of any dietary requirements at least than 72 hours prior to the conference.

Conference Banquet

The Conference banquet will commence at 7pm on Thursday night, 7th of August at the Old Swan Brewery (see Perth map) – Tickets must be pre-purchased during online registration. Please notify the organising committee of any dietary requirements at least 72 hours prior to the banquet if you did not do so before.

Transperth buses leave from Stirling Highway, UWA every 5-10 minutes and the journey takes approximately 5 minutes. Bus fares can be purchased on the bus and cost $2.10. If the weather is nice it is a 30 minute walk from the University.

UWA Campus Map

http://www.uwa.edu.au/__data/assets/pdf_file/0003/23367/campusmap.pdf

Presentations

Oral Presentations

All presenters need to provide a copy of their PowerPoint presentations on a USB (use of personal laptops is not permitted) to the organising committee the day before they are scheduled to talk. For those presenting on Monday, 4th of August please email your presentation by Friday, 1st of August (grzegorz.skrzypek@uwa.edu.au) or bring them to the Sunday evening registration at the welcome mixer. Presentation time is 20 minutes including time for questions. For presentations PC computer will be available with latest version of MS PowerPoint (pttx format preferred). Please note that due to time constrains we cannot allow the use of individual laptops for presentations.

Posters

Poster sessions will be held on Monday, 4th of August and Tuesday, 5th of August evenings from 5 to 7 pm with all posters to be set up on Monday morning prior to the start of proceedings (access to the hall from 7.45 am) and removed at the conclusion of the poster session on Tuesday. Board allocation and presenter session times will be given at registration and presenters are asked to be available for questions during their allocated session. Posters are to be in portrait format and the preferred size is A0 (841 mm X 1189 mm). Poster boards are 1200 mm x 1800 mm. Light refreshments will be served during poster sessions.

Student Awards

Best Student Oral and Poster presentations will be awarded during closing remarks on Friday afternoon.

Field Trips (All field trips had to be booked in advance during online registration.)

Yanchep National Park

Buses will leave from the University Club at 9 am on Wednesday morning the 6th of August and return at 4 pm. Yanchep National Park is about 70 km from Perth. You will need to bring sturdy footwear, wet weather gear in case of rain, hat and sunblock for an easy hike through the National Park. Lunch packs will be provided.

Rottnest Island Reserve

Buses will leave from the University Club at 8.15am on Wednesday morning the 6th of August and return 5.30pm. Lunch packs will be provided. You will need to bring sturdy footwear, wet weather gear in case of rain, hat, sunblock and a swimming costume if you wish to go snorkelling (wetsuits may be preferred as water temperatures average around 19°C in winter). Bikes and snorkels can be hired on the island from Pedal and Flipper located behind Hotel Rottnest. Bike hire is $20 for the day and includes a helmet and lock. Snorkel sets are $21 for the day, wetsuits are $31 for the day. Please note security cash bonds are required for most equipment hire. For more information on equipment hire and facilities go to http://www.rottnestisland.com/about/pedal-flipper. The Island Explorer bus service is also available, all-day rider tickets can be purchased from the Rottnest Island Visitor Centre for $20. For more information on the Rottnest Island Explorer bus go to http://www.rottnestisland.com/travel-to/getting-around-rottnest-island.

Transport

Perth CBD to The University of Western Australia

Bus

Bus routes from the city connecting to UWA include 23, 102, 107, 950. Check bus timetable No. 45. The fare from Esplanade Bus Port Stand 1B (near Perth CBD) to UWA is around $3 one-way. Tickets can be purchased on the bus with cash and change is given.

For maps, timetables and fares go to www.transperth.wa.gov.au

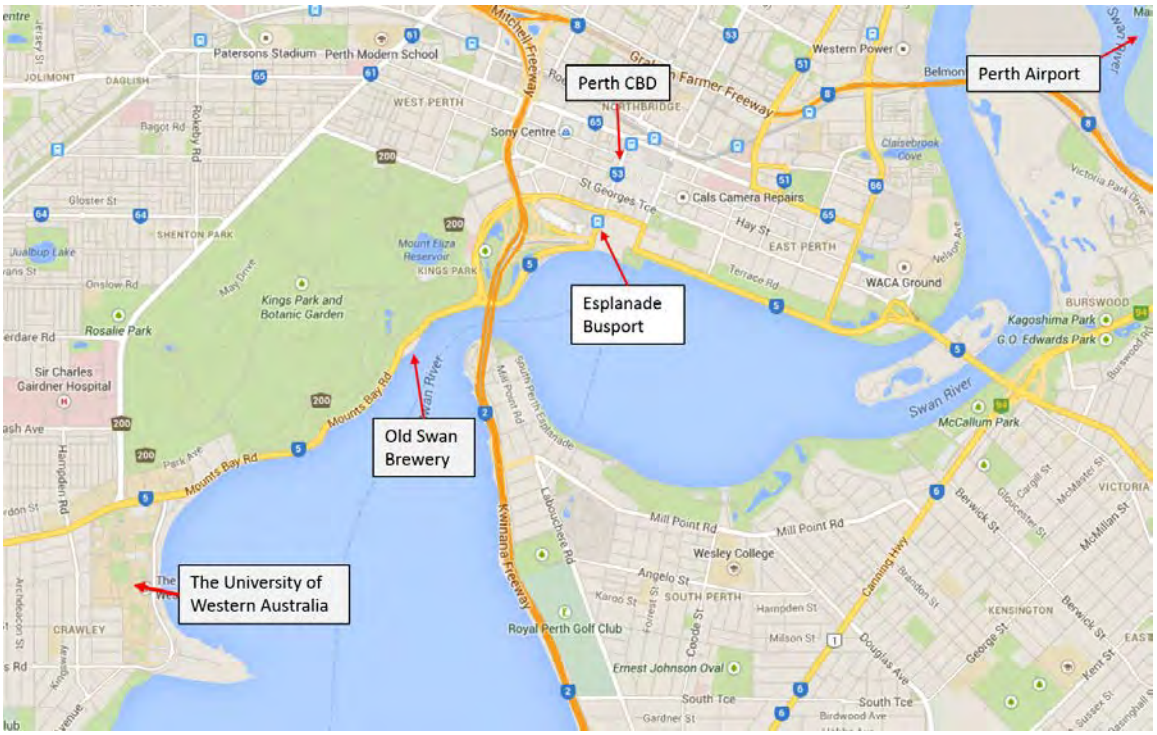
Bus timetable No. 45
http://www.transperth.wa.gov.au/timetablepdfs/Bus%20Timetable%2045%2020140706.pdf

Please note the free City Cat bus services do not go to UWA but are a great option for getting around the city. For more information go to http://www.transperth.wa.gov.au/Tickets-Fares/Free-Travel/CAT-Buses

Taxi

Perth CBD to UWA is about $15 one-way (up to four people). Taxis vehicles have credit card and EFTPOS facilities on board. Please note that there is a surcharge for using this facility.

Perth Map



Useful links

www.perth.wa.gov.au
www.westernaustralia.com
www.experienceperth.com

Oral Presentation Programme

Monday 4th August

Mixing models in food web studies and trophic transfers

8.30-8.40	**Housekeeping**		
8.40-9.00	**Welcome**	Robyn Owens	**Welcome from Deputy Vice-Chancellor (Research), UWA**
			Session 1 Chair - Mat Vanderklift
9.00-9.30	**Keynote**	Brian Popp	Insights into trophic ecology of marine animals and ocean biogeochemistry from isotope analysis of amino acids
9.30-9.50		Timothy P. Moulton	The autochthonous-allochthonous debate in tropical streams - new evidence from modelling of carbon flux in food webs using evidence from stable isotopes
9.50-10.10		Chris Harrod	Pelagic-benthic coupling writ large: benthivorous macroalgal reef fishes are fuelled by pelagic production in the Humboldt current system
10.10-10.40	**Morning tea**		
			Session 2 Chair - Sarah Bury
10.40-11.00		Andre Chiaradia	Experimental isotopic diet composition using qualified DNA priors in mixing models: searching for the real diet
11.00-11.20		Albertus J. Smit	Coupling physical processes of the Kwazulu-Natal Bight (South Africa) to the ecosystem function of its pelagic and benthic food webs
11.20-11.40		Thomas Larsen	Autochthonous derived amino acids fuel alpine and arctic lake food webs
11.40-12.00		Petra Quillfeldt	Using stable isotopes to study dietary and spatial segregation in three Pelagic storm-petrels
12.00-12.20		Nicole D. Kowalczyk	Life-stage dietary shifts in a resident seabird
12.20-13.20	**Lunch**		
			Session 3 Chair - Naohiro Yoshida
13.20-13.40		Brian Fry	Measuring changes in food webs and species niches with stable isotopes
13.40-14.00		Bonny Krell	Effects of stream restoration on aquatic prey subsidies to riparian spiders
14.00-14.20		François Remy	Turnover rates of carbon and nitrogen stable isotopes in the amphipod *Gammarus aequicauda*: insights for trophic studies of Mediterranean macrophytodetritus accumulation.
14.20-14.40		Adam Sokolowski	Tracing the trophic transfer of metals in benthic food web of the Gulf of Gdańsk (the southern Baltic sea) using stable isotopes
14.40-15.00		Thibaud Mascart	Feeding ecology of harpacticoid copepod species: insights from stable isotope analysis and fatty acid profiling
15.00-15.30	**Afternoon Tea**		
			Session 4 Chair - Brian Popp
15.30-15.50		Alex S.J. Wyatt	Isotope discrimination in planktivorous elasmobranchs focusing on the world's largest fish, captive whale sharks *Rhincodon typus*
15.50-16.10		Selena McMillan	The role of hindgut microbes in protein supply to the marine herbivorous fish, *Kyphosus sydneyanus*
16.10-16.30		Benjamin Kürten	Tracking seasonal changes in North Sea food webs: a combined stable isotope and fatty acid approach
16.30-16.50		Gabriele Stowasser	The functioning of the benthic ecosystem in the East Bellingshausen Sea: trophic links and bentho-pelagic coupling
16.50-17.00	**Housekeeping**		
17.00-19.00	**Poster session 1**		

Tuesday 5th August

Environmental tracers of biogeochemical cycles

8.30-8.40	**Housekeeping**		
			Session 1 Chair - Gerhard Gebauer
8.40-9.10	**Keynote**	Naohiro Yoshida	Specific mode analyses of isotopically substituted molecules to better constrain their cycles in the environment
9.10-9.30		Jonathan Grey	Angels & Demons: interactions between native & alien amphipods
9.30-9.50		Antoine Carlier	How does the invasive species *Crepidula fornicata* influence benthic trophic diversity and functioning in the Bay of Brest?
9.50-10.10		Meike Koester	Is the aquatic *Dikerogammarus villosus* a 'killer shrimp' in the field? – a case study on one of the most invasive species in Europe
10.10-10.40	**Morning tea**		
			Session 2 Chair - Jason Newton
10.40-11.00		Kanchana Warnakulasooriya	Interaction between scallop culture and primary production in Mutsu Bay, Japan by means of stable isotope determination of diet sources
11.00-11.20		Trent R. Marwick	The age of river-transported carbon: a global perspective
11.20-11.40		Paul Greenwood	Influence of abiotic conditions on microbial mat communities from Shark Bay, Western Australia
11.40-12.00		Jari Syväranta	Top-down control of methanotrophs regulates methane emissions from a humic lake
12.00-12.20		Sri Adiyanti	A carbon isotope-enabled model for validating carbon budget in a sub-tropical estuary
12.20-13.20	**Lunch**		
			Session 3 Chair - Margaret Barbour
13.20-13.40		Feike A Dijkstra	Plant-microbe competition for nitrogen and phosphorus affected by drought
13.40-14.00		Tina Bell	Combustion influences natural abundance of ^{15}N in plants and soil following bushfires and prescribed burning
14.00-14.20		Gabriel Moinet	Quantifying the heterotrophic component of soil respiration using natural abundance $\delta^{13}C$
14.20-14.40		Samuel Bodé	Estimation of mean residence time of amino sugars in agricultural soils
14.40-15.00		Janine Sommer	The effect of tree species on the carbon and nitrogen allocation and cycling in forest soil
15.00-15.30	**Afternoon Tea**		
			Session 4 Chair - Greg Skrzypek
15.30-15.50		Gerhard Gebauer	Hydrogen stable isotope abundance patterns provide further insight into organic matter exchange in orchid mycorrhiza
15.50-16.10		Xinhua He	Host-species dependent ecophysiological characteristics and two-way transfer of nitrogen between *Dalbergia odorifera* and its hemiparasite *Santalum album*
16.10-16.30		Longfei Yu	Natural abundances of ^{15}N and ^{18}O reflect distinct spatial patterns of nitrogen turnover along a subtropical forest catchment in China
16.30-16.50		Craig Hebert	This is for the birds: amino acid-specific $\delta^{15}N$ patterns in avian lab and field studies and relevance to contaminants monitoring
16.50-17.00	**Housekeeping**		
17.00-19.00	**Poster session 2**		

Thursday 7th August

Towards more robust stable isotope techniques in ecology

8.30-8.40	**Housekeeping**		
			Session 1 Chair - Petra Quillfeldt
8.40-9.10	**Keynote**	Margaret Barbour	Laser-based isotope techniques in plant carbon-water relations
9.10-9.30		Sebastian Pfautsch	Using deuterium to trace movement and storage of water in trees
9.30-9.50		Rosemarie Weigt	Understanding long-term tree physiological responses to environmental changes by the use of stable C and O isotopes
9.50-10.10		Pauline Grierson	Isotopic fingerprinting to understand landscape patterns and dynamics of plant water use
10.10-10.40	**Morning tea**		
			Session 2 Chair - Hilary Stuart-Williams
10.40-11.00		La'Shaye Ervin	Socioeconomic influences on urban plant and soil isotopic composition: Lessons learned from Los Angeles and Salt Lake City
11.00-11.20		Liew Jia Huan	Contrasting bottom up effects of riparian land-use on littoral invertebrate community and trophic structure
11.20-11.40		Brian Hayden	Species interactions in a warming world – insights from isotopic analyses of subarctic lakes
11.40-12.00		Catharine Horswill	Dietary specialisation reflects changing reproductive constraints in the macaroni penguin
12.00-12.20		Lorrie Rea	Age-specific vibrissae growth rates: a tool for determining the timing of ecologically important events in Steller sea lions.
12.20-13.20	**Lunch**		
			Session 3 Chair - Alex Wyatt
13.20-13.40		Clément Trystram	Can stable isotopes be used to help in the management of shark attack risk? A case study from Reunion Island, Western Indian Ocean
13.40-14.00		Laëtitia Kernaléguen	Individual foraging specialisation in female Australian fur seals: a combined approach using stable isotopes, animal-borne video data loggers and GPS tracking
14.00-14.20		Tatiana Acosta-Pachon	Inferring ontogenetic changes in trophic position and migration of swordfish from Hawaii
14.20-14.40		Garrett E. Lemons	Amino acid nitrogen analysis of green sea turtle: testing assumptions for application to field studies
14.40-15.00		Anne Lorrain	Isotopic composition of mercury in tuna from the South Pacific Ocean: a new tracer of foraging habitat?

Isoscapes and spatial patterns

15.00-15.30	**Afternoon Tea**		
			Session 4 Chair - Keith Hobson
15.30-15.50		David Soto	Using stable isotopes to infer marine migration patterns of Atlantic salmon
15.50-16.10		Lindsey Peavey	Isotopic evidence of a specialized diet for the generalist Pacific Olive Ridley sea turtle from the Costa Rica Dome
16.10-16.30		Brittany Graham	Drilling back through time to determine the factors for the decline in the New Zealand sea lions
16.30-16.50		Eric Raes	Changes in latitude and dominant diazotrophic community alter N_2 fixation
16.50-17.00	**Housekeeping**		
19.00-2200	**Banquet**		The Old Swan Brewery, Mounts Bay Road

Friday 8th August

Isoscapes and spatial patterns

8.30-8.40	**Housekeeping**		
			Session 1 Chair - Jonathon Grey
8.40-9.10	**Keynote**	Keith Hobson	Tracking animal movements with stable isotopes
9.10-9.30		Sarah Bury	A Southern Ocean isoscape informs migrational pathways and trophic ecology of Ross Sea top predators
9.30-9.50		Mat Vanderklift	Spatial patterns in stable isotope ratios reflect widespread effects of an extreme climatic event
9.50-10.10		Carolyn Kurle	Spatial and temporal variation within fine-scale, d13c and $\delta^{15}N$ isoscapes of the Southern California Bight in the Eastern Pacific Ocean
10.10-10.40	**Morning tea**		
			Session 2 Chair - Lorrie Rea
10.40-11.00		Kirsteen MacKenzie	Accurate and precise Bayesian geographic assignment of marine shelf animals using isoscapes derived from jellyfish tissues
11.00-11.20		Natasha Vokhshoori	New approach for constructing $\delta^{15}N$ and $\delta^{13}C$ isoscapes of littoral systems using compound-specifc isotope analysis of amino acids in intertidal mussels
11.20-11.40		Hannah Vander Zanden	Which water matters: how spatio-temporal characteristics of precipitation isoscapes affect geographic assignments to origin for migratory species
11.40-12.00		Grzegorz Skrzypek	Stable isotope perspectives on nitrogen availability constraints for tundra vegetation in the Arctic.
12.00-12.20		Katie Quaeck	Modelled global ocean carbon isoscapes: development, validation, application and limitations.

Decoding past environments - temporal variations and time machines

12.20-13.20	**Lunch**		
			Session 3 Chair - Shawan Dogramaci
13.20-13.40		Roshni Sharma	A high resolution Holocene climate record of the Asian monsoon
13.40-14.00		Alexandra Rouillard	Organic geochemical appraisal of carbon sources in late holocene lacustrine sediment from the semi-arid Pilbara
14.00-14.20		Francesca McInerney	Leaf-wax n-alkane $\delta^{13}C$ does not track bulk leaf $\delta^{13}C$ across gradients in available moisture
14.20-14.40		Amy C. Hirons	Paleoceanographic productivity reconstructions using marine mammal bone collagen
14.40-15.00		Chloé Plet	Carbonate concretions associated with fossils: snapshot of an anoxic marine environment in the Toarcian
15.00-15.30	**Afternoon Tea**		
			Session 4 Chair - Pauline Grierson
15.30-15.50		Max Gibbs	CSIA identify effects of historical flood engineering works adversely impacting on a Ramsar wetland ecosystem
15.50-16.10		Andrew Revill	A century of south east Australian ecosystem sensitivity archived in the carbon and nitrogen isotopes of deep-sea coral amino acids
16.10-16.30		Tracey Rogers	Change in isotopic signatures suggest food web shift off the western Antarctic Peninsula
16.30-16.50		Andrew Swales	Decoding isotopic records of long-term environmental changes preserved in estuarine sediments
16.50-17.00	**Final remarks and student prizes**		

Biographies – Keynote Speakers

Associate Professor Margaret Barbour

Margaret Barbour holds a BSc in Biology and Earth Sciences and an MSc in Biology from the University of Waikato, New Zealand, and a PhD in Plant Science from the Australian National University. Margaret was employed by Landcare Research in New Zealand from 2001 to 2009, developing a suite of laser-based techniques to measure the exchange of isotopes of CO_2 and water vapour between the atmosphere and plants, soil and the whole ecosystem. Margaret joined The University of Sydney, Faculty of Agriculture and Environment as an ARC Future Fellow in Biosphere-atmosphere interactions in 2010, and from 2014 as an Associate Professor in the Environmental Science Department. Research interests include crop water-use efficiency, linking ecosystem carbon and water cycles, and tree ring stable isotopes.

Dr Keith Hobson

Dr. Hobson is a senior research scientist with the Science and Technology Branch of Environment Canada in Saskatoon. Along with Dr. Len Wassenaar, Dr. Hobson founded the IsoEcology meetings and has been a strong proponent of the application of stable isotope methods in applied ecology, especially in the realm of animal conservation. Dr. Hobson is also an adjunct professor of Biology at the University of Saskatchewan where he supervises graduate students and is the co-editor of the journal Avian Conservation and Ecology. Recently, Dr. Hobson was inducted as a Fellow of the Royal Society of Canada.

Professor Brian N Popp

Brian has B.S. (Michigan 1978), M.S. (Illinois 1981) and Ph.D. (Illinois 1986) degrees in geology and postdoctoral experience in biogeochemistry (John M. Hayes, Indiana 1985-89). Brian is a professor of Geology & Geophysics at the University of Hawaii and director of the UH Stable Isotope Biogeochemistry Laboratories. He is also faculty in the UH Marine Biology Program and is graduate faculty in the Department of Oceanography and in the Department of Ecology, Evolution and Conservation Biology. Brian has over 100 publications in international peer-reviewed journals. His Geochimica et Cosmochimica Acta publication with co-authors Edward Laws and Robert Bidigare from UH was recognized by the Geochemical Society as the 1995 Best Paper of the Year. Brian is a Fellow of the Geochemical Society and European Association for Geochemistry and was also selected as a Frolich Fellow at the CSIRO Marine Laboratories, Hobart, Australia (2011). He has received over $10M in research grants from the NSF, NOAA, USDA and the USGS and has been chief scientist on more than a dozen oceanographic research expeditions.

Professor Naohiro Yoshida

Naohiro Yoshida is a Professor of two departments and also a PI of the Institute, Tokyo Institute of Technology. He was an Assistant Vice-President of Tokyo Tech., and served as Editor of Atmospheric Chemistry and Physics at EGU, and an Editor of Geophysical Research Letters at AGU. He is the President of the International Symposium on Isotopomers (ISI) and his professional affiliations include AGU; EGU; The Geochemical Society; The Geochemical Society of Japan currently serving as a Past President; The Meteorological Society of Japan; The Japan Radioisotope Association; The Oceanographic Society of Japan; and The Japan Society for Analytical Chemistry. He has published more than 160 papers including 8 published in Nature/Science, and his research has been recognized by the Geochemical Society of Japan Award, 2009; the Nissan Science Award, Nissan Science Foundation, 2005; the Special Technology Award, Suga Foundation, 2004 and the Global Environmental Award, Nihon Keizai Shinbun, 2001.

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Mixing Models in Food Web Studies and Trophic Transfers

KEYNOTE

INSIGHTS INTO TROPHIC ECOLOGY OF MARINE ANIMALS AND OCEAN BIOGEOCHEMISTRY FROM ISOTOPE ANALYSIS OF AMINO ACIDS

Brian N. POPP[1*]

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Ecosystem based management requires an understanding of the inter-connectedness of organisms within an ecosystem. Arguably, one of the most important of these connections is trophic interactions, or the trophic position that an organism occupies within a given food web. The nitrogen isotopic composition of a consumer's tissue has been used to investigate trophic linkages within marine food webs. However, there are a number of assumptions that must be met in order to satisfactorily interpret bulk tissue $\delta^{15}N$ values in terms of trophic position, including knowing the isotopic composition of plants at the base of the food web and the expected enrichment in ^{15}N in the consumer at each trophic step. Compound specific nitrogen isotope analysis of amino acids can alleviate some of the challenges associated with the interpretation of bulk tissue $\delta^{15}N$ values. In samples of consumer tissues some amino acids, such as phenylalanine, appear to retain the isotopic composition of nitrogen sources at the base of the food web, whereas other amino acids, such as glutamic acid, are significantly enriched in ^{15}N with each trophic transfer. As such, the isotopic composition of the base of the food web and trophic information can be obtained from the tissue of only a consumer without need for analyzing prey items or basal food web resources. The application and pitfalls of this technique to marine organisms including zooplankton, reef and pelagic fishes, sea turtles and rays will be discussed. I will also emphasize the role that compound specific isotope analysis of amino acids can play in understanding ocean biogeochemistry and in verifying or providing critical information for ecosystem models, which are often used to help understand and predict changes in ecosystems due to environmental variability and fisheries.

THE AUTOCHTHONOUS-ALLOCHTHONOUS DEBATE IN TROPICAL STREAMS – NEW EVIDENCE FROM MODELLING OF CARBON FLUX IN FOOD WEBS USING EVIDENCE FROM STABLE ISOTOPES

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The temperate model of ecosystem functioning of small forested streams states that the principal energy/carbon source is allochthonous material (leaves, etc.) from the surrounding forest. Some debate exists as to whether this holds for tropical streams, or at least whether tropical streams are more autochthonous based at equivalent forest shading (Brito et al. 2006; Dudgeon et al. 2010). Two lines of evidence support this conjecture: 1. some stable isotope analysis indicates that the food webs of tropical streams are strongly aligned with autochthonous algae, 2. shredding taxa and shredding activity seem to be less. We combined evidence of dietary carbon source from carbon and nitrogen stable isotope analysis with estimates of primary and secondary production of food web components to assess the quantitative flow of carbon. Because of the difficulty of separating algae from the mixture of material in periphyton we used known herbivores as surrogates for the algal isotopic signature.

Our preliminary results swing the balance back towards allochthony: secondary production of macroinvertebrates was found to be predominantly fuelled by allochthonous material even when the food web contained many autochthonous-based taxa (because allochthony was both less efficient and associated with greater biomass of consumers). We found no strong correlation with forest cover. Herbivores were apparently not limited by the production of autochthonous source (periphyton algae) which was well in excess of carbon flow to herbivores.

REFERENCES

Brito, E. F., T. P. Moulton, M. L. Souza, and S. E. Bunn. 2006. Stable isotope analysis indicates microalgae as the predominant food source of fauna in a coastal forest stream, south-east Brazil. Austral Ecology 31:623-633.

Dudgeon, D., F. K. W. Cheung, and S. K. Mantel. 2010. Foodweb structure in small streams: do we need different models for the tropics? Journal of the North American Benthological Society 29:395-412.

PELAGIC-BENTHIC COUPLING WRIT LARGE: BENTHIVOROUS MACROALGAL REEF FISHES ARE FUELLED BY PELAGIC PRODUCTION IN THE HUMBOLDT CURRENT SYSTEM

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Marine upwelling regions are renowned for their extreme pelagic productivity, but little is known regarding the effects of upwelling-derived primary production on adjacent non-pelagic ecosystems. Consumers inhabiting such ecosystems can potentially be subsidised by pelagic-derived energy and nutrients via pelagic-benthic coupling. The Humboldt Current System of South America supports the World's largest industrial fishery, targeting pelagic fishes which, although captured in staggering numbers, are not directly consumed by humans. Human fish consumption in the region is actually supported by small-scale fisheries targeting benthic fishes inhabiting coastal rocky–macroalgal reefs. These inshore habitats (and taxa) are typically considered to be fuelled by benthic production i.e. macroalgae and epilithic microalgae, but are potentially net receivers of subsidies from adjacent productive pelagic habitats.

We used $\delta^{13}C$ and $\delta^{15}N$ to estimate the relative contribution of pelagic- and benthic-derived C and N to benthic reef-associated fishes of the Mejillones Peninsula (23°S, 70°W) in northern Chile during the Austral summer and winter of 2012. Six locations were sampled along a ca. 150 km section of coastline to examine spatial and temporal variation in potential pelagic-benthic coupling. At each location, benthic and pelagic sources of primary production, as well as grazing gastropods (benthic indicator) and filter feeding bivalves (pelagic indicator) were collected. Dominant benthic fishes were collected by spearfishing. $\delta^{13}C$ and $\delta^{15}N$ values were estimated for all producers and consumers (muscle tissues).

Mixing model results (SIAR) showed that C and N in rocky/macro-algal reef fish were almost entirely (median 98%) of pelagic origin. Our results not only reveal the importance of pelagic-benthic coupling in the region, but also that these economically important benthic fish assemblages are functionally part of the pelagic foodweb. This highlights the putative role of offshore subsidies for nearshore ecosystems, and the need to understand such ecological links in terms of resource management and sustainable fisheries.

EXPERIMENTAL ISOTOPIC DIET COMPOSITION USING QUALIFIED DNA PRIORS IN MIXING MODELS: SEARCHING FOR THE REAL DIET

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2. Department of Conservation Biology, Applied Marine Ecology Group, Estación Biológica de Doñana (EBD-CSIC), Sevilla, Spain
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Reconstructing the diet of top marine predators is of great significance in several key areas of applied ecology, requiring accurate estimation of their true diet. Their diet can offer insights into the fluctuations of fish stocks and overall marine ecosystem variability. Data on diet and changes in their trophic habits can also provide information on dramatic changes in prey composition or in oceanographic conditions and these data are crucial building blocks in ecosystem models. However, from conventional stomach content analysis to recent stable isotope and DNA analyses, no one method is bias or error free.

Here, we evaluated the accuracy of recent methods to estimate the actual proportion of a controlled diet fed to a top-predator seabird, the *Eudyptula minor* (Little penguin). We combined published DNA data of penguins scats with blood plasma $\delta^{15}N$ and $\delta^{13}C$ values to reconstruct the diet of individuals fed experimentally.

Mismatch between controlled (true) ingested diet and dietary estimates obtained through the separately use of stable isotope and DNA data suggested some degree of differences in prey assimilation (stable isotope) and digestion rates (DNA analysis). In contrast, combined posterior isotope mixing model with DNA Bayesian priors provided the closest match to the true diet. We provided evidence suggesting that the combined use of these complementary techniques may provide better estimates of the actual diet of top marine predators- a powerful tool in applied ecology in the search for the true consumed diet.

REFERENCES

Chiaradia, A., M. G. Forero, J. C. McInnes and F. Ramírez (2014). "Searching for the True Diet of Marine Predators: Incorporating Bayesian Priors into Stable Isotope Mixing Models." PLoS ONE **9**(3): e92665. DOI: 10.1371/journal.pone.0092665.

COUPLING PHYSICAL PROCESSES OF THE KWAZULU-NATAL BIGHT (SOUTH AFRICA) TO THE ECOSYSTEM FUNCTION OF ITS PELAGIC AND BENTHIC FOOD WEBS

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The generally oligotrophic KwaZulu-Natal Bight on the South African east coast is an oceanographically important shelf area that supports highly biodiverse benthic and pelagic ecosystems and two important fisheries.

Our study elucidates the main drivers of the Bight's pelagic and benthic ecosystems, with special reference to three potential physical drivers. Two of these are oceanographic features linked to the Agulhas Current, *viz*. a topographically induced upwelling cell, and a cyclonic lee eddy. The third is fluvial forcing by estuaries and rivers on the coast, which we hypothesise mediates the physical, chemical and geological drivers at the coastal edge of the Bight.

Results based on the analysis of $\delta^{13}C$, $\delta^{15}N$, % organic C, % N and C:N ratios indicate that terrigenous allochthonous sources of particulate organic matter (POM) sustain the pelagic food web during the wet season (Austral summer), but that oceanic drivers dominate during the dry season. Tracer studies involving the addition of ^{13}C- and ^{15}N-enriched inorganic materials suggest that fluvially derived dissolved inorganic N is responsible for supporting phytoplankton production in parts of the Bight, particularly in Austral summer. The benthic food web is controlled by riverine input of POM in all seasons, with omnivory the most wide spread feeding strategy for demersal organisms.

Our results challenge the widely held belief that the highly energetic Agulhas Current is the dominant driver of marine ecosystems along the South African east coast.

AUTOCHTHONOUS DERIVED AMINO ACIDS FUEL ALPINE AND ARCTIC LAKE FOOD WEBS

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There is an ongoing debate on the extent allochthonous and autochthonous sources fuel lake food webs. It is also under debate how much lake food webs rely on bacterial sources. To provide a new perspective, we used $\delta^{13}C$ fingerprinting of essential amino acids (EAA) to trace bacterial, algal and plant subsidies to dominant consumer species in five arctic lakes in northern Alaska with moderate to high dissolved organic carbon (DOC) concentrations and three alpine lakes in the Pyrenees with low DOC concentrations.

Algae were the main subsidy of EAA to consumers in both arctic and alpine lakes (Fig. 1). We found that incorporation of plant EAA was similar in both locations in spite of alpine lakes having five times less DOC. In terms of bacterial EAA, consumers in alpine lakes assimilated nearly twice as much as in arctic lakes (Fig. 1), suggesting that bacterial contribution is related to aquatic rather than terrestrial carbon sources. The proportion of bacterial EAA in consumers was higher than in the seston, epilithon and sediment biofilm, indicating preferential assimilation of bacterial derived food sources.

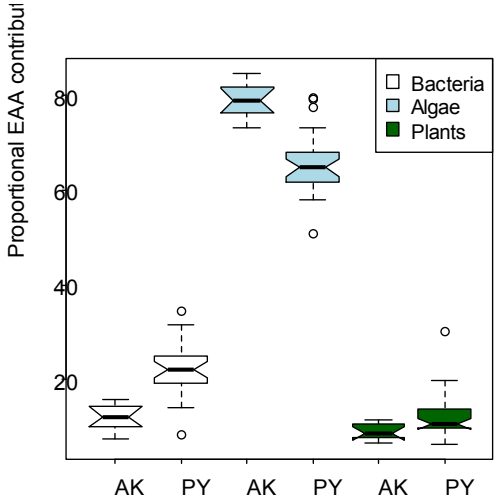

Figure 1 Boxplots of the relative contribution of bacterial, algal and plant EAA to crustaceans and invertebrates inhabiting Alaskan (AK) and Pyrenean (PY) lakes. The boxplots reflect mean contribution across species and lakes obtained by the Bayesian mixing model FRUITS.

USING STABLE ISOTOPES TO STUDY DIETARY AND SPATIAL SEGREGATION IN THREE PELAGIC STORM-PETRELS

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Stable isotopes are useful tools to investigate ecological segregation within and among species of seabirds, and can give insights into mechanisms of ecological segregation in diet and spatial distribution. In this case study, we explored ecological segregation in three sympatric species of *Oceanodroma* storm-petrels, breeding on the San Benito Islands, off Baja California, Pacific Ocean. Of the three species, Black storm-petrels *Oceanodroma melania* and Least storm-petrels *O. microsoma* are endemic species breeding on both sides of the Baja California Peninsula, on islands in the Gulf of California and the Pacific, while Leach's storm-petrels *O. leucorhoa* are a wide-spread species in the northern Atlantic and Pacific Ocean. Thus, we aimed to test the hypothesis that Leach's storm-petrels are more flexible in their diet choice than the two endemic species, which may have narrower isotopic niches. We collected feathers, egg membranes and blood samples, as well as diet samples, and applied Bayesian methods of SIBER to describe niches and SIAR mixing models to explore diet composition. We found ecological segregation in these pelagic seabirds, both in diet and distribution. Intra-specific differences were detected among years and among adult self-feeding and chick-feeding diets. To interpret our findings, we further present isotope data of zooplankton samples collected on both sides of the Baja California Peninsula.

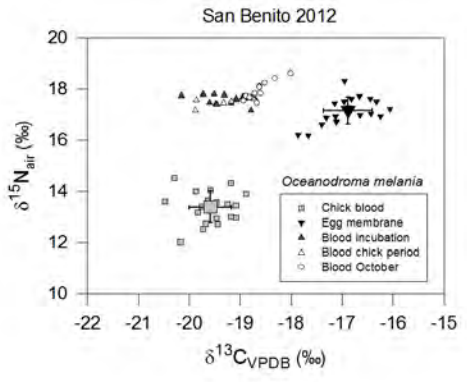

Fig. 1. Raw and mean stable isotope values of tissue samples representing the breeding season in Black storm-petrels.

LIFE-STAGE DIETARY SHIFTS IN A RESIDENT SEABIRD

Nicole D. KOWALCZYK[1*] Andre Chiaradia[2] Tiana J. Preston Richard D. Reina[1]

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Resident seabirds have relatively small foraging ranges and require access to predictable and local prey resources year-round. This constraint makes them vulnerable to local shifts in prey availability and highlights the need to understand their diet at the breeding and non-breeding stages of the annual cycle. However, such studies are uncommon in diet analysis literature. In this study, we used stable isotope analysis to reconstruct the diet and isotopic niche of a resident seabird, the little penguin *(Eudyptula minor),* throughout the annual cycle, over four years. We found that within years, the breeding and non-breeding diets of little penguins were broadly similar at a species level and that anchovy dominated the diet of penguins year-round. However, subtle life-stage (pre-moult, winter, breeding) differences in the isotopic position of penguins were detected and are likely related to seasonal fluctuations in the prey assemblage age structure. During winter, penguins had more enriched $\delta^{15}N$ and $\delta^{13}C$ levels relative to pre-moult penguins. This shift was likely due to the increased consumption of juvenile anchovy (< 2 yrs cohort), which have enriched carbon and nitrogen levels and dominate prey biomass in this bay in winter. During the breeding season, the $\delta^{13}C$ values of breeding penguins were more depleted than winter adults. This shift is likely in response to the increased consumption of prey that enters the bay from offshore regions to spawn. Although the ontogenetic structure of fish communities in the bay appears to be seasonal, their recruitment success and abundance can fluctuate dramatically between years. Annual fluctuations in prey abundance and availability are reflected in the varying diet and isotopic niche dimensions of little penguins across years, and are likely responsible for the observed high annual variance in penguin reproductive success. Long-term monitoring of the foraging behaviour and reproductive success of resident seabirds will not only provide information about how they respond to fluctuations in their prey, but can be used to infer the spatial and temporal distribution of their prey species.

MEASURING CHANGES IN FOOD WEBS AND SPECIES NICHES WITH STABLE ISOTOPES

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Many human and natural events can impact aquatic populations and communities, leaving strong imprints as altered food web dynamics. Stable C and N isotopes in fish can record these altered trophic dynamics in an integrated way, and a new methodology is presented to extract measures of food web change from isotope measurements of fish species. Measured CN isotope data are re-scaled as modified Z scores to equalize effects of average food inputs, then graphed in (x,y) space to obtain food web shapes. Pairs of food webs are compared for shifts in isotope values of individual species and pairs of species, and these shifts are used to assess overall constancy of species niches and fish food webs. Application of the methodology shows that 1) relatively undisturbed natural fish communities often show substantially different food web structure even when the same species of fish are present, 2) substantial migration leads to apparent homogenization of food web structures involving fish, 3) many fish species have 20-40% variability in their trophic niches, and 4) factors such as species invasions and dredging result in measurable differences between food webs that can be used to assess food web condition in conservation and restoration contexts.

EFFECTS OF STREAM RESTORATION ON AQUATIC PREY SUBSIDIES TO RIPARIAN SPIDERS

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For centuries, streams have been modified according to human needs such as agriculture or hydropower, often resulting in degraded aquatic and riparian communities. More recently, European and other governmental programs aim to restore streams to a more natural state. Previous studies have shown that aquatic emergent insects contribute substantially to the diet of riparian predators, yet these studies have mainly been performed in undisturbed areas. Therefore, our aim was to investigate the implications of restoration projects on the coupling of the aquatic and terrestrial ecosystems. To test this, we studied the contribution of aquatic and terrestrial resources to the diet of web-weaving (*Tetragnatha* sp.) and ground-dwelling (*Pardosa* sp.) riparian spiders. We used bulk stable isotope analyses of $\delta^{13}C$ and $\delta^{15}N$ from these spiders and potential resources at restored and non-restored sections along ten streams (Rhineland-Palatinate, Germany). Results from SIAR analyses of aquatic emergent insects and terrestrial arthropods will be compared to the results of the abundance and body condition of riparian spiders. To our knowledge, this is the first study using stable isotope mixing models to evaluate stream restoration projects regarding the aquatic-terrestrial linkage.

TURNOVER RATES OF CARBON AND NITROGEN STABLE ISOTOPES IN THE AMPHIPOD *GAMMARUS AEQUICAUDA*: INSIGHTS FOR TROPHIC STUDIES OF MEDITERRANEAN MACROPHYTODETRITUS ACCUMULATION.

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A quite diverse and abundant macrofauna assemblage is found in the Mediterranean Sea in exported *Posidonia oceanica* macrophytodétritus accumulations along with meiofauna, microalgae, fungi and bacteria. This study focused on a dominant vagile macroinvertebrate species living and feeding in exported dead *P.oceanica* leaves litter from Calvi Bay (Corsica, France): *Gammarus aequicauda.* Results of gut content observations and stable isotope analysis (SIAR data) showed clearly that *G. aequicauda* is the most important dead *P. oceanica* consumer with up to 50% of dead leaves contribution.

An isotopic turnover experiment was conducted with 3 controlled simultaneous treatments: 1. amphipod feeding for 43 days, 2. Green algae feeding for 30 days and 3. *Posidonia oceanica* litter feeding for 30 days. Individuals (n = 12 to 16) have been sampled every 7 days and whole individual stable isotope analysis have been conducted. An exponential decay regression model and calculations resulted in half-lives for C ranging from 11.63 days (treatment 1) to 45.67 days (treatment 3). Treatment 2 data did not allow us to fit a curve, consequence of a potentially very low turnover rate. For N, no significant increase or decrease of the $\delta^{15}N$ values have been observed, and we thus concluded that $\delta^{15}N$ was at the equilibrium from the beginning to the end of the experiment. It appears that amphipods feeding on low quality food (high to very high C/N ratio) like algae and Neptune grass dead leaves, show a lower turnover rate for C than amphipods feeding on a high quality animal food (low C/N ratio). Carbon and Nitrogen stable isotope "Trophic Enrichment Factor" (TEF) were calculated for treatments where $\delta^{13}C$ or $\delta^{15}N$ were at the equilibrium at the end of the experiment. Calculated TEF for nitrogen ranged from 0.53‰ ± 0.439 to 0.96‰ ± 0.424 for treatment 2 and 3 (consistent with detritus-feeder invertebrate values) and was 2.91‰ ± 0.558 for treatment 1 (consistent with predator invertebrate values). For C calculations, only treatment 1 gave a TEF of 1.23‰ ± 0.824 (probably over-estimated as $\delta^{13}C$ value at the end of the experiment was not perfectly at the equilibrium).

TRACING THE TROPHIC TRANSFER OF METALS IN BENTHIC FOOD WEB OF THE GULF OF GDAŃSK (THE SOUTHERN BALTIC SEA) USING STABLE ISOTOPES

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Spatial heterogeneity with regard to hydro-geochemical conditions and ecological factors make the Gulf of Gdańsk (southern Baltic Sea) an ideal environment in which to study trophic links over a range of habitat structures and biodiversities. The gulf is also subjected to elevated metal pollution (there is marked asymmetry in metal contamination) due to anthropogenic pressure and restricted water exchange with the oceanic system.

Stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope composition and metal concentrations (Fe, Mn, Cu and Zn) were measured seasonally in abiotic (suspended particulate organic matter, sediments) and biotic ecosystem components (benthic macrophytes and macrofauna) at six sites of different ecological features over a full year. When a uniform trophic enrichment factor of 1.0‰ for $\delta^{13}C$ and 3.4‰ for $\delta^{15}N$, and site-specific food web baselines are applied to trophic relations, the primary food source to fauna is suspended organic matter (SPOM), of which autochthonous phytoplankton serves as the main source, and sediment organic matter (SOM). The benthic food webs of the gulf have three to four trophic levels (food chain length, FCL varied 2.90 to 3.48). Coupling the isotope technique with conventional metal measurements in organisms at different trophic levels allowed quantifying metal behaviour along food chains. Iron and Mn concentration decreases in successive trophic levels (biodiminution rates of 3.0-fold and 2.3-fold, respectively) as a function of trophic position because of interspecific differences of metal handling strategies. The basal food web metal level appears, therefore, to cause primarily local discrepancies in the accumulated concentrations of the metals in the benthic biota. A similar two-phasic pattern was identified for Cu and Zn, and included an increase in metal concentrations between food sources and primary consumers (breaking points at 7.9 ‰ and 9.0‰ $\delta^{15}N$) followed by a decrease in higher trophic levels. Considering the entire food web, from the base to its top predators, Zn tends to biomagnify by a factor of 1.2 and Cu shows no trophic transfer (0.0).

FEEDING ECOLOGY OF HARPACTICOID COPEPOD SPECIES: INSIGHTS FROM STABLE ISOTOPE ANALYSIS AND FATTY ACID PROFILING

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Understanding how biodiversity influence ecosystem functioning is a major research question in current ecology research. Trophic diversity within communities strongly affects ecosystem functioning through trophic interactions between species. Various studies tackled ecosystem functioning via interactions between trophic guilds such as bottom-up and top-down control. However, few studies focussed on interspecific variability in the feeding ecology of organisms with overlapping trophic niche.

Here, we unravel the trophic diversity of a benthic copepod community in a North-Western Corsican *Posidonia oceanica* seagrass meadow and its variability over one year. The extensive *P. oceanica* meadows are occasionally interrupted by bare sand patches which serve as deposition and accumulation area for detritus, mainly derived from senescent macrophytes. These macrophytodetritus accumulation harbour a diverse community of Harpacticoida (Crustacea, Copepoda). The most abundant harpacticoids and their potential food sources (i.e. macrophytodetritus, epiphytic biofilm, macroalgae and particulate matter) were analysed for stable isotope ratios ($\delta^{13}C$, $\delta^{15}N$). Bayesian mixing model (SIAR) showed a minor contribution of macrophytodetritus while the epiphytic biofilm, present on the macrophytodetritus, appeared to be the major food source of harpacticoid copepods. In order to distinguish the several components of the epiphytic biofilm and their contribution, fatty acid profiling was used. The outcome revealed a general harpacticoid diet preference towards diatoms and bacteria, however specialisation for certain components seemed to reduce competition between harpacticoid species.

In conclusion, our results underline the importance of multiple biomarker species-specific analysis, especially in complex and dynamic environments where a wide variety of potential trophic niches are present.

ISOTOPE DISCRIMINATION IN PLANKTIVOROUS ELASMOBRANCHS FOCUSING ON THE WORLD'S LARGEST FISH, CAPTIVE WHALE SHARKS *RHINCODON TYPUS*

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Accurate diet-tissue discrimination factors (DTDF) are essential for quantifying diets and trophic positions (TP) using stable isotope analyses (SIA), with potential variation between diets, tissues, organisms and environments arguing against untested application of meta-analysis averages (e.g. 3.4 ‰ for bulk nitrogen ($\delta^{15}N_{bulk}$), ~0.5 ‰ for bulk carbon ($\delta^{13}C_{bulk}$), and 7.6 ‰ and 0.4 ‰ for nitrogen of glutamic acid ($\delta^{15}N_{glu}$) and phenylalanine ($\delta^{15}N_{phe}$), respectively). Experimental derivations of DTDF in elasmobranchs (sharks and rays) are scarce, with large-bodied organisms difficult to maintain in captivity and non-lethal multi-tissue sampling problematic for both captive and wild individuals. SIA of captive whale sharks *Rhincodon typus*, one male (8.5 m in length) and two females (7.1 and 7.2 m), fed a mixed diet composed mainly (~ 48 % each) of Antarctic krill *Euphausia superba* ($\delta^{15}N$ = 3.45 ‰, $\delta^{13}C$ = -26.3 ‰) and North Pacific krill *E. pacifica* ($\delta^{15}N$ = 5.88 ‰, $\delta^{13}C$ = -21.6 ‰), provide an opportunity to examine DTDF in the world's largest fish and one of three planktivorous sharks. DTDFs estimated based on temporally averaged diets for easily sampled but slow turnover fin tissue were close to previous observations, but varied between individuals, perhaps reflecting differing growth rates with size or physiological differences between the sexes: $\delta^{15}N_{bulk}$ (2.6, 3.3, 3.1 ‰), $\delta^{13}C_{bulk}$ (3.9, 4.5, 5.9 ‰), $\delta^{15}N_{glu}$ (7.6, 6.5, n.d. ‰) and $\delta^{15}N_{phe}$ - (0.3, 0.2, n.d. ‰). Short turnover tissues, such as liver or blood, may be difficult or impossible to obtain for these species, requiring non-lethal isotopic proxies to examine diet and TP at higher temporal resolution. For instance, SIA of faecal material was highly variable but reflected day-to-day variation in minor (<3 %) components of the sharks' diets. DTDF will be discussed in the context of sampling constraints related to multi-tissue SIA and recent radioisotope approaches for understanding feeding and aggregations of planktivorous elasmobranchs, including recent application to a wild caught (4.4 m) specimen of the smallest planktivorous shark, the rare megamouth shark *Megachasma pelagios*.

THE ROLE OF HINDGUT MICROBES IN PROTEIN SUPPLY TO THE MARINE HERBIVOROUS FISH, *KYPHOSUS SYDNEYANUS*

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Bulk stable isotope analysis (SIA) and, more recently, compound specific stable isotope analysis (CSIA) have been used in ecology to determine dietary sources and to describe trophic relationships. Here, we use SIA ($\delta^{15}N$ and $\delta^{13}C$) to investigate nutritional inputs in the marine herbivorous fish species *Kyphosus sydneyanus* (Kyphosidae) in New Zealand. Inputs of the algal diet and hindgut microbes were examined in liver and muscle tissue of the fish. We also used CSIA ($\delta^{15}N$ and $\delta^{13}C$) to determine the source(s) of assimilation for 12 amino acids from the diet (algae) and/or symbiotic hindgut bacteria (microbes) to the liver and muscle tissues of the fish.

Bulk stable isotope analysis indicated that all *K. sydneyanus* tissues and gut contents varied little in $\delta^{13}C$ mean values (-17.3‰ to -15.9‰). In contrast, potential sources and consumer tissues were trophically fractionated in $\delta^{15}N$, and the four sample types (muscle, liver, algae and microbes) were isotopically distinct in $\delta^{15}N$.

CSIA revealed that both algae and microbes contributed amino acids to the fish, with relative contribution varying among amino acids. We determined the modal contributions of algae and microbes to fish liver and muscle using the Bayesian-based statistical model SIAR (Stable Isotope Analysis in R). Microbes contributed over 70% $\delta^{15}N$ to glycine and threonine in muscle and liver, whereas algae and microbes contributed equally to lysine in muscle, and dietary algae contributed most (86.5%) to liver. We found differences in $\delta^{13}C$ between liver and muscle in sources of some amino acids. For aspartate, glutamine, and threonine the muscle received <5% contribution from algae. Conversely, algae was the source of 32-45% of these 3 amino acids in liver.

Our results suggest not only that both the algal diet and hindgut microbes contribute carbon and nitrogen to amino acids in fish tissues, but also that the predominant sources of some amino acids differ between muscle and liver. In general, the liver seems to receive more amino acids from endogenous digestion of algae in the foregut. The muscle seems to assimilate more amino acids directly from microbes, and possibly derives carbon skeletons for dispensable amino acids from bacterially-derived short-chain fatty acids in the hindgut.

TRACKING SEASONAL CHANGES IN NORTH SEA FOOD WEBS: A COMBINED STABLE ISOTOPE AND FATTY ACID APPROACH

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Shallow waters and high nutrient inputs into the North Sea (NS) sustain one of the most biologically productive shelf seas of the North Atlantic. The East Anglia plume (EAP) in the southern NS receives large amounts of nutrients from UK estuaries and transfers water masses across the NS. Uncertainties exist about inherent ecological implications for the propagation of macronutrients through and pelagic-benthic coupling in NS food webs.

Combining the study of bulk C and N stable isotope analysis (SIA), with compound-specific stable isotope analysis (CSIA) of phospholipid-derived fatty acids (PLFAs; GC-c-IRMS) of particulate organic matter (POM), zooplankton and epibenthic macrofauna, the present study describes the trophodynamics and energy fluxes within and between the pelagic and benthic food webs. Temporal and spatial variability was accounted for by repetitive sampling during seven cruises over 14 months (February 2007 to April 2008) in three hydrodynamically distinct regions, the Sean Gas field, the Oyster Ground, and at a site on the northern slope of the Dogger Bank.

Bulk isotopic signatures of most functional feeding groups changed temporally. The changes were greatest for zooplankton, suspension and subsurface deposit feeders, indicating a direct trophodynamic relationship of pelagic and benthic consumers with primary producers. Yet, over the seasons only small isotopic signature changes occurred in filter-feeding animals. Increased essential Omega-3 and other polyunsaturated PLFA concentrations were recorded in POM during and after the spring bloom in the central NS, whereas in the year-round well-mixed southern NS, the zooplankton was constantly supplied with food of lower quality. General elevated isotopic enrichment observed in POM and zooplankton collected from water masses influenced by the EAP suggest a higher degree of heterotrophy and a larger influence of the microbial loop for the southern NS. In addition, the analysis of mesozooplankton PLFA fingerprints indicated that some structural lipids used to maintain membrane integrity, remain present in relatively constant proportions, whilst this was accounted for by incorporation of PLFAs whose $\delta^{13}C$ signatures followed seasonal changes in POM $\delta^{13}C$ signatures. The present study highlighted the general suitability and also limitations of the two biogeochemical approaches often used to study end-to-end trophodynamics.

THE FUNCTIONING OF THE BENTHIC ECOSYSTEM IN THE EAST BELLINGSHAUSEN SEA: TROPHIC LINKS AND BENTHO-PELAGIC COUPLING

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Along the West Antarctic Peninsula (WAP) air and sea temperatures are increasing, glacial retreat is rapidly accelerating, and sea ice is decreasing in both area and duration. Therefore, animals in the East Bellingshausen are exposed to one of the most rapidly changing environments on the planet. In particular collapsing ice-shelves in the region are giving rise to new phytoplankton blooms generating complex feedback mechanisms within the food web. Signatures of water column productivity are often found in benthic species. Furthermore, it has become apparent that some parts of the pelagic community feed on the seabed more than initially thought.

We established the trophic links between the pelagic and the benthic by measuring carbon and nitrogen stable isotope ratios in suspended and sinking POM, sediments and key benthic and pelagic species at 4 stations in Marguerite Bay. There was significant overlap in $\delta^{13}C$ between the pelagic and benthic species at 3 of the 4 stations suggesting connectivity between the two realms. At the fourth station, the overlap was low implying greater separation between the benthic and the pelagic food chains.

Further resolution on the source of primary productivity at the base of the food web was provided by a novel suite of lipid biomarkers, highly branched isoprenoids (HBIs), which can discriminate phytoplankton communities that originate from sea-ice from those that originate from the open ocean. This is of particular value when establishing how the changing dynamics of bentho-pelagic coupling are affected by spatial and temporal variability in seasonal ice-cover.

Environmental Tracers of Biogeochemical Cycles

KEYNOTE

SPECIFIC MODE ANALYSES OF ISOTOPICALLY SUBSTITUTED MOLECULES TO BETTER CONSTRAIN THEIR CYCLES IN THE ENVIRONMENT

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Natural abundance isotope ratios in material and/or bulk molecule level have been analysed to trace biogeochemical cycles in different scales of the environment, and also inside of living organisms. Researches have been developed from the determination of the bulk content of a single isotope to multi-isotope, mass independent fractionation (MIF) or non-mass dependent fractionation (NMD) of oxygen, sulfur, and mercury isotopes, doubly substituted isotopologues or clumped isotopes, and position specific analyses at molecular level or isotopomers.

The progress of several analytical techniques, such as, Nuclear Magnetic Resonance (NMR) not only for deuterium but for carbon-13, Continuous Flow-Isotope Ratio Mass Spectrometer (CF-IRMS), high resolution isotope ratio mass spectrometer, Tunable Diode Laser Absorption Spectroscopy (TDLAS) with light sources of near infrared to quantum cascade laser and/or different frequency generation, Fourier Transform Infra-Red (FTIR), sub millimetre sounder remote sensor, and others, permits these analyses.

MIF, clumped isotopes, position specific isotope analyses at natural abundance level, have been applied rapidly providing invaluable information for better understanding of biogeochemical processes occurring in nature. They allow us to study biogeochemical mechanisms and pathways, the response of organisms to environmental change.

Much more efforts have become necessary for the synthesis, maintenance and nomenclature of original standard materials, their inter-laboratory calibrations, cross check of the multi spectrometric technologies, observations, theory and simulations of fractionations, and their archives. In so doing, however, we can develop our scientific applications of isotopic substitution to the diverse fields of research in the environment. Some examples of such analytical developments are briefly overviewed with their application to the material cycle analyses.

ANGELS & DEMONS: INTERACTIONS BETWEEN NATIVE & ALIEN AMPHIPODS

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Invasive species are considered one of the greatest global threats to biodiversity alongside habitat destruction. Many studies have been devoted to understanding the ecological impacts of such species but typically only once they have become established within ecosystems and essentially already made an impact. Another criticism of some of these studies might be that they treat a particular invasive species in isolation whereas there is a wealth of literature demonstrating that invaders are often facilitative and interactive.

Ponto-Caspian gammarids such as *Dikerogammarus villosus* and *D. haemobaphes* have both recently invaded the UK. They have been branded with emotive common names, killer and demon shrimp, respectively, on the basis of their alleged more predatory nature (relative to native gammarids) stemming from microcosm feeding arena studies. We have combined field surveys and mesocosm experiments to re-evaluate these claims from an isotopic perspective.

Field sites were chosen representing a density gradient of the invaders relative to a native (*Gammarus pulex*). Using SIBER to characterise the isotopic niche space occupied, there was little evidence that *D haemobaphes* or *Gammarus tigrinus* were any more predatory than the native in the R Thames. Replicated mesocosm studies indicated that the invader occupied the same isotopic niche as the native when in allopatry. However, when in sympatry, the invader tended to occupy that same niche but displace the native to another niche. The resultant relative positions in isotopic space do indeed make the invader appear more predatory. On the basis of our experiments the wider ramifications for ecosystem functioning were the invaders to replace the natives may not be as dramatic as the media headlines imply.

HOW DOES THE INVASIVE SPECIES *CREPIDULA FORNICATA* INFLUENCE BENTHIC TROPHIC DIVERSITY AND FUNCTIONING IN THE BAY OF BREST?

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The non-native slipper limpet (*Crepidula fornicata*) has massively proliferated in the Bay of Brest during the 90s after its introductions during World War II Allied shipping operations and then with commercial oysters during the 70s. This stack-forming suspension-feeding gastropod has become a dominant species both in terms of density (> 2000 ind.m^{-2}) and biomass (126 000 t in the Bay in 2000). *C. fornicata* modifies benthic habitats (by biodeposition and presence of shells), alters biogeochemical fluxes at the water-sediment interface and possibly controls the pelagic primary production, with further consequences for benthic diversity and species interactions within colonised areas.

Here, we tested the effects of *C. fornicata* beds occurrence on the benthic food web complexity through the use of isotopic trophic indices (ITI), as a surrogate of functional diversity. Since slipper limpet has recently started to decline in the southern part of the bay of Brest, forming large empty shells accumulation, we specifically assessed whether live and dead *Crepidula* beds lead to different trophic interactions among benthic communities.

Overall, only small differences were found in terms of species diversity and trophic functioning between live and dead *Crepidula* beds. The suspension-feeders guild showed a lower trophic niche overlap (or a lower trophic redundancy) in live compared to dead *Crepidula* beds. This possibly indicates food limitation and competitive interactions among co-occurring suspension feeding species in areas which still exhibit high density of slipper limpets. Interestingly, the benthic food web within *Crepidula* beds (either live or dead) was as complex as in maërl beds, a coralline red algae known to be hot-spots of benthic biodiversity in the Bay of Brest, suggesting that *Crepidula* shells promote functional diversity by increasing the availability of trophic niches for the associated community.

IS THE AQUATIC *DIKEROGAMMARUS VILLOSUS* A 'KILLER SHRIMP' IN THE FIELD? – A CASE STUDY ON ONE OF THE MOST INVASIVE SPECIES IN EUROPE

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Invasive species impact the community structure and food web by changing habitat conditions and availability of food resources, and therefore represent an increasing threat for native biodiversity, especially in freshwater ecosystems. One of the most important invasive species in Central-Europe is the ponto-caspian amphipod *Dikerogammarus villosus*. Following the establishment of *D. villosus* in invaded systems, decreasing densities of many other macroinvertebrate taxa in invaded habitats were recorded. Previous laboratory studies have revealed a strong potential predatory impact of *D. villosus* on other macroinvertebrate species, including other amphipods.

This predatory behaviour is often assumed to be the key driver of the observed species displacement. Therefore, in recent years *D. villosus* is often called 'killer shrimp'. However, little is known about the importance of the predatory strength of *D. villosus* in the field. Since natural conditions are much more complex than simulated in laboratory experiments, we hypothesized that this factor is of minor importance in the field independent from the colonized habitat. To test this, we used bulk stable isotope analyses of $\delta^{13}C$ and $\delta^{15}N$ of *D. villosus* and potential food resources to determine the tropic niche of *D. villosus* in different habitats of the River Rhine system. Our results show that the feeding strategy of *D. villosus* is on average similar to that of primary consumers, like *Ancylus fluviatilis*, *Dreissena* spp. and *Corbicula fluminea*, co-occurring in the different habitats studied. However, the isotopic signature of *D. villosus* shows high intraspecific variability, which can even exceed one trophic level. Furthermore, SIBER analyses revealed a similar trophic position for *D. villosus* and the coexisting amphipod species and showed an strong overlap of their trophic niches. To our knowledge, this is the first study clearly indicating a minor importance of the predatory behaviour of *D. villosus* in the field, but also gives hints for a strong differentiation within one population of the invasive amphipod.

INTERACTION BETWEEN SCALLOP CULTURE AND PRIMARY PRODUCTION IN MUTSU BAY, JAPAN BY MEANS OF STABLE ISOTOPE DETERMINATION OF DIET SOURCES

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Biomass changes in bivalves can cause significant changes in total phytoplankton biomass in estuarine systems, but few studies document ecosystem-level impacts of these changes. This study documents a significant increase in phytoplankton biomass concurrent with the collapse of Japanese Scallop (*Mizuhopecten yessoensis*) biomass during summer 2010 in Mutsu Bay, Japan. Stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopes, ingestion rates of scallops, variations in chlorophyll a concentrations and primary production within the bay were investigated.

$\delta^{13}C$ and $\delta^{15}N$ in rectum contents of juveniles, one year olds and adults in hanging cultured scallops were compared with potential food sources in order to determine the diet candidates. Relative contribution of each food source to their diet was estimated using the MODEL ISO-ERROR. Results of stable isotope analysis revealed plankton fractions (100-335 μm and 335 μm) were the major food sources of scallops. After the collapse of the scallop biomass, the scallop grazing pressure was 77% lesser than it had been in previous year and at the same time an increase in chlorophyll a concentrations and primary production ($P<0.0001$) was observed at depths up to 30 m. These observations all together explain a significant interaction between scallop grazing and primary production.

REFERENCES

Cranford P. J. Armsworthy S. L. Mikkelsen O. A. Milligan T. G. 2005. Food acquisition responses of the suspension-feeding bivalve *Placopecten magellanicus* to the flocculation and settlement of a phytoplankton bloom. Journal of Experimental Marine Biology and Ecology 326:128–143.

THE AGE OF RIVER-TRANSPORTED CARBON: A GLOBAL PERSPECTIVE

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Rivers play a pivotal role in regional and global carbon (C) budgets, processing significant quantities of terrestrial C inputs, as well as linking the terrestrial to the oceanic C pool. Despite the potential of radiocarbon (^{14}C) measurements to elucidate sources and cycling of different riverine C pools, there remain large regions for which no data are available, and no comprehensive attempts to synthesize the available information and examine global patterns in the ^{14}C content of different riverine C pools. Here, we present new ^{14}C data on particulate and dissolved organic C (POC and DOC) from six river basins in tropical and subtropical Africa, and compiled >1200 literature ^{14}C data and ancillary parameters from rivers globally.

Within the global ^{14}C dataset, paired C stable isotope ($\delta^{13}C$)- $\delta\ ^{14}C$ measurements suggest three primary organic carbon (OC) sources bound global riverine POC and DOC export fractions, with these being: (i) modern C_3 plants (^{13}C-depleted, ^{14}C-enriched), (ii) modern C_4 plants (^{13}C-enriched, ^{14}C-enriched), (iii) ^{14}C-dead ($\delta\ ^{14}C = -1000‰$) fossil carbon (i.e. kerogen sources). Our analysis reveals a consistent pattern whereby POC is progressively older in systems carrying higher sediment loads, coinciding with a lower organic carbon content. This relationship is combined with a global database of riverine sediment and POC fluxes, from which we propose a median global riverine $\delta\ ^{14}C$ of POC value of −208‰ (representing a radiocarbon age of ~1800 years BP), and suggesting approximately 20% of global riverine POC export to coastal zones is of fossil origin. For DOC, the symmetric frequency distribution of $\delta\ ^{14}C$ data suggests that the mean or median value (+30 and +50‰, respectively) offer a reasonable approximation to the ^{14}C signature of global riverine DOC – a value in contrast to DOC ^{14}C ages reported from open ocean environments (~6000 years). Weathering regimes complicate the interpretation of ^{14}C ages of dissolved inorganic carbon (DIC), but the available data favors the hypothesis that in most cases, more recent organic C is preferentially mineralized.

INFLUENCE OF ABIOTIC CONDITIONS ON MICROBIAL MAT COMMUNITIES FROM SHARK BAY, WESTERN AUSTRALIA

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Stromatolites, accretionary sedimentary structures produced by the activities of mat-building communities of mucilage-secreting microorganisms represent the earliest traces of life, with macro-fossil specimens reported in the rock record back to 3430 Ma. Yet, the general lack of microfossils or molecular fossils during this period of life's early evolution makes the study of microbial assemblages highly challenging and prone to scrutiny. Modern microbial mats, including from the World Heritage listed Shark Bay, W. Australia are modern analogues of early-formed stromatolites. Consequently, the study of these specimens provides an opportunity to gain a better understanding of ancient microbial assemblages.

We investigated the influence of abiotic conditions (i.e. water depth and salinity) on microbial mat communities from Shark Bay. The distributions and $\delta^{13}C$ values of lipid biomarkers and the $\delta^{13}C$ of the biomass in four different mats along a tidal flat gradient to showed several important differences. Shallower mats contained a higher diatom contribution, concordant with previous mat studies from other locations (e.g., Antarctica). Conversely, the organic matter of the deeper mats showed evidence for a higher seagrass contribution [high C:N, ^{13}C depleted long chain *n*-alkanes]. The morphological structure of the mats may have also influenced CO_2 diffusion leading to more ^{13}C-enriched lipids in the shallow mats. In addition, three smooth mats from different Shark Bay sites were analysed to investigate potential functional relationship of the microbial communities with differing salinity levels. Isotopic analysis revealed that the autotrophic biomasses dominating the most and least saline mats were likely using different CO_2 fixation pathways. Furthermore, diatom markers were observed in higher abundance in the most saline mat, suggesting a salinity control on diatoms. This study has highlighted the important interplay between abiotic parameters and the biotic response of modern stromatolites.

TOP-DOWN CONTROL OF METHANOTROPHS REGULATES METHANE EMISSIONS FROM A HUMIC LAKE

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Many boreal lakes can be significant sources of methane (CH_4), as CH_4 production in anaerobic layers of stratified lakes often exceeds oxidation by methanotrophic bacteria (MOB), leading to CH_4 fluxes to the atmosphere. MOB abundance and bacterial community structure could be altered via cascading trophic interactions in these lakes, ultimately impacting on CH_4 oxidation rates and emissions. We studied these expectations by experimentally dividing a small, humic and naturally fishless lake with high zooplankton abundance (mainly large-bodied *Daphnia longispina*) into two treatment basins with a plastic curtain. We then altered the predation pressure on zooplankton by introducing either adult or juvenile European perch (*Perca fluviatilis*) populations into the different basins, or leaving the other basin fishless.

We hypothesised that differences in the strength of zooplanktivory through predator presence and size would similarly cascade down the food web altering the abundance of *Daphnia* and their grazing on MOB, thereby impacting on CH_4 oxidation rates and ultimately emissions to the atmosphere. Concurrently with zooplankton abundance and CH_4 concentration measurements, MOB abundance was assessed using quantitative PCR by targeting specific functional genes. We also added ^{13}C-enriched bicarbonate into lake water to elevate $\delta^{13}C$ values in autochthonous primary production, as well as ^{15}N-enriched ammonium nitrate to spike the $\delta^{15}N$ of inorganic nitrogen pool. Stable isotopes ($\delta^{13}C$, $\delta^{15}N$) were then used as tracers of changing *Daphnia* diets and energy flow patterns in the lake.

Increasing predation pressure on zooplankton quickly reduced their biomass, resulting in corresponding increases in MOB abundance followed by decreases in epilimnetic CH_4 concentrations and thereby emissions. $\delta^{13}C$ and $\delta^{15}N$ values of *Daphnia* indicated clear differences in diets between the treatments, and agreed well with the hypothesis of relaxed grazing on MOB. Observed changes in CH_4 concentration were clearly linked to MOB abundance which, in turn, was regulated by *Daphnia* biomass. Our results illustrate that cascading trophic interactions can extend to regulate biogeochemical processes in humic lakes.

A CARBON ISOTOPE-ENABLED MODEL FOR VALIDATING CARBON BUDGET IN A SUB-TROPICAL ESTUARY

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Estuaries are productive and diverse ecosystems. They serve as a biogeochemical filter that process catchment-derived inorganic and organic matter and regulate carbon and nutrients delivery to the coastal ocean. A coupled 3-D hydrodynamic and carbon isotope-enabled model provides a powerful tool to better resolve the process and pathways of carbon of a net heterotrophic sub-tropical Caboolture River estuary in south east Queensland, Australia. However, modelling the metabolism of an estuary is not an easy task due to the large spatiotemporal variability in water quality of the contributing environments and biogeochemical processes within the estuary. And most of the time, this variability are not captured with routine monitoring programs.

We report an alternative method to perform unbiased and accurate estimation of the dissolved inorganic and organic carbons along the freshwater-marine continuum by combining deterministic and stochastic approaches. The proposed method aims to: (1) reduce model equifinality through application of an isotope-enabled biogeochemical model, and (2) undertake an uncertainty assessment on the biogeochemical parameters by using a 1-D isotope-enabled mixing model (Reigner and P'Kane, 2004) within a Bayesian Hierarchical Formulation (BHF). The 3-D carbon isotope model is developed accounting for processes at the air-water surface exchange, water column, and sediment.

A comprehensive water quality dataset collected by the Southeast Queensland Ecosystem Health Monitoring Program (SEQ-EHMP) and Centre for Coastal Biogeochemistry (CCB) of the Southern Cross University as part of an ARC Linkage Grant were utilised. The seasonal carbon budgets along the estuary to ocean continuum are presented.

REFERENCES

Reignier, P., P'Kane, J.P., 2004. On the mixing processes in estuaries: the fractional freshwater method revisited. Estuaries 27(4): 571-582.

PLANT-MICROBE COMPETITION FOR NITROGEN AND PHOSPHORUS AFFECTED BY DROUGHT

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Competition for nutrients between plants and microbes is an important determinant for plant growth, biodiversity and carbon cycling. Perturbations such as drought affect plant-microbe competition for nitrogen (N) and phosphorus (P). Despite the importance of these nutrients in most ecosystems, plant-microbe competition for N and P remains poorly understood. We used a novel dual isotope labelling technique (^{15}N and ^{32}P) to assess plant-microbe competition for N and P affected by drought in two different plant-soil systems.

Mesocosms were extracted from a grassland site where plants were strongly limited by N (N-limiting system) and from a grassland site that showed strong soil P adsorption (P-adsorbing system). Half of the mesocosms were subjected to drought one week prior to injection of the tracers. Stable ^{15}N (as KNO_3) and radio-labelled ^{32}P (as H_3PO_4) were injected, and measured in the plant and microbial biomass 72 hrs later.

Microbial uptake of ^{32}P was strongly reduced by drought (on average by 89%), while microbial ^{15}N uptake was not. In contrast, drought reduced plant uptake of ^{15}N (by 28%), but not of ^{32}P. Microbial ^{15}N uptake was much larger in the N-limiting system than in the P-adsorbing system (by 491%), while plant ^{32}P uptake was much larger in the P-adsorbing system than in the N-limiting system (by 703%). Both plants and microbes showed large flexibility in taking up ^{15}N and ^{32}P with the largest uptake of the nutrient that was in greatest demand.

Our results suggest that under drought conditions, plants lose in terms of N uptake, but win in terms of P uptake when competing for these nutrients with microbes. These different sensitivities to drought by plants and microbes may enhance decoupling of the N and P cycle with increased drought conditions, depending on if plants and microbes are N or P limited.

COMBUSTION INFLUENCES NATURAL ABUNDANCE OF ^{15}N IN PLANTS AND SOIL FOLLOWING BUSHFIRES AND PRESCRIBED BURNING

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A series of before-and-after-impact studies featuring changes in the natural abundance of nitrogen (^{15}N) were used to investigate the transformation of N during and after bushfire ('unplanned') and prescribed ('planned') burning. We measured the ^{15}N signatures of soil, charred and uncharred organic material, ash and foliage in three sub-alpine plant communities (Huber *et al*. 2013) and in temperate forest and woodland in south eastern Australia. For studies involving high intensity bushfire there was sequential enrichment of ^{15}N of unburnt leaves > ash > charred organic material. For studies involving low intensity planned fires the differences between ^{15}N of unburnt and charred organic matter was much smaller than for unplanned fires and often negligible transformation of N occurred. Surface soil was enriched in ^{15}N immediately after bushfire compared to charred organic material and ash in all plant communities investigated. The enrichment of soil and charred organic matter was associated with fractionation of N during combustion and volatilization of N. The rapid decline in ^{15}N of bulk soil to pre-fire values indicates that depleted ash, containing considerable amounts of total N, was readily incorporated into the soil and taken up by regenerating plants. The use of natural abundance of ^{15}N in soil, organic matter, ash and foliage can be used as a means of comparing transformation of N in relation to fire intensity (i.e. bushfires compared to prescribed fires).

REFERENCES

Huber E. Bell T.L. Adams M.A. 2013. Combustion influences on δ^{15}N in soil and plants following a wildfire in a sub-alpine ecosystem. Oecologia 173: 1063–1074.

QUANTIFYING THE HETEROTROPHIC COMPONENT OF SOIL RESPIRATION USING NATURAL ABUNDANCE $\delta^{13}C$

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Losses of CO_2 from soils, together considered as soil respiration (R_S), comprise several processes. For practical purposes, R_S can be partitioned into two sources: autotrophic respiration (R_A) by plant roots and their associated microbes, and heterotrophic respiration (R_H), from the decay of soil organic matter. R_A represents the rapid cycling of plant-derived carbon and has therefore limited influence on long-term carbon storage in soils. Thus, quantifying R_H as distinct from R_S is critically important to investigate the long-term consequences of land use change and climate change on soil carbon cycling. We compared two techniques for partitioning R_S in an experiment with intact soil cores from a grassland field site supplied with two levels of nitrogen growing in controlled conditions. The two techniques were an isotopic technique using natural abundance $\delta^{13}C$ (NAT), and the root exclusion technique (RET). Neither technique showed differences in the rate of R_H between nitrogen treatments (p=0.08 and p=0.84 respectively for NAT and RET), but there was a significant difference in R_H between techniques (p<0.0001). Possible explanations for this difference are discussed and we argue that the natural abundance $\delta^{13}C$ is a preferable method.

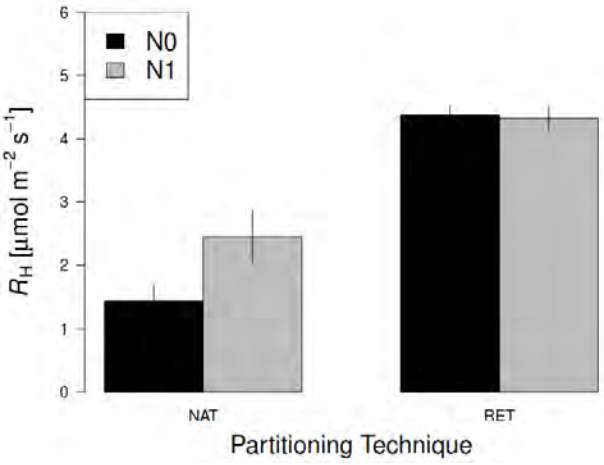

Figure 1: R_H (µmol m^{-2} s^{-1}) for two nitrogen treatments (N0 and N1, 100 and 450 kgN ha^{-1} y^{-1}, respectively) and two partitioning techniques (NAT and RET). Each bar represents the mean of replicates grassland soil cores and the bars shown are standard errors.

ESTIMATION OF MEAN RESIDENCE TIME OF AMINO SUGARS IN AGRICULTURAL SOILS

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Soil organic matter (SOM) is one of the largest carbon (C) pools on earth that actively exchanges with the atmosphere. Small variation in the net fluxes of CO_2 biosphere-atmosphere exchange can have large effects on earth's C balance. Fungi and bacteria are responsible for the majority of the SOM degradation processes and their residues represent typically between 25 and 50% of the top soil C. The estimation of mean residence times (MRT) of microbial residues is therefore indispensable to better understand sequestration and degradation mechanisms of SOM. Amino sugars are used to assess the contribution of fungal and bacterial residues to the SOM. However, very little is known about their turnover in soils.

Therefore, in this study we determined MRT of amino sugar C and SOC by mean of natural abundance ^{13}C labeling using a C3/C4 crop transition experiment with four soil types, and two different (low and high) C input treatments, extending over 22 years. The isotopic composition of the individual amino sugars was determined using liquid chromatography – isotopes ratio mass spectrometry (LC-IRMS) after hydrolyzation of soil samples. The MRTs were compared using a commonly used steady state one pool model, and a non-steady state one pool model, with a correction for changes in plant C input, and a two pools model with successive pools.

In all sites, turnover of glucosamine and galactosamine was similar or slightly shorter than that of original soil organic carbon (SOC), while muramic acid C appeared to have a faster turnover. Muramic acid C had MRTs, ranging from 11 till 67 years, while glucosamine C and galactosamine C had similar MRTs ranging from 45 till 200 years. The site with highest clay and silt content revealed longer MRT for all amino sugars C and SOC. This effect was much more pronounced for the amino sugars than for SOC. The high C input system resulted in longer MRT for both amino sugars C and original SOC, which can be attributed to decreased competition for more recalcitrant C (and N) sources (e.g. amino sugars).

THE EFFECT OF TREE SPECIES ON THE CARBON AND NITROGEN ALLOCATION AND CYCLING IN FOREST SOIL

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Transformation and translocation of carbon (C) and nitrogen (N) in soils are affected by tree species composition. The tree species affect the dynamics and rates of rhizodeposition and its incorporation into microbial biomass and soil organic matter. A whole tree canopy $^{13}CO_2$ and $Ca(^{15}NO_3)_2$ pulse labeling of *Fagus sylvatica* L. and *Fraxinus excelsior* L. has been conducted to investigate the impact of species on C and N allocation within trees, belowground C translocation and incorporation in microbial biomass and soil organic matter.

The labeling experiment was conducted on 40 trees 3-4 m high in a species rich broadleaf forest of Germany. Soil samples were taken in three depths at 15 cm distance from the tree and bulk soil organic matter $\delta^{13}C$ and $\delta^{15}N$ were determined. The C and N incorporation into plant tissue of leaves, stem and roots were measured. The microbial biomass and its isotope composition were determined by Chloroform-Fumigation–Extraction.

The photosynthetic carbon assimilation is twice as high in *F.sylvatica* (20,2% of the applied $^{13}CO_2$) than in *F.excelsior* (9,1% of the applied $^{13}CO_2$) but the nitrogen incorporation is very similar between those tree species (ca. 45% of the applied $Ca(^{15}NO_3)_2$). The $\delta^{13}C$ and $\delta^{15}N$ values also indicate that photosynthates are transported more rapidly through beech from the leaf to stem and root tissue and into the soil in comparison to *F.excelsior*. Beech has also an initially higher and more constant ^{13}C and ^{15}N rhizodeposition and thus promotes the growth of microbial biomass. This leads to a higher ^{13}C incorporation of the released ^{13}C into microbial biomass and subsequent a higher sequestration of assimilated C in the soil organic matter. In contrast, ash allocates more ^{13}C and ^{15}N from the above- into the belowground plant biomass, but not into soil. Thus, microbial growth is limited and overall incorporation of ash-derived ^{13}C is lower. This demonstrates that individual tree species with their specific annidation mechanisms are determinative for key processes of soil C and N cycles.

HYDROGEN STABLE ISOTOPE ABUNDANCE PATTERNS PROVIDE FURTHER INSIGHT INTO ORGANIC MATTER EXCHANGE IN ORCHID MYCORRHIZA

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Previous investigations have shown that fully mycoheterotrophic orchids are enriched in heavy carbon (C) and nitrogen (N) isotopes in comparison to accompanying autotrophic plants (Gebauer & Meyer, 2003). The underlying reason for the ^{13}C and ^{15}N enrichment in fully mycoheterotrophic orchids is the characteristic ^{13}C and ^{15}N enrichment in fungi, which serve as C and N source for the orchids. For a couple of green orchids from dark forest sites and associated with ectomycorrhizal (ECM) fungi a positioning specifically of C isotope abundances between fully mycoheterotrophic orchids tapping on ECM fungi and autotrophic reference plants has been found (Gebauer & Meyer, 2003). This kind of nutrition is called partial mycoheterotrophy, i.e. partial C gain by photosynthesis and simultaneous C gain via the fungal route. For many green orchid species exclusively associated with fungi of the polyphyletic rhizoctonia group characteristic ^{15}N enrichment was found (Hynson et al., 2013). However, only in very few cases this ^{15}N enrichment was accompanied by significant ^{13}C enrichment. It was hypothesized that this kind of isotope abundance pattern indicates a kind of "cryptic" partial mycoheterotrophy (Hynson et al., 2013). By adding hydrogen (H) stable isotope abundance data to the C and N isotope pattern we here provide for the first time evidence that confirms partial mycoheterotrophy also for a couple of forest orchids associated with fungi of the rhizoctonia group. The H isotope abundance approach is expected to improve (i) further identification of partially mycoheterotrophic plants and (ii) quantitative estimates of fungus-plant matter fluxes based on mixing model approaches.

REFERENCES

Gebauer G. Meyer M. 2003. ^{15}N and ^{13}C natural abundance of autotrophic and mycoheterotrophic orchids provides insight into nitrogen and carbon gain from fungal association. New Phytologist 160: 209-223.

Hynson N.A. Madsen T.P. Selosse M.A. Adam I.K.U. Ogura-Tsujita Y. Roy M. Gebauer G. 2013. The physiological ecology of mycoheterotrophy. In: V.S.F.T. Merckx (ed.) Mycoheterotrophy: The Biology of Plants Living on Fungi. Springer, pp 297-342.

HOST-SPECIES DEPENDENT ECOPHYSIOLOGICAL CHARACTERISTICS AND TWO-WAY TRANSFER OF NITROGEN BETWEEN *DALBERGIA ODORIFERA* AND ITS HEMIPARASITE *SANTALUM ALBUM*

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Understanding interactions between root hemiparasite *Santalum album* and its hosts has theoretical and practical significance in sandalwood plantation. In a pot study we first tested effects of N_2-fixing (*Acacia confusa, Dalbergia odorifera*) and non-N_2-fixing (*Bischofia polycarpa, Dracontomelon duperreranum*) on ecophysiological characteristics and nitrogen (N) nutrition of *S. album*. Photosynthetic rates, shoot, root and haustoria biomass, N and total amino acid were significantly greater in paired *S. album* grown with N_2-fixing hosts (*D. odorifera* the best). Foliage and root ^{15}N of *S. album* were significantly lower when grown with N_2-fixing than with non-N_2-fixing hosts. We then examined the role of N_2-fixation in 2-way N-transfers between 7-month-old *Bradyrhizobium elkanii* nodulated *D. odorifera* and its hemiparasitic *S. album*. With four potted-pairings, ^{15}N were externally labelled to host or hemiparasite and the host either nodulated or grown on combined inorganic-N. Haustoria of *S. album* attached on *D. odorifera* roots and N_2-fixation supplied 41−44% of total N in *D. odorifera*. Biomass, N and ^{15}N were significantly greater in both nodulated *D. odorifera* and *S. album* grown with paired nodulated *D. odorifera*. Significantly higher plant ^{15}N-recovery was in N-donor *D. odorifera* (68−72%) than in N-donor *S. album* (42−44%) irrespective of nodulation. N-transfer to *S. album* was significantly greater (27.8−67.8 mg/plant) than to *D. odorifera* (2.0-8.9 mg/plant) and 2.4−4.5 times greater in nodulated than in non-nodulated pairs. Irrespective of nodulation, *S. album* was the N sink plant. Amounts of 2-way N-transfer were increased by the presence of effective nodules, resulting in greater net N-transfers (22.6 mg/plant) from host *D. odorifera* to hemiparasite *S. album*. Our results may provide N management strategies for successfully mixed plantation of *S. album* with *D. odorifera.*

REFERENCES

Lu J.K., Kang L.H., Sprent J.I., Xu D.P., He X.H. 2013. Two-way transfer of nitrogen between *Dalbergia odorifera* and its hemiparasite *Santalum album* is enhanced when the host is effectively nodulated and fixing nitrogen. Tree Physiology 33: 464-474.

NATURAL ABUNDANCES OF ^{15}N AND ^{18}O REFLECT DISTINCT SPATIAL PATTERNS OF NITROGEN TURNOVER ALONG A SUBTROPICAL FOREST CATCHMENT IN CHINA

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Subtropical forests in China are under chronically high nitrogen stress due to increasing atmogenic deposition. Little is known about the fate of the deposited reactive nitrogen but high N_2O emissions have been reported from forested catchment during wet–humid summer. In order to understand nitrogen retention on a watershed scale, it is important to assess N-turnover processes in dependency of landscape position and hydrological connectivity.

In the present study, we analysed ^{15}N and ^{18}O natural abundances of NO_3^- and NH_4^+ in soil and water along a hydrological flow path of a headwater catchment, spanning from a hilltop, through a forested hillslope, a groundwater discharge zone, an artificial dam to a stream. Both, data from periodic sampling throughout summer and from samples collected after a discrete rain episode are reported. The isotopic signals showed a clear distinction between hillslope and ground water discharge zone (GDZ) both in time and along the hydrological flow path, indicating that nitrification was a strong sink for deposited NH_4^+ in acid soils on the hillslope whereas denitrification in soils of the GDZ acted as sink for NO_3^- leached from the hillslope. Isotopic abundances in adjacent water courses appeared to be less conclusive. Our data show the potential of stable isotope signatures to discern prevailing N-transformation processes in complex landscapes. The results will be discussed in relation to N-runoff, N_2O emissions and functional gene copy numbers.

REFERENCES

Zhu J. Mulder J. Wu L. Meng X. Wang Y. Dörsch P. 2013. Spatial and temporal variability of N_2O emission in a subtropical forest catchment in China. Biogeosciences 10: 1309–1321.

Billy C. Billen G. Sebilo M. Birgand F. Tournebize J. 2010. Nitrogen isotopic composition of leached nitrate and soil organic matter as an indicator of denitrification in a sloping drained agricultural plot and adjacent uncultivated riparian buffer strips. Soil Biology & Biochemistry 42: 108-117.

THIS IS FOR THE BIRDS: AMINO ACID-SPECIFIC δ^{15}N PATTERNS IN AVIAN LAB AND FIELD STUDIES AND RELEVANCE TO CONTAMINANTS MONITORING

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Top predator birds integrate lower food web processes making them useful indicators of ecosystem state. Monitoring and research programs using such bird species have been underway for decades (Elliott and Elliott 2013). Core goals of these programs include understanding the environmental fate of contaminants and detecting environmental change through alterations in ecological processes, e.g. food web disruption by exotic species. Meeting these goals requires methods to accurately assess pathways of energy, nutrient, and contaminant flow to avian species. Stable isotope analysis is one such method.

In the past, most nitrogen isotopic studies of birds have been based upon the analysis of bulk tissues. However, spatial and temporal comparison of δ^{15}N values may not be appropriate because of potential differences/changes in δ^{15}N values at the base of the food web. Amino acid compound-specific nitrogen isotope analysis (AA-CSIA) may provide the means to address this issue by generating δ^{15}N baseline and trophic position estimates from the same sample. Here, we describe AA-CSIA results stemming from avian laboratory and field studies. A laboratory feeding study was conducted using a terrestrial carnivore, the American Kestrel. Adult kestrels were fed an isotopically-characterized diet. They were sacrificed and δ^{15}N patterns in individual amino acids were compared in their tissues and food. In the field, δ^{15}N patterns in individual amino acids in tissues from laying female Herring Gulls and their eggs were examined. Eggs are commonly used in avian biomonitoring studies so it is important to determine if egg isotope patterns are consistent with those observed in other tissues. Finally, we provide an example of how baseline correction of δ^{15}N data is useful when interpreting egg contaminant monitoring data.

REFERENCES

Elliott J.E. Elliott K.H. 2013. Tracking marine pollution. Science 340: 556.

Towards More Robust Stable Isotope Techniques in Ecology

KEYNOTE

LASER-BASED ISOTOPE TECHNIQUES IN PLANT CARBON-WATER RELATIONS

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Laser-based instruments capable of on-line, real-time stable isotope measurements have been available for about a decade, and are becoming an important tool in studies of exchange between the biosphere and the atmosphere. High temporal resolution measurements in the field are helping to advance understanding of processes regulating exchange of CO_2 and H_2O in ecosystems as diverse as agricultural systems and alpine forests under snow. But the new instruments also allow detailed mechanistic studies of exchange of CO_2 and H_2O between individual leaves and the atmosphere, at temporal resolutions previously unobtainable. Arguably the most significant development has been the ease and temporal resolution of measurements of mesophyll conductance (g_m, the conductance of CO_2 from the leaf intercellular air spaces to the chloroplasts) using on-line measurements of photosynthetic carbon isotope discrimination. These measurements have promoted new understanding of the genotypic variability and dynamic nature of g_m in C_3 plants and its limitation on photosynthesis. Further, when CO_2 oxygen isotope measurements are combined with measurements of transpiration isotopes, g_m is able to be estimated in C_4 plants for the first time, allowing a new appreciation of g_m in C_4 plants. Measurements of transpiration isotopes are also emerging as a significant tool in understanding pathways of water movement through leaves. Using both labelled water and changes in leaf evaporative conditions, leaf water turnover times have been determined and models of water pools within leaves tested. The recent development of new instruments that are relatively inexpensive, portable, energy efficient and robust enough to take into the field looks set to revolutionise our understanding of regulation of plant carbon and water exchange in both agricultural settings and natural ecosystems.

USING DEUTERIUM TO TRACE MOVEMENT AND STORAGE OF WATER IN TREES

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Deuterium (D) has successfully been used to characterize some relationships between tree hydraulic architecture and whole-tree water flux (e.g. Meinzer et al., 2006). Given that global climate models forecast increasing severity and duration of droughts that will increase tree mortality we need to refine our understanding of how trees transport, store and remobilize water. It is the latter two mechanisms that have been shown to represent key functions to allow trees to withstand drought and extreme heat events (Pfautsch et al. 2013).

Here we present a study from a common garden environment where deuterium enriched water (1350 ‰ label strength) was introduced into the transpiration stream of mature *Eucalyptus* trees. We used two species that naturally grow in regions of high (*Eucalyptus tereticornis*) and low (*E. siderloxylon*) rates of annual precipitation. We systematically assessed the fate of water along the vertical axis of the trees by measuring the label strength in bark, sap- and heartwood. After feeding deuteriated water for four consecutive days into the base of stems the trees were felled, samples of all woody tissues were collected from different heights of the stem and water was extracted using a cryogenic vacuum system.

We discuss our results in an ecohydrological and anatomical context using synchronous measurements of tree water-use, stem and leaf traits and environmental drivers of transpiration.

REFERENCES

Meinzer F.C. *et al.* 2006. Dynamics of water transport and storage in conifers studied with deuterium and heat tracing techniques. Plant, Cell and Environment 29: 105–114.

Pfautsch S. Adams M.A. 2013. Water flux of *Eucalyptus regnans*: Defying summer drought and a record heatwave in 2009. Oecologia 172: 317–326

UNDERSTANDING LONG-TERM TREE PHYSIOLOGICAL RESPONSES TO ENVIRONMENTAL CHANGES BY THE USE OF STABLE C AND O ISOTOPES

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In an interdisciplinary study, physiological responses to environmental changes are investigated across a range of forest sites along a climatic gradient throughout Europe using isotopic tree ring time series and growth data. Trees were sampled from defined plots representing the actual stand structure. The isotopic signature of $\delta^{18}O$ and $\delta^{13}C$ in tree ring cellulose was measured simultaneously by pyrolysis, with a correction for the slightly dampened $\delta^{13}C$ signal.

First results show a high variability between sites, and, particularly regarding $\delta^{13}C$, within sites. Long-term trends in both isotopes towards slightly increased values in recent decades at many sites further indicate decreases in stomatal conductance, perhaps at increased photosynthesis.

By combining both isotopes as dual isotope approach with the information on tree growth per individual tree, changes in carbon allocation in response to environmental conditions can be triggered. This was done in a first case study for a high elevation site in the Swiss Alps by applying a mixed effects model to identify the contribution of environmental and physiological factors to growth of ~400yrs old larch (*Larix dedicua*) trees. Growth development and isotopic signature suggested that environmental factors such as insect attack, increased temperature and CO_2 concentration affected different physiological processes at the level of gas exchange and stem cell formation at this rather temperature limited site. Additionally, previous year's ring growth may indicate the storage capacity influencing the preceding growth.

In a further step within this project, the empirical tree ring time series of different sites will be compared to physiological growth models at larger scale. Thereby, linking different scales – from individual trees to site and landscape – will contribute to reduce uncertainties in modelling large-scale variability of forest biomass production under current climate change.

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ISOTOPIC FINGERPRINTING TO UNDERSTAND LANDSCAPE PATTERNS AND DYNAMICS OF PLANT WATER USE

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Vegetation structure in the arid subtropics is often highly variable across the landscape, reflecting at least in part the spatial and temporal heterogeneity of rainfall, groundwater and soil moisture. Here, we investigated how patterns of water uptake by trees and shrubs differed across landscape positions in the Pilbara region of northwest Australia and assessed the responsiveness of trees and shrubs to large (cyclonic) rainfall events in order investigate pulse-driven eco-hydrological responses. We sampled water stable isotope compositions of xylem, soil, rain and groundwater as well as soil water content and root distributions eucalypt and mulga woodlands in the Pilbara region over three years. Based on the ^{18}O results, we found that the sampled plant taxa (mulga, *Eucalyptus victrix*) were using water originally derived from a large rainfall event (Cyclone Heidi), both at lowland and upland sites. Trees and shrubs such as mulga were accessing shallow soil water of meteoric origin. *Eucalyptus victrix* accessed water deeper in the profile (8-10 m) as surface soils dried out. Mulga appeared to store water for many months after the recharge event. This ability to take up and likely store a large proportion of shallow soil water after rainfall is a key feature enabling mulga to survive through the period of greatest water demand and to acclimate to the spatiotemporal changes to water conditions in the soil profile. Alternatively, episodic cyclonic recharge maintains deep soil and groundwater resources that maintain deeper-rooted species such as *E. victrix* throughout the prolonged drought periods.

SOCIOECONOMIC INFLUENCES ON URBAN PLANT AND SOIL ISOTOPIC COMPOSITION: LESSONS LEARNED FROM LOS ANGELES AND SALT LAKE CITY

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Urban biogeochemical cycles are controlled by complex interactions between humans and the environment. In this project, we tested one hypothesis related to residential plants and soils: Carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope ratio values are significantly correlated to two socioeconomic factors (resident income and housing age). To test this hypothesis, we measured the leaf chemistry of trees, grasses and soils located in neighborhoods that varied in median household income and age throughout the Salt Lake Valley, Utah (hereafter SLC) and Los Angeles and Orange Counties in California (hereafter LA). In LA, we only analyzed the leaves of a variety of tree species and in SLC we analyzed the shoots and surrounding soils of *Bromus tectorum.* We then compared carbon and nitrogen content and isotopic composition with two socioeconomic factors (income, housing age). For urban settings in both LA and SLC, we found that residential income was negatively correlated with $\delta^{15}N$ (LA, $r = -0.465$, $p = 0.01$; SLC, $r = -0.272$, $p = 0.01$). We also found that, in both cities, residential income was negatively correlated with $\delta^{13}C$ (LA, $r = -0.264$, $p = 0.01$; SLC, $r = -0.125$, $p = 0.05$). Housing age was only significantly correlated with tree $\delta^{15}N$ ($r = 0.449$, $p = 0.01$) in LA, but was significantly correlated with soil $\delta^{15}N$ ($r = -0.121$, $p = 0.06$) and shoot $\delta^{13}C$ ($r = -0.180$, $p = 0.01$) in SLC. From these observations, we observe evidence in support of our hypothesis that isotope ratios of vegetation and soils in urban regions reflect differences in socioeconomic factors. It is tempting to infer from these data that higher income properties tend to have both greater applications of Haber-Bosch nitrogen fertilizer and greater proportions of C_3 landscapes in habitats that would otherwise have been expected to exhibit C_4 photosynthesis.

CONTRASTING BOTTOM UP EFFECTS OF RIPARIAN LAND-USE ON LITTORAL INVERTEBRATE COMMUNITY AND TROPHIC STRUCTURE

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The development and land-use of riparian zones have been shown to impact aquatic organisms both directly and indirectly. Lentic systems, particularly in land-scarce countries like Singapore, are important and biodiverse freshwater habitats that are increasingly subjected to such impacts of anthropogenic shoreline modification. In view of the heightened ecological sensitivity often reported in tropical aquatic ecosystems, a better understanding of the mechanisms driving negative trends in impacted habitats would be essential for facilitating informed environmental management efforts.

To characterise the impacts of riparian land-use on littoral invertebrate communities, we investigated potential differences in community and trophic structure along shores with various types of anthropogenic activity. To this end, we employed biotic and diversity indices to characterise communities, and stable isotope analysis to elucidate trophic interactions.

Using one of Singapore's urban reservoirs with multiple shoreline land-use as a model, we observed contrasts in littoral invertebrate community diversity and composition along shores associated with different types of land-use, with riparian zones actively used for agriculture and recreation were associated with pollution tolerant taxa. The trends in assemblage, however, were not reflected in trophic interactions. This suggests that bottom up effects resulting from land-use do not significantly affect littoral food webs despite differences in diversity and composition. The limited extent of land use impacts on trophic interactions, coupled with the localised nature of effects on community, alludes to the feasibility of small scale mitigation measures, which poses a less formidable logistical challenge to environmental managers.

SPECIES INTERACTIONS IN A WARMING WORLD – INSIGHTS FROM ISOTOPIC ANALYSES OF SUBARCTIC LAKES

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Climate change is causing fundamental changes to ecosystems across the globe. Increasing temperatures facilitate poleward migrations of species ranging from micro-organisms to megafauna. How these invasive species interact with resident biota is of fundamental importance to understanding the long term effects of a warming climate on ecosystem function.

We conducted a three year investigation of trophic interactions (quantitative ecology, stomach content, SIA of muscle & liver) between resident and invasive fishes in subarctic lakes of northern Europe. The study incorporated both (open-water) summer and (ice-covered) winter seasons and assessed how interactions varied along a gradient of lake morphometry, productivity and consumer diversity.

Seasonal variation in the resource use of resident species was evident in liver SIA but not muscle (Hayden et al., 2014a) and followed the annual lake productivity cycle i.e. benthic invertebrates during winter and pelagic zooplankton in summer. Invasive species could dominate prey to which they were evolutionarily adapted, excluding resident species from the same niche. This trend is most evident in deep lakes or during winter when resources were scarce but was alleviated by high productivity and resource diversity (Hayden et al., 2014b).

These results display how stable isotope analysis of aquatic communities may help to fill a data gap between species distribution models and observed effects of climate warming on aquatic ecosystems.

REFERENCES

Hayden B. Harrod C. Kahilainen K. 2014a. Dual-fuels: intra-annual variation in the relative importance of benthic and pelagic resources to maintenance, growth and reproduction in a generalist salmonid fish. Journal of Animal Ecology In press.

Hayden B. Harrod C. Kahilainen K. 2014b. Lake morphometry and resource polymorphism determine niche segregation between cool- and cold-water adapted fish. Ecology 95 (2): 538-552.

DIETARY SPECIALISATION REFLECTS CHANGING REPRODUCTIVE CONSTRAINTS IN THE MACARONI PENGUIN

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An increasing number of studies have found evidence that generalist populations are actually made up of relatively specialised individuals. However, investigating the presence of multiple dietary types within a population is typically limited by the complexity of a system as well as the ability to collect data across all the relevant parameters. For example, unless the mechanisms underpinning discrete diets are known prior to analysis, linear modelling approaches will not be able to summarise the trend or pattern in the data. Here, we applied multivariate clustering methods to stable isotope data in order to examine discrete dietary types within a population of macaroni penguins (*Eudyptes chrysolophus*). The resulting clusters were then evaluated in relation to the levels of central place constraint experienced during different phases of the breeding season, and spatial tracking data collected concurrently from a subset of the individuals. Geographically discrete dietary types were present during breeding phases with more relaxed central place constraint, and individuals showed high levels of consistency in dietary types between years. This approach enables discrete dietary types to be identified within a generalist population without the need for simultaneously collecting extensive tracking or diet data.

AGE-SPECIFIC VIBRISSAE GROWTH RATES: A TOOL FOR DETERMINING THE TIMING OF ECOLOGICALLY IMPORTANT EVENTS IN STELLER SEA LIONS

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Steller sea lions (*Eumetopias jubatus*) grow their vibrissae continually, with abrasion and breakage occurring primarily at the distal tip, providing a multiyear record suitable for dietary inference based on stable isotopes. An accurate age-specific vibrissae growth rate is essential for registering a chronology along the length of the record, and for interpreting the timing of ecologically important events. We utilized 4 different methods to estimate the growth rate of vibrissae in fetal, rookery pup, young-of-the-year, yearling, subadult and adult Steller sea lions. The majority of vibrissae were collected from Steller sea lions live-captured in Alaska and Russia between 2000 and 2013 (n=1115), however vibrissae were also collected from 11 Steller sea lions found dead on haulouts and rookeries during field excursions to increase the sample size of underrepresented age groups. We found that the growth rates of vibrissae were generally slower in adult (0.44 ± 0.15 cm mo^{-1}) and subadult (0.61 ± 0.10 cm mo^{-1}) Steller sea lions than in young-of-the-year (0.87 ± 0.28 cm mo^{-1}) and fetal (0.73 ± 0.05 cm mo^{-1}) animals, but that there was high individual variability in these growth rates within each age group. Some of the variability in vibrissae growth rates was attributed to the somatic growth rate of young of the year sea lions between capture events (p=0.014, R^2=0.206, n=29). We suggest that when vibrissae growth rates specific to each animal are unavailable, age-appropriate mean values can be used to register the chronology with consideration of uncertainty specific to the method of estimation.

CAN STABLE ISOTOPE BE USED TO HELP IN THE MANAGEMENT OF SHARK ATTACK RISK? A CASE STUDY FROM REUNION ISLAND, WESTERN INDIAN OCEAN

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Tiger (*Galeocerdo cuvier*) and bull sharks (*Carcharhinus leucas*) are two apex predators suspected to be responsible of human attacks in coastal zones in tropical waters. Since 2011 at La Reunion Island in the western Indian Ocean, 17 attacks of shark occurred. Consequently in January 2012 a scientific program begun in order to improve the knowledge on shark ecology with the aim to reduce risk of attacks. One of the tasks was to investigate the foraging ecology and habitat use using stable isotopes. An underlying assumption was that meetings between human and sharks could occur in their foraging habitats.

Stable isotopes (carbon and nitrogen) were combined with stomach content to assess trophic ecology of sharks using mixing model analyse and were measured both in organic matter sources and fish to evaluated habitat use through niche width analyse. A portion of muscle and/or blood was collected from 15 bull and 17 tiger sharks. Twenty-two fish species were also sampled as potential prey. Particulate and sedimentary organic matters were analysed along inshore-offshore transects to draw the isoscapes along the west coast of Reunion Island, and to have the baseline of the pelagic and benthic food webs.

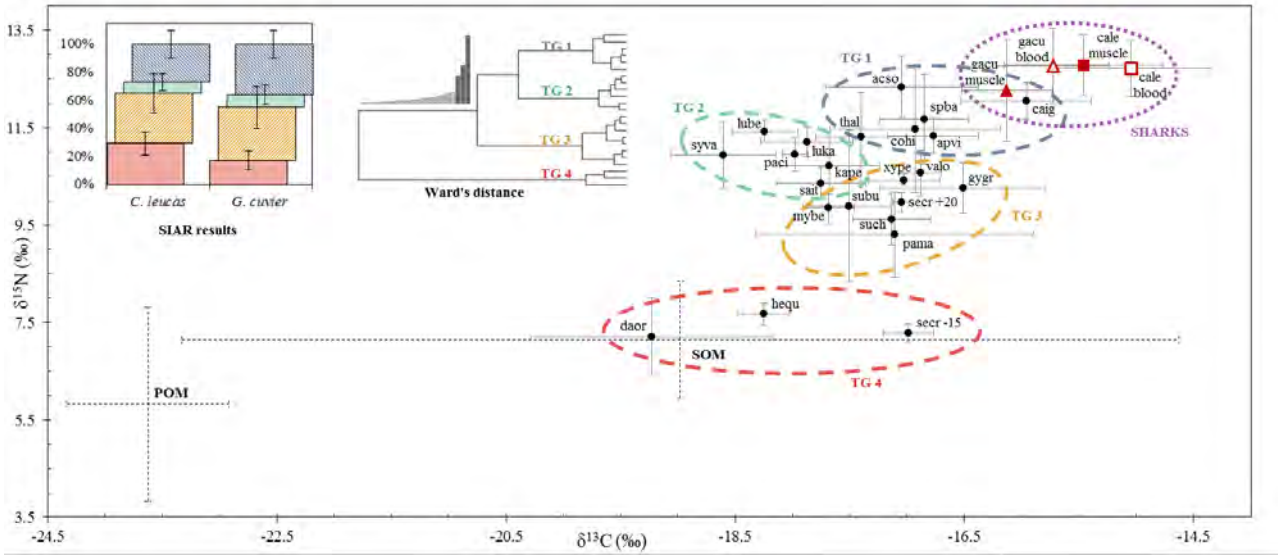

Figure 1: Isotopic values (mean± SD) of sharks and potential fish prey species grouped by trophic groups defined by cluster analysis and there relative contributions in sharks' muscle values (mixing model results).

INDIVIDUAL FORAGING SPECIALISATION IN FEMALE AUSTRALIAN FUR SEALS: A COMBINED APPROACH USING STABLE ISOTOPES, VIDEO CAMERA AND GPS TRACKING

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Individual variations in resource use have been increasingly documented in many taxa and have profound implications in many ecological and evolutionary processes. However, the time scale over which individual specialisation occurs is usually unknown, mainly due to fieldwork limitations. Animal-borne video data and GPS loggers provided quantitative information on the diet and the foraging grounds of female Australian fur seals (*Arctocephalus pusillus doriferus*) over a single foraging trip. While all seals exploited similar foraging areas, short-term individual specialisations occurred (mean pairwise overlap=0.58), with up to 90% of the estimated biomass consumed by some individuals comprising of one prey order. However, the shortness of the temporal window is likely to artificially increase the level of specialisation by not recording the whole diet of seals. The $\delta^{13}C$ and $\delta^{15}N$ values of tissues of contrasted turn over (plasma, red blood cells and sub-sampled whiskers that integrate the feeding ecology over a few days, weeks and years, respectively) allowed us to determine the appropriate time scale to study individual specialisation in this species. Plasma isotopic values were weakly correlated to red blood cell values and exhibited higher standard deviations, suggesting plasma isotopic values were not representative of the entire individual isotopic niches. Accordingly, the more specialised individuals appeared in the video camera data, the higher the difference between $\delta^{13}C$ values of the two tissues was. In contrast, red blood cell and whisker mean isotopic values were highly and significantly correlated and presented similar standard deviations. Red blood cell isotopic values were thus a good indicator of long-term individual variations. Interestingly, isotopic differences between individuals were consistent all along the length of whiskers indicating that specialisations were persistent across seasons and years (on average 4.2 ± 1.6 y). Such long-term variations in foraging niche may be an important factor in this species' plasticity with significant consequences for life-history traits and how it may respond to environmental variability.

INFERRING ONTOGENETIC CHANGES IN TROPHIC POSITION AND MIGRATION OF SWORDFISH FROM HAWAII

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Investigating the feeding ecology and migration of top predators is critical to understand their role in food webs and monitor the effect of fisheries over food webs dynamics. However, little is known about basic biological aspects of the life history of many migratory species such as the swordfish (*Xiphias gladius*). To understand ontogenetic variation in diet and movement of swordfish, we developed a new methodology to investigate ontogenetic shifts in diet or movement of swordfish. We used anal spine to determine age and quantify stable isotope ratios of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) per annual growth ring deposited in the anal fin spine. Following a systematic sampling, we built isotopic profiles to detect abrupt isotopic changes at specific ages and compare patterns between individuals caught in Hawaii.

We didn't observe any abrupt shifts in $\delta^{13}C$ and $\delta^{15}N$ for any of the swordfish analyzed neither a common isotopic pattern among animals. In contrast, we found moderate variations in $\delta^{13}C$ and $\delta^{15}N$ values as a function of age for all individuals suggesting that each fish fed on similar prey items throughout their lives and/or moved within the same overall ecosystem. However, despite that all animals were captured in Hawaii, we found differences of 4-5‰ for $\delta^{15}N$ and $\delta^{13}C$ among average values from each fish. These results suggest that each swordfish fed and grew in different ecosystems that are biochemically distinctive before reaching Hawaii. We expect that this novel method, can be applicable to other billfish species to investigate life history events and possible infer long-distance migration, and population dynamic of species that are poorly known.

AMINO ACID NITROGEN (^{15}N) ANALYSIS OF GREEN SEA TURTLE AMINO ACIDS: TESTING ASSUMPTIONS FOR APPLICATION TO FIELD STUDIES

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The endangered East Pacific green turtle (*Chelonia mydas;* EPGT) is characterized by a complex life history which includes an ontogenic habitat shift as they transition from oceanic waters as juveniles to neritic, coastal habitats utilized as adults. Although a few studies have examined the ecology of green turtles in the open ocean [1,2], studies of this important life stage have proven difficult due to the logistical challenges of research in open ocean systems. Recent studies on stable isotope analysis of amino acids demonstrate potential for the application of this analysis to study the ecology of marine turtles in challenging systems [3,4,5].

Stable isotope analysis of a consumer's tissues has been widely used to infer the organism's life history and ecology. For example, sea turtle $\delta^{15}N$ values of bulk tissues can provide insights into the trophic dynamics and critical habitat of these animals. However, bulk tissue $\delta^{15}N$ values can be influenced by both nutrient cycling dynamics at the base of the food web and the ^{15}N enrichment in organisms that occurs during trophic transfer. This can lead to confusing and often incorrect estimations of trophic level. Recently, a novel technique, amino acid nitrogen isotope analysis [AA-CSIA, 3,4], has shown the ability to overcome some of the uncertainty associated with bulk tissue analysis. AA-CSIA can generate a more accurate estimation of trophic level by simultaneously providing an estimate of trophic level (using "trophic" amino acids) that controls for variations in $\delta^{15}N$ values at the base of the food web (using "source" amino acids)[3,6,7]. However, critical assumptions essential to the appropriate application of this method require experimental validation. In this study we are experimentally determining **I)** the appropriate "source" and "trophic" amino acids, **II)** the trophic discrimination factors for various amino acids for skin and blood plasma, and **III)** the ^{15}N isotope incorporation rates for skin and blood plasma of the green turtle. Preliminary results highlight the appropriate trophic and source amino acids for green turtle skin and plasma, trophic discrimination factors for green turtle skin and plasma, and provide initial insight into ^{15}N isotope incorporation times for green turtle plasma. Our study experimentally tests the critical assumptions required for the correct application of amino acid nitrogen isotope analysis to sea turtle field studies.

[1] Reich K, et al. (2007) Biol Lett 3(6): 712-714. **[2]** Arthur KA, et al. (2008) Mar Ecol Prog Ser 362: 303 311**[3]** McClelland JW, Montoya JP (2002) Ecol 83:2173–2180 **[4]**Chikaraishi et al.(2009) Limnol Oceanogr Meth7:740-750 **[5]** Seminoff JA et al. (2012) Plos one 7:5 **[6]**Popp BN et al. (2007) Vol Terre Ecol Ser Elsevier 1 73-190 **[7]** Germain LR et al. (2013) Mar Ecol Prog Ser 482: 265-277

ISOTOPIC COMPOSITION OF MERCURY IN TUNA FROM THE SOUTH PACIFIC OCEAN: A NEW TRACER OF FORAGING HABITAT?

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The question of Methylmercury's (MeHg) origin and its accumulation in fish species is fundamental and of growing interest for its impact on human health. Understanding how and where fish accumulate MeHg is therefore essential to reduce human exposure. Mercury isotopes have recently been used to trace the origin of the mercury that enters the marine food web through the determination of both mass-dependant (δ^{202}Hg) and mass-independent fractionation (Δ^{199}Hg) signatures in fish.

In this work, bigeye tuna (*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*), and swordfish (*Xiphias gladius*) muscle samples were analyzed for Hg concentration, Hg isotopes and trophic tracers (δ^{13}C, δ^{15}N). They were collected in the South Pacific Ocean along an E-W transect between New Caledonia (160°E) and French Polynesia (130°W) and along a N-S gradient from New Caledonia (22°S) to Gilbert island (5°N), thus sampling regions with very contrasted oceanographic conditions. Species-specific Hg levels showed higher Hg concentrations for bigeye tuna and swordfish compared to yellowfin tuna at all sampling locations. Furthermore, our mercury isotope results (N = 80) showed a systematic and significant decrease in Δ^{199}Hg values with the depth at which the animals forage. This supports the idea that MeHg accumulation in pelagic fish is under the combined influence of foraging ecology and *in situ* oceanic MeHg production zones. Hg levels for the different pelagic species shows marked geographical patterns across the South Pacific Ocean for mesopelagic foragers (bigeye) but not for epipelagic ones (yellowfin). We also found significant latitudinal variations of Δ^{199}Hg in bigeye tuna, possibly related to the depth of the oxycline and/or different sources of mercury between the equator and the southern latitudes. These results indicate that the combination of Hg levels and isotopic composition parameters may be used as tracers of habitat utilization of South Pacific pelagic fish.

Isoscapes and Spatial Patterns

USING STABLE ISOTOPES TO INFER MARINE MIGRATION PATTERNS OF ATLANTIC SALMON

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Atlantic salmon (*Salmo salar*) populations have declined significantly in both European and North American rivers over recent decades. Atlantic salmon is an anadromous fish that migrate to the Atlantic Ocean into the North Atlantic Sub-polar Gyre (NASpG) spending either one or more years at sea for feeding and growth. Numerous factors associated with their marine foraging areas contribute to the species' survival, and the likelihood of successfully returning to their natal river for spawning. This knowledge is crucial to understanding the population dynamics and survival of this species with such complex a life history. However, regions within the NASpG used by regional populations of Atlantic salmon are poorly known. Salmon scales and otoliths were analyzed for stable isotopes of carbon (δ^{13}C) and oxygen (δ^{18}O) from bands or circuli representing at-sea growth to identify marine foraging areas used by adult salmon returning to rivers that have declining populations such as the St. John River, Canada. These data in combination with marine isoscapes were used to infer migratory patterns of Atlantic salmon within the NASpG. Stable isotope analysis of archived tissues could be an extensive tool used for investigating long-term and retrospective ecological patterns of significance for conservation.

ISOTOPIC EVIDENCE OF A SPECIALIZED DIET FOR THE GENERALIST PACIFIC OLIVE RIDLEY SEA TURTLE FROM THE COSTA RICA DOME

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Eastern Pacific (EP) olive ridley sea turtles (*Lepidochelys olivacea*) uniquely inhabit and forage in the open-ocean and are thought to be opportunistic, generalist consumers. Intentional movement patterns, possible distinct -- even if dynamic -- foraging regions, niche width, and trophic role(s) in the EP ocean (EPO) are largely unknown. Most, if not all, other sea turtle species consistently use identifiable foraging grounds, including fellow pelagic consumer the Pacific leatherback. Stable isotope analysis can clarify food web interactions and roles of consumers, however bulk tissue analysis alone is not sufficient to tease apart the influences of a food web's baseline δ15N versus the consumer's trophic status. However, compound-specific stable isotope analysis of amino acids (CSIA-AA) can inform this distinction. To examine large-scale δ15N spatial relationships and variation in olive ridley trophic position across the EPO, we performed CSIA-AA on five or more olive ridley skin (epidermis) samples in five oceanographically distinct EPO sub-regions: (1) Gulf of California (GC); (2) North Equatorial Current (NEC); (3) Eastern Pacific Warm Pool (EPWP); (4) Costa Rica Dome (CRD), and (5) Peruvian Current (PC).

Following Chikaraishi *et al.* 2009, trophic amino acid glutamic acid and source amino acid phenylalanine isotopic values were used to calculate the Trophic Level (TLGlu/Phe) of each individual. Average TLGlu/Phe in the GC, NEC, EPWP, and the PC subregions was ~3.1, suggesting that the diet of olive ridleys does not significantly change between these foraging locations. Average TLGlu/Phe in the CRD, a highly productive oceanographic region due to a shallow thermocline and persistent upwelling, was ~3.5, suggesting that here, olive ridleys may be consuming higher-nutrient prey and exhibiting individual specialization. These results are part of a larger EP olive ridley open-ocean ecology study that is generating spatial knowledge of olive ridley foraging behavior in the EPO on a seascape scale, with the goal of determining if and where discrete, dynamic pelagic foraging areas exist.

DRILLING BACK THROUGH TIME TO DETERMINE THE FACTORS FOR THE DECLINE IN THE NEW ZEALAND SEALIONS.

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One of the rarest pinnipeds, the New Zealand sea lion, has been in decline at its largest breeding colonies on the Sub-Antarctic, Auckland Islands. Pup production has declined there by approximately 50% since the late 1990s. Although well studied, the factors for this decline remain unclear, but commercial trawl fishery mortalities, disease-related mortalities of pups, and changes in prey availability have been suggested as major contributing factors. We present stable carbon and nitrogen isotope data of samples collected from teeth annuli that represent a biannual signal extending over 15 years from before and after their population decline. The stable isotope dataset, along with other datasets, including prey abundance estimates and climate indices, suggest that there have been shifts in ocean climate conditions and in their trophic ecology over this period.

CHANGES IN LATITUDE AND DOMINANT DIAZOTROPHIC COMMUNITY ALTER N_2 FIXATION

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The contribution of planktonic diazotrophs to the overall N budget is a key unknown in the eastern Indian Ocean. To explore this we investigated the relationships between dissolved inorganic nutrients, phytoplankton pigment composition, microbial community structure, nitrogen fixation rates and the $\delta^{15}N$ of fractionated zooplankton samples along the shelf break of Western Australia (32° to 12°S) in September 2012. Bulk nitrogen fixation rates declined from 4.8 $nmol.L^{-1}.h^{-1}$ in the colder and more saline sub-tropical waters at higher latitudes to 1.5 $nmol.L^{-1}.h^{-1}$ in the warmer and fresher Timor Sea at lower latitudes. A regional bloom of *Trichodesmium* was identified between 13˚- 9˚S in the Timor Sea. *Trichodesmium* specific N_2 fixation rates were 0.05±0.01 $nmol.col^{-1}.h^{-1}$. Highest dissolved inorganic nitrogen (DIN) concentrations occurred at highest NH_4^+:NO_3^- ratios, thereby deviating from the paradigm that suggests that greater DIN concentrations come primarily from increased NO_3^- through advection, mixing or upwelling. Both the microplankton and nanoflagellate fraction declined significantly in warmer waters, with higher DIN concentrations but decreasing % NO_3^-. A clear increase in the prokaryotic diagnostic pigment zeaxanthin was seen with increasing temperatures from higher to lower latitudes. The microbial community, measured using ARISA, clustered strongly according to the water mass biogeochemistry including temperature, salinity, DIN and phosphate concentrations ($p<0.001$). Isotopic analysis suggested that injections of low $\delta^{15}N$ from N_2 fixation lowered the zooplankton $\delta^{15}N$ signature of animals up to ~500 μm in size and that nearly 47% of the fixed nitrogen was utilised by zooplankton (≤ 500μm fraction) in the Timor Sea.

KEYNOTE

TRACKING ANIMAL MOVEMENTS WITH STABLE ISOTOPES

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Critical to the conservation of populations of migratory animals is an ability to make migratory connections between key locations used during the annual cycle. This task has proven to be remarkably difficult for all but a few species with limited range distributions and high recovery/resighting rates of extrinsic markers or transmitters. The use of intrinsic markers such as naturally occurring stable isotope ratios of the light elements ($\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$, $\delta^{18}O$, $\delta^{2}H$) that can be linked to spatial patterns within foodwebs (isoscapes) requires only a single capture of individuals and so can provide an unbiased estimate of origin. While the isotope approach to forensic tracking of migration is certainly not new, the field is constantly being improved as our understanding of isoscapes and animal physiology increases and with the incorporation of Bayesian assignment models. Here, I will review the basic principles of isotopic tracking of wildlife with an emphasis on migratory birds and insects and how the field has advanced from fairly humble beginnings as reported at the very first IsoEcology meeting in Saskatoon, Canada. I will also discuss the use of isotopic measurements to trace the origins of nutrients to reproduction and recommend some fertile areas of future research.

A SOUTHERN OCEAN ISOSCAPE INFORMS MIGRATIONAL PATHWAYS AND TROPHIC ECOLOGY OF ROSS SEA TOP PREDATORS

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A joint collaborative venture between National Institute of Water & Atmospheric Research (NIWA) and Australian Antarctic Division (AAD) resulted in the Australia –New Zealand Antarctic Whale Expedition research voyage (2010). Latitudinal phytoplankton transects were collected from New Zealand to the Ross Sea shelf and along the shelf edge. Measurements of underway temperature, salinity, chlorophyll *a*, HPLC, and flourometry enabled key oceanographic features to be identified and variations in phytoplankton isotopic values to be interpreted. A Southern Ocean carbon isoscape, derived from the phytoplankton data, is enabling Antarctic toothfish and humpback whale movements to be interpreted in the context of tagging data. A nitrogen isoscape is providing baseline isotope values to inform trophic studies of Ross Sea top predators. These combined stable isotope dietary and migration data are facilitating an assessment of the impact of the Antarctic toothfish fishery on associated Ross Sea species and are informing conservation management of humpback whales.

SPATIAL PATTERNS IN STABLE ISOTOPE RATIOS REFLECT WIDESPREAD EFFECTS OF AN EXTREME CLIMATIC EVENT

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In December 2010 an unprecented rainfall event (6,000% of the monthly mean) led to widespread flooding of the Gascoyne and Wooramel Rivers adjacent to Shark Bay. The resulting floods deposited massive amounts of freshwater and sediment into Shark Bay, which is a World Heritage Area. Shortly afterwards a heatwave, in which water temperatures reached up to 5ºC above average, also affected the region. We surveyed seagrasses and consumers (crabs, fish, elasmobranchs) across >800 km^2 three months after the floods started, and found extremely high turbidity and widespread seagrass mortality up to 20 km from the mouth of the Wooramel River. $\delta^{13}C$ and $\delta^{15}N$ of the most widespread and abundant seagrass, *Amphibolis antarctica*, declined with increasing proximity to the Wooramel River, a result that was consistent with patterns in light measured by *in situ* sensors. $\delta^{13}C$ of seagrasses (*A. antarctica* and *H. uninervis*) spanned a range up to 17‰, and included some of the lowest values ever recorded for seagrass. $\delta^{15}N$ of seagrasses spanned a range up to 15‰ and also included some of the lowest values ever recorded for seagrass, including values lower than -10‰. The results indicate severe widespread effects of the extreme events on the seagrasses that are the foundation of the food web in Shark Bay.

SPATIAL AND TEMPORAL VARIATION WITHIN FINE-SCALE, δ^{13}C AND δ^{15}N ISOSCAPES OF THE SOUTHERN CALIFORNIA BIGHT IN THE EASTERN PACIFIC OCEAN

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Stable carbon (δ^{13}C) and nitrogen (δ^{15}N) isotope values in organic matter provide natural markers that can be used to trace animal foraging and movement patterns in marine systems. These isotope values are dependent upon the values at the base of the food web which can vary depending upon the chemical, physical, and biological processes that dominate in different geographic areas and at different times of year. Therefore, understanding the potential for spatial and temporal variation in the δ^{13}C and δ^{15}N values from organic matter at the base of marine food webs is important for their best use as meaningful tracers of organisms in marine systems. We analyzed the δ^{13}C and δ^{15}N values from particulate organic matter (POM) collected across five seasons from 2012-2013 at 30 sampling stations in collaboration with the Cal-COFI program to create high resolution isotope maps or isoscapes of the Southern California Bight, a 189,789.82 km^2 region in the eastern Pacific Ocean. We created our isoscapes using a continuous surface approach where POM δ^{13}C and δ^{15}N values from known collection stations were used to spatially interpolate isotope values in adjacent areas without measurements.

The isotope values varied by season and year, but the overall variability observed across all seasons and the entire region was fairly constrained with mean (±SD) δ^{13}C and δ^{15}N values of -22.7±2.0‰ and 8.0±1.5‰, respectively (n=164 for each; δ^{13}C range: -27.2 to -13.46‰; δ^{15}N range: 3.46 to 11.93‰). To assess isotopic variability among seasons for each collection location, we created maps of the standard deviations from the δ^{13}C and δ^{15}N values from POM at each collection station over the five seasons. Variability in the δ^{13}C and δ^{15}N values among seasons was most evident in the region of the Santa Barbara Basin which is most likely driven by seasonal changes in upwelling intensity which can influence isotope values. Our data allowed us to examine the potential for fine-scale seasonal, yearly, and spatial variability in the δ^{13}C and δ^{15}N values from POM to a degree that marine isoscapes created from meta-analyses of isotope data collected at ocean basin-wide scales are less able to investigate. In addition, we created a large-scale isoscape of the Southern California Bight that will contribute to a future overall isoscape of the Pacific Ocean and allow for the optimal interpretation of stable isotope data from marine vertebrates of conservation interest that utilize these waters year-round or during their seasonal migrations.

ACCURATE AND PRECISE BAYESIAN GEOGRAPHIC ASSIGNMENT OF MARINE SHELF ANIMALS USING ISOSCAPES DERIVED FROM JELLYFISH TISSUES

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In marine systems, the use of isoscapes as tools for geographic assignment of animals has been restricted by relatively homogenous distributions of O and H isotopes. The isotopic compositions of carbon and nitrogen in marine primary production also vary systematically in space however, providing a potential signal for the construction of isoscapes. Construction of isoscapes based on biological indicators requires a reference organism. Ideally such an organism would be widely distributed, stationary, and have relatively rapid growth. Benthic organisms may be stationary, but are often restricted to specific substrates. Here we demonstrate the potential of using jellyfish tissues as reference organisms for the construction of marine isoscapes.

We concurrently sampled jellyfish bell tissues and environmental variables across the North Sea, and produced carbon and nitrogen isoscapes which demonstrate broad hydrodynamic controls over the spatial variations in isotopic composition. Jellyfish-derived isoscapes are broadly similar to isoscapes produced from scallop tissues a decade ago, highlighting temporal stability of the constructed isoscapes.

We then used a Bayesian assignment method to estimate feeding location from the isotopic composition of c. 300 herring caught at known locations across the North Sea. The median absolute distance between the isoscape-predicted 6 km^2 highest probability area and known capture locality was <300 km. Isotopic assignments of feeding area identified regions of the North Sea where fisheries intercept herring during their annual spawning migration, and also identified different feeding area origins of coincident juvenile and adult herring.

In shelf systems, where access to widely dispersed organisms is relatively simple, carbon and nitrogen isoscapes based on gelatinous zooplankton may be extremely effective tools for geographic assignment.

NEW APPROACH FOR CONSTRUCTING $\delta^{15}N$ AND $\delta^{13}C$ ISOCAPES OF LITTORAL ECOSYSTEMS USING COMPOUND-SPECIFC ISOTOPE ANALYSIS OF AMINO ACIDS IN INTERTIDAL MUSSELS

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Isoscapes are increasingly used to answer questions about marine ecology, animal migration, and biogeochemical cycles. In oceanographic research, isoscapes are often based on isotopic measurements of total carbon and nitrogen on short-lived organisms thus capturing a relatively short snapshot of time. Since this approach may not represent annualized values in a variable system, we examined a new approach for constructing isoscapes by measuring $\delta^{13}C$ and $\delta^{15}N$ values of individual amino acids (AA) in intertidal mussels. The use of compound-specific isotope analysis of amino acids (AA-CSIA) has the ability decouple fractionation effects linked to trophic transfers from baseline $\delta^{13}C$ and $\delta^{15}N$ values. We investigate the spatial variability of $\delta^{13}C$ and $\delta^{15}N$ values in the mussels' adductor tissue of the extensively studied California Upwelling Ecosystem (CUE) at 28 sites between Coos Bay, OR and La Jolla, CA. We then used subgroupings of AAs to determine the integrated $\delta^{13}C$ and $\delta^{15}N$ values of primary production with latitude.

For $\delta^{13}C$, we found both average bulk and AA-CSIA $\delta^{13}C$ values for the entire coastal range clustered around a relatively constant value and no trend with latitude ($P>0.05$), indicating that mussels feed on isotopically similar primary production sources across all sites. In contrast, $\delta^{15}N$ in both bulk and AA-CSIA show a strong linear relationship with latitude ($P<0.0001$), consistent with slowly attenuating northward transport of ^{15}N-depleted nitrate via California Undercurrent. For both C and N, we propose calibrations for our AA-CSIA data to estimate the $\delta^{15}N$ and $\delta^{13}C$ values of primary production and finally use these to construct the first direct isoscapes of coastal microalgae primary production in the CUE.

Overall, the results of our study demonstrate the power of CSI-AA to determine baseline isotopic processes from specific AAs measured in higher trophic level organisms, and so may have important implications for ecosystem studies in both modern and paleo-environments.

WHICH WATER MATTERS: HOW SPATIO-TEMPORAL CHARACTERISTICS OF PRECIPITATION ISOSCAPES AFFECT GEOGRAPHIC ASSIGNMENTS TO ORIGIN FOR MIGRATORY SPECIES

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The hydrogen isotopic composition of animal tissues in conjunction with predictive maps of long-term mean isotopic composition of precipitation (δ^2H_p) are useful for determining the geographic origin of migratory animals. We examined how the temporal and spatial characteristics of precipitation isoscapes affected the efficacy of assignment using δ^2H data from known-origin tissues of two migratory organisms in North America and Europe. We used pre-existing datasets from monarch butterflies (*Danapus plexippus*) and Eurasian reed warblers (*Acrocephalus scirpaceus*) to address two objectives. First, we examined whether using biologically relevant year-specific δ^2H_p isoscapes improved assignment to origin predictions. Typically, δ^2H_p isoscapes that reflect amount-weighted, long-term average values of precipitation over the growing season (mean monthly temperature > 0^oC) have been used to assign organisms to origins. However, animal tissues may assimilate H from the food web during shorter season periods of the growing cycle, creating a discrepancy in the time periods represented in the isoscape and tissue. We compared the accuracy, precision, and similarity of assignments using short- and long-term precipitation isoscapes created in IsoMAP (isomap.org). Second, we examined the effect of spatial density of the sampling stations used to create the δ^2H_p isoscapes. We further addressed the problem of unequal spatial coverage in the short- and long-term datasets used to create the interpolated surface. We did not find that short-term models were more suitable in determining geographic origin. These approaches can be used in future studies to select appropriate time periods in the creation of precipitation isoscapes and predict how the characteristics of these isoscapes will affect assignment results in the region of interest.

STABLE ISOTOPE PERSPECTIVES ON NITROGEN AVAILABILITY CONSTRAINTS FOR TUNDRA VEGETATION IN THE ARCTIC

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Identification of the relative contributions of different N-sources to total N-pool available for plants is critical for understanding the reasons of spatial distribution of tundra vegetation types in the High Arctic. This study was carried out in Fuglebekken catchment at the fjord of Hornsund (SW Spitsbergen, 77°00'N 15°30'E).

The sampling strategy was designed to obtain representative $\delta^{15}N$ data for 1) three major N-sources, 2) each of ten types of tundra, and 3) the altitudinal N deposition gradient as function of distance from seabird (the Little Auk *Alle alle*) breeding colonies. The stable nitrogen isotope mass balance mixing model was used to estimate the contributions from the major N-sources (birds, atmospheric deposition, and N_2-primary fixation) based on $\delta^{15}N$ of the mosses *Sanionia uncinata* and *Racomitrium lanuginosum.*

The $\delta^{15}N$ values of plants in the studied catchment widely varied from -5.45‰ (lichen *Cladonia rangiferina*) to 14.24‰ (moss *Tetraplodon mnioides*), reflecting different contributions from three major N-sources available for plants and metabolical preferences. The percentage of the tundra N-pool provided by birds calculated, based on moss $\delta^{15}N$, ranged from 0-26% in Patterned-ground tundra and Geophytic initial tundra to 100% in Ornithocoprophilous tundra and Wet moss tundra located just beneath Little Auks colony. The mean relative contribution from the three N-sources in the whole Fuglebekken catchment was 41% from birds, 45% from atmospheric deposition, and 14% from atmospheric N_2 fixation. The stable nitrogen isotope mixing mass balance indicates the ratio of actual N-loads acquired by plants from different N-sources and therefore enhances our understanding of the importance of different N-sources for the Arctic tundra.

MODELED GLOBAL OCEAN CARBON ISOSCAPES: DEVELOPMENT, VALIDATION, APPLICATION AND LIMITATIONS.

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Geographic assignment of marine animals using stable isotopes is severely compromised by the lack of spatio-temporally explicit reference isotope data. A solution to this problem lies in extending ocean biogeochemical-ecosystem models to predict spatio-temporal variations in the isotopic composition of primary producers across the global ocean. Here we present an extension to the NEMO-MEDUSA ocean biogeochemical-ecosystem model to predict the carbon isotope composition ($\delta^{13}C$) of phytoplankton at one degree and monthly resolution. Rather than discretely modeling ^{12}C and ^{13}C, we simply apply transfer functions based on the underlying mechanisms of carbon isotope fractionation to the NEMO-MEDUSA outputs. This simplification enables offline isoscape generation within the R programming language, and thus makes isoscape development available to all isotope ecologists without requiring access to the full NEMO-MEDUSA model.

Validation of global model isoscapes is challenged by the same lack of spatio-temporally explicit reference samples that encourages their development. We show that broad latitudinal and longitudinal, and temporal (within year) variations in phytoplankton $\delta^{13}C$ values are recovered by simulated isoscapes. Also, as an example of their potential applications, we use simulated isoscapes to interpret isotopic compositions of marine animal tissues in a suite of published studies.

Model isoscapes are limited by the ecological assumptions implicit in the underlying biogeochemical models, the difficulty in estimating uncertainties, and the lack of suitable field validation data. Nonetheless, they provide useful tools to interpret ecological isotope data, especially in wide-ranging oceanic migrants. Confidence in geographic assignments produced from simulated isoscapes will be improved by combining data from a range of biogeochemical models, and by modelling multiple isotope systems.

Decoding Past Environments - Temporal Variations and Time Machines

A HIGH RESOLUTION HOLOCENE CLIMATE RECORD OF THE ASIAN MONSOON

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This study provides a high resolution independently dated record of climate variability from the early Holocene from stable isotopes from authigenic carbonates held in lake sediment archives from closed basin deep tropical lakes. The biogeochemistry of these lake surface waters are modified in response to climatic triggers, with algal blooms triggering increased alkalinity which results in the precipitation of calcium carbonate crystals. These carbonates are sequestered in the sediment record, preserved with minimal disturbance due to the morphology of the lake basins, facilitating a faithful high resolution reconstruction of past climate.

The response of the Asian monsoon over mainland Southeast Asia is an important yet little studied aspect of the monsoon system. This region is of interest due to its location on the cusp of the Indian monsoon and East Asian monsoon subsystems. This study provides new insights into the timing of the onset of dryer conditions in this region following the Holocene Optimum in the mainland Southeast Asian region, assisting in understanding the complex dynamics of climate forcing and teleconnections in the broader Asian monsoon system.

ORGANIC GEOCHEMICAL APPRAISAL OF CARBON SOURCES IN LATE HOLOCENE LACUSTRINE SEDIMENT FROM THE SEMI-ARID PILBARA

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Organic geochemical appraisals based on the molecular composition and stable isotopic signatures of sedimentary organic matter (OM) have been widely applied to study OM sources, diagenetic processes and depositional environment of a large variety of recent to ancient geological sediments. Molecular fossils retaining a structural link to their biological source, or having biomarker potential, are particularly informative analytes. However, the most abundant biomarkers found in sediment often derive from multiple sources, which can reduce their diagnostic value. Stable isotope composition of biomarkers has proved to provide even more detailed information for understanding biogeochemical cycling and organic carbon (OC) sources. Here, we report the organic geochemical characterisation of late Holocene sediment samples from the arid Pilbara (NW Australia). We retrieved a 60 cm core from a perennial pool on the Fortescue Marsh. Solvent extractable fractions of sediments were analysed by gas chromatography-mass spectrometry (GC-MS) and isotope ratio monitoring (IRM) GC-MS. The core was separately dated (^{210}Pb, ^{137}Cs & ^{14}C) to span a period beyond ~AD 800. The extremely low OC content (<1%), consistent with an arid and low productivity environment, placed limits on the analytic resolution that could be achieved. Organic analytes were below GC-MS detection limit in sediments older than AD 800, which suggests conditions were even more arid than present and typical for an ephemeral river reach. The stable carbon isotope (δ^{13}C) composition of *n*-C_{21} – C_{33} alkanes (-27 to -30 ‰) derived from leaf waxes in sediments spanning the last 1,200 years largely reflected a relatively even and stable contribution of both C_3 and C_4 terrestrial plants. These data showed no evidence of significant change in vegetation assemblage; however, a progressive decrease in aridity as the pool became perennial was inferred from other proxies analysed in the sediment sequence (e.g., particle size analysis, depositional rate, macrofossils).

LEAF-WAX *n*-ALKANE $\delta^{13}C$ DOES NOT TRACK BULK LEAF $\delta^{13}C$ ACROSS GRADIENTS IN AVAILABLE MOISTURE

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The bulk carbon isotope ratio ($\delta^{13}C_{bulk}$) of leaves has long been recognized to vary with available moisture in C_3 but not C_4 plants. This has been attributed to the effects of water stress on stomatal conductance, and the reduction of the partial pressure of CO_2 inside the leaf (p_i) relative to the atmosphere (p_a), which influences carbon isotope fractionation by Rubisco in C_3 but not C_4 plants.

As a corollary, carbon isotope ratios of leaf-wax n-alkane ($\delta^{13}C_{lipid}$) would be expected to vary with available moisture in C_3 but not C_4 plants. Yet, this assumption has not been extensively tested. In order to examine whether $\delta^{13}C_{lipid}$ varies in parallel with $\delta^{13}C_{bulk}$ in relation to available moisture, we have compiled new and published data on $\delta^{13}C_{bulk}$ and $\delta^{13}C_{lipid}$ from C_3 and C_4 plants over a range of climatic conditions.

As expected, $\delta^{13}C_{bulk}$ demonstrates a significant dependence on potential evapotranspiration in C_3 but not C_4 plants. For C_3 plants, drier conditions correspond to more positive $\delta^{13}C_{bulk}$ values and wetter conditions correspond to more negative $\delta^{13}C_{bulk}$ values. In contrast, $\delta^{13}C_{lipid}$ values from these same C_3 plants show no dependence on potential evapotranspriation. These results indicate that the fractionation of carbon isotopes between the bulk leaf and lipid ($\varepsilon_{l/bulk}$) is not constant in C_3 plants. In fact, it appears that $\varepsilon_{l/bulk}$ varies with available moisture in both C_3 and C_4 plants, with greater negative fractionation under drier conditions, and less negative fractionation under wetter conditions. In this dataset, the net result is that the variation in C_3 plant $\delta^{13}C_{bulk}$ with available moisture is compensated by the opposite variation $\varepsilon_{l/bulk}$. As a consequence $\delta^{13}C_{lipid}$ appears to be insensitive to variations in available moisture. To rule out the potential influence of plant type on the observed pattern, variation in $\varepsilon_{l/bulk}$ within single species along climatic gradients is being examined in Hawaii, the Central USA and Queensland.

PALEOCEANOGRAPHIC PRODUCTIVITY RECONSTRUCTIONS USING MARINE MAMMAL BONE COLLAGEN

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Changes in primary ocean productivity play a key role in determining the structure and biomass yield of the North Pacific ecosystem. Archaeofaunal remains of marine mammals from the Aleutian Islands, Alaska were used as a proxy for marine productivity changes over decade, century and millennial scales throughout the Holocene. Marine vertebrate remains from several previously excavated, well-dated archaeological deposits on Unalaska Island span the period AD 1912-5500 BP. Stable carbon and nitrogen isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) derived from marine mammal bone and tooth collagen provide information about changes in food web dynamics and marine productivity levels and, through inference, about ecosystem changes. The paleorecord of phytoplankton production, in response to changes in atmospheric and oceanic fluctuations, is reflected in the stable isotope composition of the skeletal remains of these animals. An analysis of three hundred pinniped and cetacean individuals over the six thousand year period indicated a consistent inverse relationship existed between the two isotopes. A minimum of five time periods occurred when both stable isotopes changed from either a positive to negative slope or negative to positive slope.

CARBONATE CONCRETIONS ASSOCIATED WITH FOSSILS: SNAPSHOT OF AN ANOXIC MARINE ENVIRONMENT IN THE TOARCIAN

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A carbonate concretion (CC) is often found encapsulating fossils with an exceptional degree of preservation. CC formation may be initiated by decaying organic matter (OM) mediated by microorganisms (Berner, 1968). Organic and inorganic geochemical analyses are used *to* identify processes related to CC growth, in particular addressing the role of microorganisms in shaping the paleo-microenvironment. Changes therein are deducted by comparing the chemical inventory of the CC with that of the surrounding (shaley) host rock. Hence, the CC and host rock give information on both, the sedimentary environment during CC growth as well as the microbiota responsible for its formation. Encapsulation processes occurring in the subsurface often preserve the structural bedding of the sediment.

We investigated the chemical and isotopic composition of a CC and its host rock collected from the Toarcian (183 Ma) Posidonia Shale in SW-Germany. Eight subsamples were taken from the nucleus composed of jet towards the outer part of the concretion covering both directions, parallel and perpendicular to bedding. Mineralogy, trace element patterns, lipid biomarker distributions and $\delta^{13}C$ values, complemented by carbonate $\delta^{13}C$ and $\delta^{18}O$ values are used to determine paleo-environmental conditions prevailing during CC growth in shallow sediments of the Tethys Ocean. While the mineralogy is dominated by calcite, pyrite is also present, concentrated in the outer rim of the CC. Trace elements reveal a redox front within the CC located before this pyrite rim. Throughout the Posidonia Shale CC *n*-alkanes are generally depleted in ^{13}C as found in previous Devonian CC studies (Melendez *et al*., 2013). In concert, the mineralogy, the main and trace elemental distribution, and the $\delta^{13}C$-signature of lipids point toward an involvement of sulfate-reducing bacteria in the formation of the CC and the preservation of OM during the Toarcian anoxic crisis.

REFERENCES

Berner, R. A. 1968. Calcium carbonate concretions formed by the decomposition of organic matter. Science (80-.). 159, 195–197

Melendez, I., Grice, K., Trinajstic, K., Ladjavardi, M., Greenwood, P., Thompson, K., 2013. Biomarkers reveal the role of photic zone euxinia in exceptional fossil preservation: An organic geochemical perspective. Geology 41, 123–126

CSIA IDENTIFY EFFECTS OF HISTORICAL FLOOD ENGINEERING WORKS ADVERSELY IMPACTING ON A RAMSAR WETLAND ECOSYSTEM

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Whangamarino wetland (7290 ha) is one of six Ramsar wetland sites in New Zealand. It is the second largest bog and swamp complex in the North Island and is home to about 20% of Australasian bittern/matuku in New Zealand. In 1963 the hydraulics of the Whangamarino wetland was permanently altered by the construction of the Pungarehu canal, which carries water from Lake Waikare into the wetland as part of the flood control scheme on the lower Waikato River. The natural inflow to the Whangamarino wetland is catchment (210 km^2) runoff via the Whangamarino River. Although sedimentation monitoring using land-survey methods failed to show any sediment accumulation in the wetland, it became apparent that fine sediment inputs were adversely affecting aspects of the wetland ecology. The present study was designed to identify sediment sources and the rates of sediment accumulation in the wetland.

We used compound specific stable isotope analysis (CSIA) of Fatty Acid biomarkers (Gibbs 2008) to identify the sources of sediment by land use impacting on the wetland, both spatially and temporally (from sediment cores), and sediment accumulation rates (SAR) were determined from radioisotope-dated cores (^{210}Pb, ^{137}Cs). The results showed that while catchment sources of sediment from cropping (maize) were minimal compared to sediment from steep pastured hillsides and intensive lowland dairy farming, about 90% of sediment came from Lake Waikare. There was close correlation between the dates of the sudden increase in SAR and the construction of the canal. The CSIA results showed a change from native-plant derived sediments to Lake Waikare sediment at this transition depth, indicating a major shift in the system. The depth to this transition point reduced with distance from the canal such that the sediment front into the wetland matched the start of the decline in wetland plant diversity. The greatest sediment effect was closest to the outflow from the Pungarehu canal.

REFERENCES

Gibbs M.M. 2008. Identifying source soils in contemporary estuarine sediments: A new compound-specific isotope method. Estuaries and Coasts 31: 344–359.

A CENTURY OF SOUTH EAST AUSTRALIAN ECOSYSTEM SENSITIVITY ARCHIVED IN THE CARBON AND NITROGEN ISOTOPES OF DEEP-SEA CORAL AMINO ACIDS

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South-east Australian seamounts and their associated deep-sea ecosystems are located in an oceanographically complex and climatically sensitive region. Across this region, Bamboo Corals inhabit a tremendous depth range (600-4000m) archiving surface processes by incorporating raining particulates into their banded skeletons. Bulk organic ^{15}N has previously been used to substantiate the region's shifting surface regimes in response to current climate change, but trophic enrichment was necessarily approximated, obscuring the ^{15}N-signal of the producers at the base of the food web [1]. In this study, we revisit the ^{15}N archive, instead using individual amino acids (AA) to reconstruct ecosystem dynamics. We are able to capture and decouple a centenary of trophic interactions from the ^{15}N-signal of primary production. Furthermore, as specimens were collected between 1000-3000m, we are able to explore deep-sea particle transformations and microbial heterotrophy that connects surface and deepwater ecosystems. By exploiting previously validated ^{15}N-AA patterns [2] and considering those in the ^{13}C-AA record, we propose likely mechanisms that could support the inexplicably high biomass that has been reported within the local bathyl zone [3]. Our preliminary results indicate that clear distinctions seen between depths in the bulk record naturally reflect the isotopic signature of the most abundant AA, glycine, as well as trophic complexity. Furthermore we find evidence of differing particulate processing histories, provenance and species effects that all have important implications for the future interpretation of records from deep-sea coral organics.

REFERENCES

[1] Sherwood et al. (2009) Mar. Ecol. Prog. Ser. 397, 209-218.
[2] McCarthy et al. (2007) GCA 71, 4727-4744.
[3] Thresher et al. (2011) Nat. Sci. Reports 1, 119.

CHANGE IN ISOTOPIC SIGNATURES SUGGEST FOOD WEB SHIFT OFF THE WESTERN ANTARCTIC PENINSULA

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The local warming occurring within the Western Antarctic Peninsula (WAP) is causing some of the greatest environmental shifts on the planet. We document a significant trophic downshift at the top of the food web in the 1980s unprecedented in the last 140 years.

Over the past 140 years there have been profound biological and physical perturbations to the wildlife of the WAP. This includes the removal and then return of krill-eating whale (humpback and southern right) and seal (fur seals) populations, fin-fish and krill fisheries, as well as local warming. Despite the century-long perturbations in the WAP the top predators, the leopard seals, show a trophic downshift only in recent times, post 1980s. The stability of $\delta^{15}N$ values in the population prior to and post the 1980s suggests that the top-predators vertebrate diet was stable until the 1980.

Stable isotope signatures show the leopard seal to have shifted from eating vertebrates to krill. This brings into question that krill-shortage alone has driven the decline in krill-feeding penguins. Predation by leopard seals may have been implicated in the demise of penguin populations. The trophic shift by this top predator, seen in concert with changes at all levels lower in the food web, suggests that the WAP moved through a regime shift in the 1970-80s and today reflects an alternate stable state.

DECODING ISOTOPIC RECORDS OF LONG-TERM ENVIRONMENTAL CHANGES PRESERVED IN ESTUARINE SEDIMENTS

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Sediment records preserved in aquatic sinks, including estuaries, enable long-term environmental histories to be reconstructed and provide insights into how past environmental changes have shaped present-day ecosystems. In New Zealand, the transition from pristine to highly-modified ecosystems resulting from human activities (e.g., deforestation) began only ~700 years ago with the arrival of Polynesians.

In this study, we use stable isotope analysis of Fatty Acid biomarkers (Gibbs 2008) in combination with radioisotope-dated cores (^{210}Pb, ^{137}Cs, ^{14}C) to reconstruct the evolution of the landscape and receiving marine environments of the Bay of Islands (BoI, NZ) over the last ~2,700 years. This analysis focuses on the sources of eroded catchment soils, by vegetation type, and their fate. Sediment cores were collected along a sedimentation gradient, extending from major river outlets onto the inner continental shelf. Sediment-source characteristics were determined from composite sampling of catchment soils by vegetation type. Feasible soil sources in each dated sediment layer were evaluated using an isotopic mixing model after correcting δ^{13}C signatures for time-dependent changes associated with the Suess effect (i.e., post-1700 AD).

The results indicate that natural disturbance of the landscape was a feature of this system prior to humans. Human activities greatly accelerated soil erosion, with pre-human deposition rates in the BoI system increasing ten-fold to ~500,000 t/yr. The effects of deforestation and land conversion to agriculture on soil erosion over the last ~200 years are evident due to the introduction of exotic plants with characteristic isotopic signatures by European settlers. Soils associated with agriculture (e.g., dry-stock pasture, root crops, citrus) enter the sedimentary record from the mid-1800s. These eroded agricultural soils have been widely dispersed, accumulating in fringing estuaries, the Bay and on the inner shelf.

REFERENCES

Gibbs M.M. 2008. Identifying source soils in contemporary estuarine sediments: A new compound-specific isotope method. Estuaries and Coasts 31: 344–359.

Abstracts

Poster Session 1

MIXING MODELS IN FOOD WEB STUDIES AND TROPHIC TRANSFERS

1	Lydia Luise Bach	Trophic status of species in UK coastal marine food webs at a hierarchy of spatial scales
2	Samuel Bodé	Free fatty acids as sediment fingerprint: A case study of Kunchal watershed of Nepal
3	Antione Carlier	Trophic role of thiobacteria in a marine coastal ecosystem influenced by geothermal power plant
4	Lucie Chovrelat	The trophic position of the brown bamboo shark (*Chiloscyllium punctatum*) in Shark Bay (WA)
5	Jonathan Grey	Chemosynthetic contributions to food webs in the most unexpected places
6	Ana Hacohen-Domene	Trophic habitat use of the whale shark and the giant manta ray in the Mexican Caribbean
7	Chris Harrod	Rapid assessment of foodwebs in a high altitude salar using stable isotope and fatty acid analyses
8	Bonny Krell	Aquatic prey subsidies to riparian spiders in a stream with different land use types
9	Thomas Larsen	Introducing the novel Bayesian mixing model FRUITS to reconstruct food sources
10	Trent R. Marwick	Disproportionate contribution of riparian inputs to organic carbon pools in freshwater systems
11	Ferdaus Mohamat-Yusuff	Tracing the food web in aquatic environment of a peat swamp forest using stable isotope markers
12	Robyn Paice	Exploring the role of submerged macrophytes in food webs in south west streams
13	Emma Steggles	Using mixing models to identify water sources for Western Myall
14	Sonia Valladares	New insights into the feeding ecology of seahorses by stable isotopes
15	Syaizwan Zahmir Zulkifli	Application of stable isotope fingerprints to trace existing food web in an intertidal area of Johor Straits

POSTER 1

TROPHIC STATUS OF SPECIES IN UK COASTAL MARINE FOOD WEBS AT A HIERARCHY OF SPATIAL SCALES

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Anthropogenic impacts affect abundance and size structure of marine communities, thereby changing food web structure. It is difficult to predict community response to these changes and requires understanding about complex biological interactions.

We still lack some understanding of the relationship of food web and spatial scale. Understanding regularities of food webs will enable us to understand fundamental properties of ecosystems and predict how these may change in the future.

The aim of this study was to investigate how the trophic status of species in coastal ecosystems varies across spatial scales, by enumerating trophic relationships in the system, ultimately showing how resources and patterns of energy flow vary.

We used stable isotope analysis investigate changes in isotopic variation in three sampling sites, and across four spatial scales. Samples were collected in Essex mudflats in summer 2013 using fyke, seine and push nets. Smaller macroinvertebrates were collected using cores.

As expected, $\delta^{13}C$ & $\delta^{15}N$ differed between sampling sites, associated with site specific environmental variation, such as terrigenous carbon, which may confound results, pushing isotopic signatures to 'offshore'- like $\delta^{13}C$ values.

In contrast to our hypothesis, local variation in food availability & quality did not result in local patch heterogeneity of isotopic values of the species under investigation or the assemblage as a whole. We found a positive correlation between body size and δ15N in all macrofauna species, implying larger animals feed at higher trophic levels. Finally, we hypothesized that variation in isotopic values decreases with body size, but found no such patterns for the four macrofauna species under investigation. Intra and interspecific variation in species life history were reflected in the isotopic values across spatial scales. Many marine species undergo ontogenetic shifts in diet, feeding on species on higher trophic levels during their later life stages. This was particular apparent the green shore crab.

In the future, we aim to link these results with the food webs generated using stomach content analysis and a review of feeding interactions from the literature, to investigate if food web properties in this study area are scale dependent. Understanding the scaling relationships may help us recognize the change and interrelation of parameters within complex food webs.

POSTER 2

FREE FATTY ACIDS AS SEDIMENT FINGERPRINT: A CASE STUDY OF KUNCHAL WATERSHED OF NEPAL

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Soil erosion by water is national concern in Nepal due to it's in-situ land degradation and ex-situ hydroelectric dam siltation. Identification of sediment sources is prime importance for conservation erosion hotspots and reduce sediment load in the stream. This study aimed to determine the contribution of sediments (time-integrated and event) by different land uses in Kunchal Stream of Nepal. $\delta^{13}C$ of free fatty acids (FFA) extracted from potential sediment sources and sediment sinks were measured using GC-c-IRMS. Linear discriminate analyses of the $\delta^{13}C$ of FFA from the different potential sources clearly showed that the FFA $C \geq 20$ have high separation potential in comparison to short chain FFA ($C < 20$) to discriminate between the different land uses. Using an isotopic mixing model (MixSIAR) to our data revealed that the steep mixed forest contributed highest sediment load (60%) during early monsoon while the sediment load switched to lowland agricultural terraces (65%) during late monsoon. Check dams remain important man-made structure disconnecting sediment cascade into the stream.

POSTER 3

TROPHIC ROLE OF THIOBACTERIA IN A MARINE COASTAL ECOSYSTEM INFLUENCED BY GEOTHERMAL POWER PLANT

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In addition to their primordial roles in nutrient cycling, benthic bacteria can represent an important food source in some particular environments. In abyssal hydrothermal vents, chemolithotrophic bacteria are known to underlie the whole foodweb but in coastal environments, those bacteria are uncommon and their trophic role remains uncertain. In Bouillante Bay (Guadeloupe – French West Indies), effluents released into the marine environment by a geothermal power plant represent an unlimited source of sulfides, allowing for the development of thriving mats of benthic thiobacteria. The aim of the present study is to determine if the input of this particular bacterial biomass constitutes a food resource for the local marine fauna. Carbon and nitrogen isotopic compositions were analyzed on several meio and macrofaunal organisms belonging to different trophic levels such as grazers, filter or suspension feeders, predators, detritus feeders or scavengers. Isotopic compositions showed an evolution along a 250-meter long transect from the effluent channel, suggesting a potential assimilation of the thiobacteria mats by 6 of the 11 studied organisms. This feeding behavior does not seem to be directly linked to the trophic level and the size of the considered species. The evaluation of the total abundance of fishes along the transect showed an increase in density with the proximity of the effluent channel but also a decrease during plant's maintenance, revealing a localized attraction for fast moving species. Those complementary approaches both suggest a key trophic role of chemolithotrophic bacteria in the studied coastal ecosystem.

POSTER 4

THE TROPHIC POSITION OF THE BROWN BAMBOO SHARK (*CHILOSCYLLIUM PUNCTATUM*) IN SHARK BAY (WA)

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Understanding the dynamics of marine food webs is an important challenge, especially in places that are highly vulnerable to climate change. In December 2010, the seagrass meadows of Shark Bay experienced heavy rains, which resulted in an unprecedented flood of the Wooramel River (usually dry). The flood discharged large amounts of freshwater and sediment into the bay that impacted the main basal source of production — the seagrass *Amphibolis antarctica*. The brown bamboo shark (*Chiloscyllium punctatum*) is a common elasmobranch inhabiting these seagrass beds, and relies on a trophic pathway supported mainly by *Amphibolis*. The trophic position (TP) of *C. punctatum* was calculated using $\delta^{15}N$ of *A. antarctica* as the base trophic level. A mean trophic position of 4.17 was found for the brown bamboo shark, indicating that it is a mesopredator. This result was higher than a previous result of 3.78 found for the same species in a nearby location. $\delta^{15}N$ was also positively correlated with the length of the individual ($F = 35.59$, $p < 0.0001$). Considering the low turnover rate occurring in shark's cartilages tissues used in this study and the short period of time (3 months) between the flood and the sampling of shark, it was too early to assess potential impacts on TP as result of the flood. Nevertheless, this study provides new understanding of the trophic status of this common seagrass inhabitant.

POSTER 5

CHEMOSYNTHETIC CONTRIBUTIONS TO FOOD WEBS IN THE MOST UNEXPECTED PLACES

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Biogenic methane typically has a very distinct isotopic value, which when oxidised and converted to bacterial biomass, becomes even more so, thereby providing an ideal signal to link biogeochemical cycles with food webs. Stable isotope studies have been instrumental in demonstrating the importance of this greenhouse gas as a fuel for food webs at point sources and where methane concentrations are very high. Here we show that chemosynthetic primary production has a role to play in some less obvious ecosystems where we might expect photosynthetic primary production to dominate.

As a first example, groundwater dominated lowland rivers are typically over-saturated with methane but still at very low concentrations relative to other wetlands such as stratifying lakes and rice-paddies. Using ^{13}C-enriched methane, we have estimated the efficiency with which methane oxidising bacteria (MOB) fix that source of carbon, and in a separate series of experiments, demonstrated the uptake of methane-derived carbon into macroinvertebrate biomass. Analyses of the methane gas $\delta^{13}C$ from river water reveals a much higher value on average compared to stratifying lakes suggesting our previous assessment of the importance of this carbon source to the food web (Trimmer et al 2009) is an underestimate.

In a second example, bioturbation by ecosystem engineers such as crayfish in lakes has been shown to enhance nutrient concentrations in the water column by resuspending sediments and hence boost phytoplankton production. This has a cascading effect on zooplankton community abundance and composition typically switching from one that is diverse to more of a monoculture. We show that bioturbation also has considerable impacts upon methane dynamics and isotopic evidence infers that zooplankton become more reliant upon methane-derived carbon as a consequence

REFERENCES

Trimmer M. Hildrew A.G. Jackson M.C. Pretty J.L. Grey J. 2009. Evidence for the role of methane-derived carbon in a free-flowing, lowland river food web. Limnology and Oceanography 54: 1541.

POSTER 6

TROPHIC HABITAT USE OF THE WHALE SHARK AND THE GIANT MANTA RAY IN THE MEXICAN CARIBBEAN.

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The whale shark (*Rhincodon typus*) and giant manta ray (*Manta birostris*) are planktivorous elasmobranches found seasonally in the Mexican Caribbean when there is increased primary productivity. However, specific details of their feeding ecology, such as shared resource use, remain enigmatic. This study's aim is to determine the trophic habitat use of whale sharks (WS) and giant manta ray (GM) in the Mexican Caribbean through stable isotope analysis of carbon and nitrogen. We analyzed WS (n=84) and GM (n=46) skin samples of different sizes and sex from individuals caught in 2010-2012. We also analyzed plankton (n=40) from this sampling period during feeding and non-feeding events. The stable isotope values of WS and GM were not substantially different (mean $\delta^{13}C \pm SD$: GM= -14.4±1.1‰; WS= -13.9±0.6‰; mean $\delta^{15}N \pm SD$: GM= 8.1± 0.6‰; WS=8.2± 0.7‰).We did not find significant differences (α=0.05) between GM isotopic values ($\delta^{13}C$ and $\delta^{15}N$) for sex suggesting similar foraging area and prey. For WS, the isotopic values did not differ between years, sex, and size for $\delta^{13}C$ values; however $\delta^{15}N$ values between adults and juveniles showed a slight difference (8.5±0.7‰ vs. 8.0±0.6‰, respectively; F= 2.929, p=0.06). We compared the isotopic niche between species using SIBER, a Bayesian analysis of isotopic polygons, which suggested the two species have different trophic amplitude (GM=1.31; WS=0.89) with an overlap value of 0.7. Finally, a Bayesian dietary mixing model (SIAR) indicated that differing proportions of copepods from Cabo Catoche and Isla Contoy and chaetognata from Isla Contoy are the highest prey contribution, which differs from direct feeding observations.

POSTER 7

RAPID ASSESSMENT OF FOODWEBS IN A HIGH ALTITUDE SALAR USING STABLE ISOTOPE AND FATTY ACID ANALYSES

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We used a mixed stable isotope ($\delta^{13}C$, $\delta^{15}N$) and fatty acid approach to characterise biochemical variation between different primary producers and their likely importance to consumers in Salar de Atacama, a large (2900 km^2) evaporitic basin located in the Atacama Desert, Chile. The salar has several permanent lagoons that receive waters from the Andes and represent an extreme salinity gradient ranging from mildly brackish to hypersaline. The shallow lagoons are characterised by diverse and abundant microbial communities, including the presence of colonial cyanobacteria (e.g. *Nostoc*) and extensive microbial mats. Macrophytes are present but extremely rare and the few taxa of higher organisms present include amphipods, gastropods and brine flies as well as a number of flamingo and other bird species.

Our results revealed extreme spatial variation in stable isotope and fatty acid values between microbial mats both within site (i.e. vertically) and between sites. Amphipod $\delta^{13}C$ and $\delta^{15}N$ values overlapped with, and tracked between-site variation in surface bacterial mat values. Flamingo feathers were notably ^{13}C-enriched relative to consumers collected from low-salinity sites, indicating that although they were apparently foraging in such locations, the bulk of their assimilated C originated from other, more saline locations.

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POSTER 8

AQUATIC PREY SUBSIDIES TO RIPARIAN SPIDERS IN A STREAM WITH DIFFERENT LAND USE TYPES

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Habitat degradation in freshwater ecosystems has considerably increased over the past decades due to anthropogenic land use, which has affected the aquatic and the riparian communities. Previous studies, mainly in undisturbed systems, have shown that aquatic emergent insects contribute substantially to the diet of riparian predators. To evaluate the effect of land use on aquatic prey subsidies of riparian spiders, we performed a longitudinal study along a first order stream (Rhineland-Palatinate, Germany) covering three land use types: forest, meadow and vineyard. We determined the contribution of aquatic and terrestrial resources to the diet of web-weaving (Tetragnathidae spp.) and ground-dwelling (*Pardosa* sp.) riparian spiders using stable isotope analyses of aquatic emergent insects and terrestrial arthropods. The contribution of aquatic and terrestrial sources differed between Tetragnathidae spp. and *Pardosa* sp. as well as among land use types. Tetragnathidae spp. consumed 80-100% aquatic insects in the meadows and 45-65% in the forest and vineyards. *Pardosa* sp. consumed 5-15% aquatic insects in the forest, whereas the proportions of aquatic and terrestrial sources were approximately 50% in the meadow and vineyard. Aquatic and terrestrial prey biomass showed no significant differences among land use types, suggesting that the differences are not driven by food availability. We conclude that aquatic emergent insects can be an important subsidy to riparian spiders also in agricultural landscapes and that land use is likely to affect the proportion of aquatic sources in the spider diet.

REFERENCES

Krell B. Röder N. link M. Gergs R. Entling M.H. Schäfer R.B. (Submitted) Aquatic prey subsidies to riparian spiders in a stream with different land use types.

POSTER 9

INTRODUCING THE NOVEL BAYESIAN MIXING MODEL FRUITS TO RECONSTRUCT FOOD SOURCES

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The novel Bayesian model FRUITS (Food Reconstruction Using Isotopic Transferred Signals) has been developed to quantify consumer diets (Fernandes et al. 2014).

The model FRUITS assigns dietary intake probabilities by comparing isotopic signals measured in consumers with those of potential food groups. FRUITS is capable of handling multiple dietary isotopic proxies and associated uncertainties. FRUITS is also the first mixing model offering the possibility of accounting for dietary routing and it introduces the capability of entering prior information on the relative intake of potential food groups and macronutrients. FRUITS is provided as an open source user-friendly software and model outputs include probability distributions and confidence intervals on the relative intake of the different food groups.

To be presented are successful applications of FRUITS in ecological studies that include: tracing amino acid carbon sources through aquatic and terrestrial food webs (Larsen et al. 2013) and identifying dietary changes in wild mice associated with shifts in their intestinal microbiome composition (Wang et al. 2014).

REFERENCES

Fernandes R. Millard A.R. Brabec M. Nadeau M.J. Grootes, P. 2014. Food Reconstruction Using Isotopic Transferred Signals (FRUITS): A Bayesian Model for Diet Reconstruction. PLoS ONE 9: e87436.

Larsen T. Ventura M. Andersen N. O'Brien D. M. Piatkowski U. McCarthy M. D. 2013. Tracing Carbon Sources through Aquatic and Terrestrial Food Webs Using Amino Acid Stable Isotope Fingerprinting. PLoS ONE 8: e73441.

Wang J. Linnenbrink M. Künzel S. Fernandes R. Nadeau M. J., Rosenstiel P. Baines J. F. 2014. Dietary history contributes to enterotype-like clustering and functional metagenomic content in the intestinal microbiome of wild mice. Proceedings of the National Academy of Sciences: 201402342.

POSTER 10

DISPROPORTIONATE CONTRIBUTION OF RIPARIAN INPUTS TO ORGANIC CARBON POOLS IN FRESHWATER SYSTEMS

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A lack of appropriate proxies has traditionally hampered our ability to distinguish riverine organic carbon (OC) sources at the landscape scale. However, the dissection of C_4 grasslands by C_3-enriched riparian vegetation, and the distinct C stable isotope signature ($\delta^{13}C$) of these two photosynthetic pathways, provides a unique setting to assess the relative contribution of riparian and more distant (i.e. the C_4 grasslands) organic matter sources to riverine C pools. Here, we compared $\delta^{13}C$ signatures of bulk sub-basin vegetation ($\delta^{13}C_{VEG}$) with those of riverine OC pools (particulate OC, dissolved OC, and river bed OC) for a wide range of sites within two contrasting river basins (i.e. C_4- versus C_3-dominant vegetation) in Madagascar.

We found ^{13}C-depleted riverine OC dominated in the eastern Rianala catchment, reflective of the largely homogenous C_3 vegetation of the basin. Alternatively, in the C_4-dominated Betsiboka basin, riverine OC is disproportionately sourced from the C_3-enriched riparian fringe, irrespective of climatic season, even though $\delta^{13}C_{VEG}$ estimates suggest as much as 96% of land cover in some Betsiboka sub-basins may be accounted for by C_4 biomass. For example, $\delta^{13}C$ values for river bed OC in Betsiboka streams and rivers were on average 6.9 ± 2.7 depleted in ^{13}C compared to paired estimates of $\delta^{13}C_{VEG}$. The disconnection of the wider C_4-dominated basin is considered the primary driver of the under-representation of C_4-derived C within riverine OC pools in the Betsiboka basin, although combustion of grassland biomass by fire is likely a subsidiary constraint on the quantity of terrestrial organic matter available for export to these streams and rivers. Our findings carry implications for the use of sedimentary $\delta^{13}C$ signatures as proxies for past forest-grassland distribution and climate, as the C_4 component may be considerably underestimated due to its disconnection from riverine OC pools.

POSTER 11

TRACING THE FOOD WEB IN AQUATIC ENVIRONMENT OF A PEAT SWAMP FOREST USING STABLE ISOTOPE MARKERS

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It is important to have a deep understanding about functioning ecosystem and natural control linkage of food web in order to manage component communities in black water area. Thus, stable isotope is perfect tools as it has the potential as both natural trace and as means of characterizing trophic structure. This study was conducted to quantify a food web model of aquatic environment in North Selangor Peat Swamp Forest (NSPSF) using the stable isotope marker with stable isotope values $\delta^{13}C$ and $\delta^{15}N$. The samples collected from two selected points of peat swamp area representing disturbed and undisturbed area along the Sungai Tengi, Kuala Selangor in December 2013 and January 2014. Samples collected were then undergoing analytical procedures before being analyses using Isotope Mass Ratio Spectrometry (IRMS). There had different in trends of food web between disturbed and undisturbed area although both food web tracks spanning four trophic levels (TL). Consumer in the higher trophic level had significantly higher $\delta^{13}C$ and $\delta^{15}N$ values compare to the lower consumer. *Hemibagus nemurus* become the top predator in disturbed area while *Channa lucius* become the top predator in undisturbed area. Spatial variation in $\delta^{15}N$ of sediment and consumers correlated well with sources of nutrient availability and primary productivity transfer from one species to another species. Sampling throughout the year is highly recommended as different species only available at a certain period of time due to water input from the rainfall.

REFERENCES

Zulkifli S.Z. Mohamat-Yusuff F. Mukhtar A. Ismail A. Miyazaki N. 2014. Determination of food web in intertidal mudflat of tropical mangrove ecosystem using stable isotope markers: a preliminary study. Life Science Journal 11(3): 427-431.

POSTER 12

EXPLORING THE ROLE OF SUBMERGED MACROPHYTES IN FOOD WEBS IN SOUTH WEST STREAMS

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Aquatic macrophytes are often excluded from studies of ecological processes in rivers in Australia. Their importance in riverine food webs may have been underestimated (Watson and Barmuta, 2011), and recent stable isotope analyses in Australia highlight the potential of these plants as energy sources of high nutritional value (Reid *et al*, 2008). In south-western Australia, allochthonous inputs, particularly from riparian zones, are a vital component of food webs in healthy streams (Bunn *et al*, 1999). However many streams in this region are degraded with riparian vegetation often compromised or removed entirely, and in these systems macrophytes may provide an important alternative food source.

This study aims to examine the importance of aquatic macrophytes in food webs of south west streams and compare this role for reaches with riparian vegetation in good and poor condition. Stable isotope values ($\delta^{15}N$ and $\delta^{13}C$) for primary producers, macroinvertebrates and fish from sites with and without aquatic macrophytes in stream reaches with both good and poor condition riparian zones are used to determine relative importance of macrophytes as a food source. The outcomes of this study will increase understanding of the role of aquatic macrophytes in ecology of south west streams and their value in conservation and restoration.

REFERENCES

Bunn, S. E., Davies, P. M. and Mosisch, T. D. 1999. Ecosystem measures of river health and their response to riparian and catchment degradation. *Freshwater Biology* 14: 333-345.

Reid, D. J., Quinn, G. P. and Reich, P. 2008. Terrestrial detritus supports the food webs in lowland intermittent streams of south-eastern Australia. *Freshwater Biology* 53: 2036-2050.

POSTER 13

USING MIXING MODELS TO IDENTIFY WATER SOURCES FOR WESTERN MYALL

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The discovery of Western Myall (*Acacia papyrocarpa*) roots at 22 m below surface in 2011 during mining activities at the Jacinth-Ambrosia (JA) mine site in the far west of South Australia, highlighted a discrepancy between the root-zone depth for this species in undisturbed areas and the much shallower overburden depth in post-mine rehabilitated areas. Consequently, questions were raised about how altered plant-soil-water relations in rehabilitated soil profiles may affect the long-term survival of this common deep-rooted species at JA. A pilot study was therefore undertaken in 2012 to investigate the feasibility of using stable water isotope signatures and water potentials to determine water sources used by Western Myall.

Stable water isotope signatures ($\delta^{18}O$) from plant xylem tissue were compared with signatures of five potential water sources i.e. three groundwater sources at varying depths, rainwater and soil-water collected at increments $\leq$ 1 m below surface. IsoSource™ (US EPA) was used to determine bounds for the contributions of each source to Western Myall water use. Water potentials were also compared between plant stems, groundwaters and soil-waters ($\leq$ 1m) to help identify zones from which roots were physically capable of extracting water.

The study found that $\delta^{18}O$ signatures differed between the sources examined, making it possible to distinguish between them. IsoSource™ provided source proportions, however no $\delta^{18}O$ profiling of soil-water was undertaken below 1 m depth and therefore the contribution from deeper soil-water layers is missing from the mix of potential sources. Water potentials were useful to help identify zones from which plants were capable of extracting water. Future research plans include the use of a drill rig to obtain soil samples to greater incremental depths in the soil profile, the addition of deuterium as part of isotope analyses and the inclusion of other deep-rooted species at J-A into the research focus.

POSTER 14

NEW INSIGHTS INTO THE FEEDING ECOLOGY OF SEAHORSES BY STABLE ISOTOPES

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Understanding how seahorses use food resources in the natural environment is essential for identifying factors that affect their distribution, abundance and choice of habitat, which are relevant parameters to guide conservation management of these endangered species. The stable isotope was applied to assess the foraging ecology of the long-snouted seahorse *Hippocampus guttulatus* inhabiting coastal waters of Northwest Spain. Due to its conservative status (endangered species included in the IUCN Red List Category and Criteria), the fin-clipping sampling method was chosen as a non-lethal practice to perform stable isotope analysis.

The isotopic composition ($\delta^{13}C$ and $\delta^{15}N$) in adult seahorses *H. guttulatus* sampled in Galicia (NW Spain) are provided. Spatial (three sites: S1–Bueu, S2–Ribeira, S3–Toralla) and seasonal (winter *vs* spring 2012) shifts were analyzed. Significant seasonal differences occurred for $\delta^{13}C$ at site S3 ($t=2.54$, $p=0.03$). Comparisons between sites did not show significant differences for $\delta^{15}N$ ($F=2.15$, $p=0.13$). However, $\delta^{13}C$ values were significantly different between sites ($F=3.87$, $p=0.03$). Post-hoc comparisons showed that carbon signatures in S2 (-15.52 ± 0.60) were higher than in S1 (-16.15 ± 0.39) and S3 (-15.92 ± 0.74).

Isotopic composition ($\delta^{13}C$ and $\delta^{15}N$) for potential prey items were also measured and their relative contributions to the diet of adult seahorses was estimated using the Bayesian stable isotope multiple-source mixing model SIAR. The results suggest that the natural diet of *H. guttulatus* was mainly based on the ingestion of *Amphipoda, Caprellidae* and *Caridea* prey items.

POSTER 15

APPLICATION OF STABLE ISOTOPE FINGERPRINTS TO TRACE EXISTING FOOD WEB IN AN INTERTIDAL AREA OF JOHOR STRAITS

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Increasing human activities significantly disrupts the stability and dynamic structure of intertidal area. Indeed, concerning about this functioning ecosystem, stable isotope signature was performed in order to trace existing food web as huge step in protect, maintain and improve the health of this ecosystems. Collectively, abiotic and biotic components were collected from Tanjung Kupang intertidal area. The primary producer and consumer food chain spanning four trophic levels (TL), estimated by $\delta^{13}C$ and $\delta^{15}N$ ratio. Using a constant trophic enrichment is clearly simplify, TL three had large group of species, mainly fishes. The group comprised diverse species included fishes, crab and mollusc. Animal species had $\delta^{13}C$ values ranging from ~-27.02 to -14.83 ± 0.54‰ meanwhile for plants part range from ~-30.17 to -19.89 ± 1.04‰. On the other hand, $\delta^{15}N$ hold the values ranging from ~4.09 to 15.89 ± 0.56‰ and 3.00 to 5.42 ± 0.22‰ for animal and plants, respectively. A modelling food web has been developed based on these isotope compositions that end up with five species as top predators (*Johnius borneensis, Ephipus orbis, Cynoglossus puncticeps, Portunus pelagicus* and *Thais gradata*). Connection between all 40 species are important in determine the energy flow and trophic positioned for each biotic component. Intertidal area is not only support organism but, in other way act as ultimate carbon sources to adjacent habitat organism.

REFERENCES

Zulkifli S.Z. Mohamat-Yusuff F. Mukhtar A. Ismail A. Miyazaki N. 2014. Determination of food web in intertidal mudflat of tropical mangrove ecosystem using stable isotope markers: a preliminary study. Life Science Journal 11(3): 427-431.

ENVIRONMENTAL TRACERS OF BIOGEOCHEMICAL CYCLES

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POSTER 16

IMPACT OF ARTIFICIAL INUNDATION OF EPHEMERAL CREEK BEDS IN MATURE EUCALYPTS IN SEMI-ARID NORTHERN AUSTRALIA

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The resilience of riparian ecosystems of intermittent rivers to changes in their hydrological regimes is not well understood. In the Pilbara region of northwest Australia, streams flow only occasionally, reflecting a highly dynamic and extremely variable cycle of prolonged droughts punctuated by occasional floods. However, discharge of ground water pumped from mining activities over recent years has resulted in localised areas with constant surface water. We expected that prolonged saturation would affect the health and functioning of two co-occurring eucalypts (*Eucalyptus camaldulensis* and *Eucalyptus victrix*) through reduced stomatal conductance and more negative leaf water potential, resulting in canopy sparseness and changes in stable isotope (δ13C, δ15N and δ18O) and nutrient (N and P) composition.

Trees (n=26) were assessed at two sites with artificially permanent surface water (discharge sites) and compared to trees (n=21) at a site with a naturally occurring permanent groundwater fed pool ('reference site'), from the stream bed, the lower bank and the upper bank. Soil redox potential, an indicator of oxygen availability and other soil chemistry conditions, was measured with platinum redox probes at 25 cm depth. Bank trees did not differ between the discharge and reference sites by any measure. However, trees positioned in the stream bed at discharge sites were exposed to severely reduced soil redox potential (median = -189 mV) compared to trees growing on the lower (90 mV) or upper bank (188 mV). Trees in the stream bed were clearly separated from upper or lower bank trees using principle components analysis (PCA) for all measured attributes. Canopy cover, δ13C and δ18O contributed most to separating the groups. Canopy cover in stream bed trees was 41% and 52% sparser compared to bank trees at discharge and reference sites, respectively. Stream bed tree leaves had more enriched δ13C values but more depleted δ18O values, indicating leaf gas exchange with the atmosphere was more restricted than for the trees on the bank. Overall, we conclude that artificially constant surface water expression significantly changed environmental conditions in the stream bed and the effect on riparian eucalypt trees was highly localised.

POSTER 17

DRY-REWETTING CYCLES REGULATE WHEAT RHIZODEPOSITION AND STABILISATION IN SOIL

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The intensity of soil drying and rewetting is predicted to increase in the next decades. These events may have a strong impact on soil carbon (C) cycling, especially in the rhizosphere where plant-microbe interactions are intense. However, the direction and magnitude of these impacts are still unclear.

The aim of this study was to investigate the effect of drying rewetting cycles on soil C pools and their C fractions derived from rhizodeposition. We grew wheat in pots maintained at constant moisture (CM) and under drying rewetting cycles (DR) for 64 days in a growth chamber. We also included pots without plants. The CM treatment was maintained at 60% water holding capacity (WHC) while in the DR treatment the drying phase lasted 21 days, at the end of which pots had reached 30% WHC and were rewetted to 60% WHC, with a total of three drying-rewetting cycles during the whole experiment. Pots were destructively harvested one day before and one after each rewetting phase (total of 6 harvests). Pots were incubated in $^{13}CO_2$ depleted atmosphere in order to quantify C derived from plants.

The fraction of plant derived C (PDC) in microbial biomass C (MBC) increased with time in the CM treatment, which was closely related to the increase in plant biomass ($R^2 = 0.76$, $P < 0.001$). In the DR treatment no such relationship was found, because the fraction of PDC in MBC dropped after every rewetting phase ($P < 0.05$). Moreover, the total amount of PDC in MBC expressed per gram of root biomass decreased by 55% after rewetting (averaged across the three drying-rewetting cycles), but increased again during the drying phase reaching levels equal or greater than in the CM treatment. The contribution of PDC in soil mineral associated C (most stable C) was higher in the CM than in DR treatment ($P < 0.001$), but this difference was due to a greater plant biomass in the CM treatment, and disappeared when values were corrected for biomass.

We conclude that drying rewetting cycles can strongly influence rhizodeposition and its stabilisation in soil. The length and intensity of the drying phase are crucial factors in the production and stabilisation of rhizodeposition.

POSTER 18

LONG TERM FERTILISAION OF N BUT NOT P CAN ENHANCE MICROBIOAL BIOMASS AND ENZYME ACTIVITY IN ARID ZONE MANGROVE SEDIMENTS

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Mangroves are considered one of the most efficient ecosystems in terms of carbon sequestration, despite growing in some of the most nutrient poor environments worldwide. However, coastal development, catchment modification and extreme weather events that transport nutrients from catchments to coasts may expose mangrove forests to higher nutrient levels. Nitrogen (N) and phosphorus (P) additions are known to increase aboveground productivity and modify N-cycling processes although most studies worldwide have focussed on tropical ecosystems of high productivity. In the arid zone, pulses of nutrients resulting from cyclones may be particularly important for the maintenance of productivity. However, the influence of nutrient additions on microbial processing of carbon in sediments is unknown. Here, I assessed the responses of the sediment microbial community to long-term additions of N and P fertilisers. Study sites were focussed on contrasting *Avicennia marina* communities (shoreline and inland scrub), in the Exmouth Gulf of Western Australia. Shoreline mangrove communities were taller, denser and more productive, while scrub mangrove communities were smaller and relatively less productive. We measured soil organic matter (OM) and nutrient contents and $\delta^{13}C$ and $\delta^{15}N$ values of the sediment at three depth intervals (0-1cm, 1-4 cm, and 4-10 cm). Measurements were coupled with estimates of microbial biomass and enzyme activities in order to relate biogeochemistry to microbial activity. Nitrogen fertilisation enhanced microbial N and P biomass and enzyme activity at the inland scrub but not at the shoreline. Sediment characteristics were altered by the N treatment at the inland scrub, where $\delta^{15}N$ was depleted in the top cm, C:N was lower and OM (%) higher. It is likely N-fixing algal growth has contributed to lowering the $\delta^{15}N$ signature and an increase in labile leaf litter has increased OM content and lowered C:N. P fertilisation, however, reduced enzyme activity and OM content but had no effect on microbial N and P biomass. These findings suggest that long term fertilisation with N in inland scrub communities can increase microbial biomass and enzyme activity via OM inputs.

POSTER 19

NITROGEN INPUT VIA LITTER DEPOSITION IN TWO SILVOPASTURE SYSTEMS

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Legume trees have potential to add N to silvopasture systems alleviating N deficits commonly found in C_4-dominated grasslands. This research aimed to quantify N inputs via litter of legume trees in a silvopasture system.

Treatments were: i) signal grass (*Brachiaria decumbens* Stapf.) + *Mimosa caesalpiniifolia* Benth.; ii) signal grass (*Brachiaria decumbens* Stapf.) + *Gliricidia sepium* (Jacq.) Kunth ex Walp. A complete randomized block design was used with four replications per treatment. Legumes were established in July 2008 and planted in double rows (10 x 1 x 0.5 m) in an existing signal grass pasture. Each experimental unit measured 660 m^2 (33 x 20 m). Litter deposition was quantified every 28 d during 13 consecutive months (April 2012 – April 2013). Samples were collected using 40 quadrats (0.5 m^2) in each experimental unit. Quadrats were placed at five equidistant points in eight different transects perpendicular to the tree line in each experimental unit. Litter N and N derived from the atmosphere (%Ndfa) were determined using the natural abundance technique (Shearer & Kohl, 1989).

Litter N averaged 22.4 and 18.6 g kg^{-1} with 60.3 and 54.1% of Ndfa for Gliricidia and Mimosa, respectively. This resulted in an addition of 69.5 and 48 kg ha^{-1} yr^{-1} Ndfa for Gliricidia and Mimosa, respectively. Therefore, litter can be a significant N input pathway in a silvopasture system. Further research is needed to quantify the proportion of N internally recycled and the total N annually fixed by the tree legumes. In addition to these N inputs, silvopasture benefits include the increase of net profit by selling timber, provision of shade for livestock, and C sequestration.

REFERENCES

Shearer G. Kohl D.H. 1986. N_2-fixation in field settings: estimations based on natural ^{15}N abundance. Australian Journal of Plant Physiology, Melbourne, 13:699-756.

POSTER 20

^{31}P-NMR ANALYSIS SHOWS PHOSPHATE MONOESTERS DOMINATE ORGANIC P POOL IN OLIGOTROPHIC SEAGRASS SEDIMENTS

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Changes in phosphorous (P) availability can have distinct impacts of primary productivity and ecosystem function, particularly in coastal ecosystems where P is a limiting nutrient. The organic P pool is particularly important in low-P ecosystems, and can directly support primary productivity through processes such as microbial mineralization. Here, we use sequential extractions and ^{31}P nuclear magnetic resonance (^{31}P-NMR) to determine changes in the abundance and types of sedimentary P across a salinity gradient in Shark Bay – a coastal marine embayment with a strong salinity and P availability gradient. Labile P concentrations did not show an expected decrease along the salinity and P availability gradient, suggesting a possible mechanism for seagrasses showing variable P content across the same gradient (Fraser *et al.* 2012). Phosphate monoesters were the only organic P fraction detectable with NMR analysis in Shark Bay sediments. While phosphate monoesters usually dominate organic P pools in oligotrophic ecosystems, the distinct lack of other organic P groups such as phosphate diesters and phospholipids is extremely unusual, and in stark contrast to similar studies in mangroves, wetlands, and tropical forests. This suggests that refractory P compounds dominate P inputs into the sedimentary pool in Shark Bay, and that labile P inputs are rapidly recycled by microbes or vegetation in Shark Bay. The quick turnover of the organic P pool may support primary productivity in this iconic P-limited ecosystem.

REFERENCES

Fraser M.W.F Kendrick G.A. Grierson P.F. Fourqurean J.W. Vanderklift M.A. Walker, D.I. 2012. Nutrient status of seagrasses cannot be inferred from system-scale distribution of phosphorus in Shark Bay, Western Australia. Marine and Freshwater Research 63: 1015–1026.

POSTER 21

DETECTING MARINE SUBSIDIES IN STREAM COMMUNITIES: ENDANGERED SEABIRDS, SEALS AND A SUBANTARCTIC ISLAND

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Seabird colonies and other coastal organisms such as seals were once ubiquitous throughout New Zealand. Human-induced habitat degradation, predator introduction and fishing have greatly restricted the current distribution of these colonies. Throughout their existence, the seabird colonies provided decades of nutrient subsidies to the terrestrial environment, principally through guano deposition. These seabird derived marine subsidies are known to be important in the terrestrial environment, but their importance to freshwater ecosystems has been less studied. Even less is known of the role other land breeding marine organisms such as seals may play in coastal freshwater ecosystems.

Carbon ($^{13}C/^{12}C$) and nitrogen ($^{15}N/^{14}N$) isotope ratios ($\delta^{13}C$ and $\delta^{15}N$, respectively) are a tool often used in marine subsidy research, as $\delta^{15}N$ and $\delta^{13}C$ are typically elevated in marine ecosystems. We sampled soils, plants and benthic communities in streams in five contrasting ecosystems and use mixing models to test for the presence of marine isotopic enrichment. We present the first analysis of freshwater fauna stable isotope data from a Subantarctic island (Campbell Island), the rare alpine breeding Hutton Shearwater (*Puffinus huttoni*) colony in the inland Kaikoura ranges, an extinct seabird colony in Canterbury and a New Zealand fur seal (*Arctocephalus forsteri*) pup rearing stream in Kaikoura. We also test for historical seabird nutrient legacies in abandoned seabird colony streams adjacent to colonies of the rare Westland Petrel (*Procellaria westlandica*) near Punakaiki and in an extinct seabird colony in Canterbury.

REFERENCES

HARDING, J. S. Hawke, D. J. Holdaway, R. N. Winterbourn, M. J. **2004.** Freshwater Biology 49: 576-586
HAWKE, D.J. WU, J-R. 2012. Soil Research 50:588-595
HOLDAWAY, RN. 1989. NEW ZEALAND JOURNAL OF ECOLOGY 12:11-25
RICHARDSON, J.S. ZHANG, Y. MARCZAK, L.B. 2010. River Research and Applications 26:55-66

POSTER 22

$\delta^{13}C$ OF LEAF LITTER BIOFILMS OF PERSISTENT POOLS OF AN EPHEMERAL DRYLAND STREAM

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Leaf litter biofilms are mainly composed of algae, bacteria, fungi and microfauna embedded within an extracellular polysaccharide matrix. While biofilms are acknowledged as playing a fundamental role in carbon and nutrient cycling in streams, biofilms in Australian dryland streams remain largely undescribed and unquantified. We sought to characterise biofilm communities and their substrate types across a range of living, intact and decomposing litter of riparian vegetation and an aquatic macrophtye (*Melaleuca argentea, Eucalyptus sp.* and *Potamogeton sp.*). We sampled litter and associated biofilms from three persistent pools of an ephemeral stream in the Pilbara region of northwest Australia. Leaf litter and biofilm carbon and nitrogen stable isotope signatures in conjunction with elemental ratios and lignin and cellulose content were used to assess (i) how leaf litter quality varied and (ii) if litter was being assimilated by microbial biofilms. We found that leaf litter quality (as C/N rand C/N/P ratios) differed among species, where *M. argentea* < *Eucalyptus* < *Potamogeton*. Leaf litter $\delta^{13}C$ of *M. argentea* and *Eucalyptus* ranged from -32.5 to -31.0 ‰, while $\delta^{13}C$ of associated biofilms ranged from -32.5 to -31.0 ‰. In contrast, *Potamogeton* litter had $\delta^{13}C$ values from -29.8 to -29.6‰ while $\delta^{13}C$ of associated biofilms ranged from -25.8 to -22.2‰. Biofilm $\delta^{15}N$ were ~ 0.8 ‰ more enriched on terrestrially derived leaf litter but did not differ between *Potamogeton* leaves and biofilms. We conclude that *Potamogeton* biofilms are using other resources within their environment, most likely nutrients from the water column but also "priming" from algae. Ongoing research is now using metagenomic techniques to further understand functional difference among litter biofilms.

POSTER 23

DROUGHTS, FLOODS AND GROUNDWATER INTERACT TO CONTROL ORGANIC MATTER BIOGEOCHEMISTRY OF INTERMITTENT STREAMS

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Dissolved organic matter (DOM) plays fundamental roles in aquatic ecosystems, including maintenance of foodwebs and biogeochemical cycling of carbon and nutrients. However, the sources and composition of DOM remain poorly described, especially in intermittent streams of the arid zone, where cycles of flood and drought strongly influence hydrochemistry. In this study, we used $\delta^{18}O$ and $\delta^{2}H$ values of surface water and groundwater together with DOM fluorescence excitation-emission spectroscopy to identify: (i) the origin and extent of evaporation of pool water, and (ii) the concentration and chemical composition of DOM in relation to evaporation across four intermittent streams in the Pilbara region of northwest Australia. We found that pool water $\delta^{18}O$ varied from -8 to +13‰ and $\delta^{2}H$ -59 to +35‰, while groundwater $\delta^{18}O$ was approximately -8.5 ‰ and $\delta^{2}H$ -55‰ across all catchments. More enriched values (e.g. $\delta^{18}O$ >-3‰) indicated pool evaporation as groundwater or shallow alluvial water inputs decreased with time since flooding. Parallel factor analysis (PARAFAC) revealed that DOM fluorescence in pools was generally dominated by humic-like components, most likely derived from terrestrial organic matter. However, protein-like components were often the major contributor to total DOM fluorescence where pools were highly influenced by alluvial water inputs, suggesting greater autochthonous (algal and bacterial) contributions. While DOM fluorescence was linearly related to $\delta^{18}O$ and $\delta^{2}H$ values, this relationship was highly variable and strongly influenced by inputs of DOM during flood pulses and flushing of pools by alluvial water in the mid dry season. Our study reveals that floods and alluvial throughflow control the composition of DOM, while evaporation during the intervening drought periods determine concentrations of DOM.

POSTER 24

TRACKING CARBON FLUXES THROUGH BOREAL SOILS

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Carbon stocks in boreal forests soils alone are estimated at 470 Gigatons. Boreal forests are expected to face large temperature increases in the next century, as compared to other ecosystems. This will have a significant impact on forest composition and its carbon balance. Northward migration of the entire boreal biome is predicted and, within the main boreal forest, deciduous trees will replace evergreens. The main objective of our research is to assess how this vegetation shift may affect the overall storage and stability of boreal soil carbon.

Our work focuses on the boreal mixed wood landscape of western Canada, which consists of a mosaic of deciduous (mostly aspen)- and coniferous (mostly white spruce)-dominated stands. A series of laboratory and field incubations is being conducted using a range of ^{13}C-labelled substrates to follow the fate of plant litter as it is processed by the soil microbial communities. Specifically, incubation of ^{13}C-labelled aspen litter (leaves, roots, twigs) in spruce soils allows us to quantify effects of vegetation shifts. Carbon assimilation by microbes is tracked by isotope probing of phospholipid fatty acids, and evolved ^{13}C-CO_2 and total CO_2 measurements are used to quantify carbon utilization efficiency and overall carbon stability.

Results to date indicate that soils under aspen and spruce harbor functionally distinct microbial communities that diverge in their carbon utilization pathways, even for simple labile (i.e.; ^{13}C-glucose) compounds. Furthermore, it appears that the community under spruce is less diverse but more active in assimilating ^{13}C-labelled aspen litter. Results from this research will help enhance the global soil carbon projections of earth system models, which are singularly lacking in their simulation of microbial processes.

POSTER 25

DIFFERENCES IN NITROGEN DYNAMICS BETWEEN FRINGE AND BASIN MANGROVES IN THE SOUTHEAST COAST OF BRAZIL

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Fringe and basin mangroves are the main types of mangrove stands in Americas. Aiming to contribute to the knowledge about the functioning of mangrove ecosystems that can be useful to predict impacts of nitrogen (N) enrichment in mangrove areas, we investigated possible differences in N dynamics between fringe and basin mangroves in the southeast coast of Brazil. We tested the hypotheses that the less nutrient limited and more productive mangrove type (fringe compared to basin) would exhibit: (1) higher net rates of N mineralization and nitrification in sediment, and (2) higher $\delta^{15}N$ in the sediment-plant-litter system, compared to basin.

We collected samples of mature leaves, leaf litter, and sediment (0-10 cm depth) in fringe and basin mangrove stands in the State Park of Ilha do Cardoso, São Paulo state and measured their N isotopic signature and the net rates of N mineralization and nitrification in the sediment.

The net N mineralization rate was higher in the fringe (0.625 $mg.kg^{-1}.d^{-1}$) compared to the basin (0.287 $mg.kg^{-1}.d^{-1}$) while there were no differences in net nitrification rates between the mangrove types (fringe= 0.0047 $mg.kg^{-1}.d^{-1}$; basin= 0.0098 $mg.kg^{-1}.d^{-1}$). The $\delta^{15}N$ in the sediment-plant-litter system was higher in the fringe (sediment= 3.73‰, leaf litter= 3.36‰, plant= 3.61‰) than in the basin (sediment= 0.79‰, leaf litter= 0.07‰, plant= 0.79‰).

Fringe stands exhibited higher N availability and rates of N transformation in the sediment, and a greater importance of N inputs and outputs in relation to internal cycling compared to basin mangroves. In short timescales, N enrichment may impose greater alterations in the functioning of basin mangroves.

POSTER 26

IMPACTS OF EXOTIC C4 GRASS INTRODUCTIONS ON SOIL CARBON CYCLING IN C3-DOMINATED FOREST SYSTEM IN CENTRAL BRAZIL

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The soil C capture capacity and organic matter turnover rate vary according to photosynthetic pathways; therefore the evaluation of C at sites suffering changes from C3 to C4 vegetation is crucial to identify impacts of land use change on C cycle. Changes in the $\delta^{13}C$ values of soil organic C reflect soil organic matter turnover rate, and provide insight regarding the functional role of tropical ecosystems in the global C cycle.

Tropical forest ecosystems in the Cerrado Biome (Brazil) are protected by law since they are closely associated with headwater streams. However such ecosystems have been widely converted in other land uses, especially pastures using African C4 grasses (*Brachiaria* sp.), in the last decades.

This study aimed to evaluate C storage under natural forest ecosystems (gallery forests) and pastures, and soil C dynamics using carbon isotope ratios to identify the origin of soil C as well as the organic matter turnover. The contribution of each type of vegetation (C3-C4) to total percentage organic C up to 0.30 m depth was estimated using mixing model for 2 sources.

More soil carbon is storage in the pasture than in the forest soil up to 1.0 m depth. Soil $\delta^{13}C$ ranged between -27.0‰ at the topsoil and -21.7‰ at 1.0 m depth at forest site while $\delta^{13}C$ ranged between -16.0‰ and -15.2‰ along the soil profile at the pasture sites. Over a period of a decade these managed pastures replaced more than 70% of the C fixed by C4 carbon, indicating that C4 vegetation has a relatively faster turnover rates and that C storage are actually fixed by the new vegetation. The findings of this study are consistent with other studies in estimating soil carbon stocks changes as well carbon turnover rates due to land use changes in different tropical ecosystems.

POSTER 27

MYCO-HETEROTROPHY IN A SELECTION OF WESTERN AUSTRALIAN ORCHIDS

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The Western Australian flora – is one of the renowned hotspots in plant diversity on Earth and the Orchidaceae is one of the largest and most diverse plant family. The orchids of Western Australia with over 400 recognized taxa of which 76 are declared Rare or Priority Flora and their ecology are the topic of this project.

C and N stable isotope natural abundances in leaves of selected orchids and reference plants and a linear two-source mixing model were used to investigate different nutrition modes on a broad range of taxonomic orchid groups in Western Australia. Myco-heterotrophic plants are characterized by a strong enrichment in the heavy isotopes (^{15}N, ^{13}C) in comparison to the reference plants from the same habitat. This typical isotope signature results from the organic nutrient gain through their mycorrhizal association. Furthermore, mycorrhizal fungi from specific parts of the orchid roots were identified by molecular DNA analysis.

Data from this investigation provide evidence that at least four nutritional modes can be found among orchids from Western Australia: (1) green species fully autotrophic when adult (e.g. *Caladenia latifolia*), (2) achlorophyllous species fully mycoheterotrophic throughout their life cycle (e.g. *Gastrodia lacista*), (3) green species gaining organic N through the fungal source (e.g. *Prasophylum elatum*) and (4) green species transferring carbohydrates to their fungal partners (e.g. *Corybas recurvus*).

REFERENCES

Sommer J. Pausch J. Brundrett M.C. Dixon K.W. Bidartondo M.I. Gebauer G. 2012. Limited carbon and mineral nutrient gain from mycorrhizal fungi by adult Australian orchids American Journal of Botany 99**:** 1133-1145.

Abstracts

Poster Session 2

TOWARDS MORE ROBUST STABLE ISOTOPE TECHNIQUES IN ECOLOGY

28	Sam Barker	Natural abundances of C, H, N, O and S.
29	Sarah Bury	Elemental analyser modifications to measure isotopic values of nanomolar quantities of nitrogen
30	Sarah Bury	Stable isotope analytical issues associated with high lipid-content organisms: a focus on ceteceans and notothenioid (anti-freeze) fish
31	Douglas Ford	Reference material selection versus analytical accuracy in $\delta^{13}C$ of DOC analyses using LC-Isolink
32	Brian Hayden	Isobank – a stable isotope data repositiory
33	Natasha Kreitals	Deuterium turnover in Lake Sturgeon blood: Does diet matter?
34	Carolyn M. Kurle	Marine-derived contamination in the diets of California condors: Combining toxicology and stable isotope analysis
35	Laura McLean	Deciphering the sulphur cycle: Geochemical processes controlling the origin of dissolved sulphate in aqueous environments of the Hamersley Basin, Western Australia
36	Tamsin C. O'Connell	Insights into chimpanzee feeding behaviour from faecal isotopic analysis
37	Katie Quaeck	Eye lenses: A window to cryptic life history behaviours
38	David X. Soto	A call for routine lipid extraction from animal tissues used for stable hydrogen isotope measurements
39	Kyle William Robert Taylor	Introducing the new EcoVisION from Isoprime Limited, a complete solution for ecological IRMS research
40	Rosemarie Weigt	Advances in the simultaneous measurement of ^{18}O and ^{13}C by pyrolysis
41	Xiang Xu	An indicator of water availablity: Leaf $\delta^{13}C$ of two typical C_3 tree species of South Australia

POSTER 28

NATURAL ABUNDANCES OF C, H, N, O AND S.

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Significant gaps in the literature exist overviewing the natural isotopic ranges for the common light stable isotopes. In order to fill this gap, a review was conducted of existing data on the different isotopes of functional reservoirs and compiled in order to create the graphs of isotopic abundances. Here we present graphically the data derived from the literature review. The data demonstrates the extensive naturally occurring range of the isotopes of C, H, N, O and S. Whilst this poster is based on preliminary data and was compiled in a short time frame and therefore may be subject to future amendments, it is an advancement in the literature on stable isotopes. This unique review and collation of data will prove to be an immensely beneficial and practical learning device.

POSTER 29

ELEMENTAL ANALYSER MODIFICATIONS TO MEASURE ISOTOPIC VALUES OF NANOMOLAR QUANTITIES OF NITROGEN

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Standard analytical systems for measuring nitrogen (N) isotopic values in organic material typically require a minimum of 20-50 µgN of material to achieve accurate and precise isotopic data. Using a Flash2000 elemental analyser with zero-blank autosampler linked to a DeltaVPlus IRMS (Thermo Fisher Scientific, Bremen, Germany) we are now routinely analyzing N content and $\delta^{15}N$ values in samples down to 5µgN with an accuracy and precision of 0.2‰. This enables us to easily analyse N isotope values in carbonate-rich sediments, filtered open ocean phytoplankton samples and individual micro-invertebrates.

We are now applying further modifications to the hardware and analytical software to push the detection limit to less than 1µgN. This will have important applications to research requiring isotopic analysis of single specimens of very small organisms (e.g. phytoplankton, invertebrates, nematodes, bacteria, viruses). Such analyses will enable us to tease out what have previously been community level isotopic signatures adding extra levels of detail to trophic information at the base of food webs. In addition, analysis of protein microlayers in shells, otoliths and megafaunal teeth will open up new possibilities of fine scale chronological sampling, enabling us to trace ecological changes back in time in more detail than before.

POSTER 30

STABLE ISOTOPE ANALYTICAL ISSUES ASSOCIATED WITH HIGH LIPID-CONTENT ORGANISMS: A FOCUS ON CETECEANS AND NOTOTHENIOID (ANTI-FREEZE) FISH

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An extended stable isotope study of the Ross Sea ecosystem has resulted in over 5000 analyses of multiple fish species and humpback whales. Ross Sea fish are dominated by a single family, the notothenioids, which characteristically lack swim bladders and attain increased buoyancy by reducing skeletal mineralisation and concentrating lipid deposits in their tissues: examples being Antarctic toothfish (*Dissostichus mawsoni*), Patagonian toothfish (*Dissostichus eleginoides*), Antarctic silverfish (*Pleuragramma antarticum*), and icefish (*Chionobathyscus dewitti*). Antarctic toothfish are particularly lipid-rich, commonly with 10-30% of their body mass derived from lipids. Muscle samples from these lipid-rich fish, along with whale skin and blubber biopsies (which also include cetaceans from New Zealand waters), have presented difficulties with regard to effective lipid extraction, mass spectrometry analysis and bulk isotope data corrections. We discuss the sample processing and analytical challenges we have encountered obtaining reproducible fully lipid-extracted material, the effects of the lipid extraction process on $\delta^{15}N$ values and the isotopic corrections we have developed in order to generate reliable $\delta^{13}C$ values for bulk tissue analyses.

POSTER 31

REFERENCE MATERIAL SELECTION VERSUS ANALYTICAL ACCURACY IN $\delta^{13}C$ OF DOC ANALYSES USING LC-ISOLINK

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The development of laboratory standards for compound-specific stable isotope analyses can be challenging owing to the analytical limitations of instruments used to process primary reference materials. Several studies have demonstrated that chemical matrix matching between standards and analysed samples is needed to reduce analytical uncertainty, especially where sample matrix is very different to the primary reference. This can be the case for dissolved organic carbon compounds (DOC) directly analysed in liquid phase (e.g. using IsoLink, Thermo Fisher Scientific).

The major anchors for updated VPDB for referencing the stable carbon isotope composition are LSVEC and NBS19. However, as neither of these is an organic standard they do not match the chemical matrix of DOC. Alternatively, the preparation of standard solutions of carbonates is also challenging and may introduce additional high uncertainty of results.

In our study we evaluated reproducibility, linearity, memory effect, detection limit and efficiency for δ13C DOC analysis on IsoLink. We also evaluated which international secondary reference materials (IAEA600, USGS41, USGS40, CH6, IAEA601) are suitable for direct use in water solution for δ13C DOC on IsoLink analyses.

We found that the general reproducibility of IsoLink is high (<0.20, 1 st.dev) for simple compounds such as benzoic acid, glutamic acids and even carbonates. In contrast the reproducibility was low for compounds containing aromatic rings such as caffeine. We conclude that solutions of USGS41, USGS40, CH6, IAEA 601 can be used for direct normalization of DOC results to VPDB scale but not IAEA600.

The linearity effect is also small if the sample has signal >1.5V, which is the equivalent of 10 mg C L-1. Memory effect was also negligible (below the level of reproducibility) even after consecutively analysing samples with highly contrasting $\delta^{13}C$ values e.g., -29‰ and +37‰.

POSTER 32

ISOBANK – A STABLE ISOTOPE DATA REPOSITIORY

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The use of stable isotopes to address questions in biology, ecology and evolution has steadily increased in recent decades. Stable isotope analysis is now a standard part of research projects spanning terrestrial plants to marine megafauna. As a consequence, the amount of isotope data held by researchers is increasing rapidly. However, most of this data is solely used to address a particular question and subsequently remains stored in a researcher's personal archive.

In other fields, notably genetics, such data is stored on repository websites and made available to a wider research community. We believe that such a resource would be of great benefit to isotope ecologists. A stable isotope data repository would facilitate metanalyses of existing data and allow researchers to conduct continental or global scale investigations without the costs associated with sample collection and anlaysis. To this end, we have established IsoBank, an online repository for stable isotope data (www.isobank.org).

IsoBank is designed to hold data for all widely used isotopes ($\delta^{13}C$, $\delta^{15}N$, δD, $\delta^{18}O$ and $\delta^{34}S$) and can be accessed by anyone who registers on the website. All data held on the site must be uploaded by users and data files are assigned a unique ID which will be cited in subsequent publications. Thus the service will both increase the scope for stable isotope based studies and ensure that users who contribute data are recognised in future publications incorporating their work.

Brian will be available throughout the meeting to display the website and provide demonstrations. This project is still in its infancy and we are keen to get comments and opinion from the isotope community. Feel free to approach Brian or Chris at any point during the week to see the site or discuss improvements.

Read this barcode with your smartphone or tablet to visit www.isobank.org

POSTER 33

DEUTERIUM TURNOVER IN LAKE STURGEON BLOOD: DOES DIET MATTER?

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The historical range of Lake Sturgeon, a North American endemic species, has declined over the last century as a result of their low fecundity and late age at maturation limiting their recovery from over fishing. The most critical threat posed to existing populations is the destruction and modification of their habitat. Of particular concern to the Saskatchewan River population are the impediments to migration. To inform management decisions in the Saskatchewan River basin, deuterium has been used to assess migration of the Lake Sturgeon population and to determine important corridors for movement. We used δ^2H analysis of blood to indicate that the South Saskatchewan River was the most probably route of the populations' annual migration. However, these data were not consistent with muscle δ^2H values and we hypothesized that this was due to differences in turnover rates of ^2H in muscle. To improve the interpretation of the δ^2H analysis we conduct two laboratory experiments on tissue turnover of ^2H in Lake Sturgeon blood. In the first experiment we changed the δ^2H value in the water to measure the influence of ambient water δ^2H on blood. The half life of ^2H in the blood was approximately 38 days and indicative of short-term habitat associations. In the second experiment we changed the δ^2H value in the diet. After two diet switches over four months no change in the deuterium signature of the Lake sturgeon blood was observed. These findings indicate that for Lake Sturgeon the deuterium signature in the environmental water, and not that in the diet, is more influential to the deuterium signature in their blood. The use of δ^2H values in assessing the migration of sturgeon that move among water bodies differing in δ^2H values is now a feasible means of assessing stock movements and origins in this endangered species.

POSTER 34

MARINE-DERIVED CONTAMINATION IN THE DIETS OF CALIFORNIA CONDORS: COMBINING TOXICOLOGY AND STABLE ISOTOPE ANALYSIS

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Many factors are thought to limit the recovery of the critically endangered California condor (*Gymnogyps californianus*) including contaminant exposure from foraging on beach cast marine mammals. This threat will likely escalate as the growing condor population in coastal central California is predicted to increase their reliance on beach cast marine mammals as a food source and marine mammals contain high levels of bioaccumulating contaminants (mercury, PCBs, DDTs). To investigate risk from marine contamination, we evaluated markers for foraging behavior (observational data and carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope ratios) as well as contaminant concentrations in condor blood from free-ranging condors in California.

Behavioral data indicate that condors in central California forage on marine mammals, whereas condors in southern California forage exclusively on terrestrial animals. The mean $\delta^{15}N$ and $\delta^{13}C$ isotope values (±SD; ‰) from whole blood collected from these birds were significantly different (t-tests, df = 42, $p<0.01$ for both), supporting a dietary divergence between the central and southern California flocks. Condors in central California (n=34) forage at higher trophic levels ($\delta^{15}N$ = 10.1±0.2) and ingest greater amounts of marine derived carbon ($\delta^{13}C$ = -21.7±0.2) than condors in southern California (n=10) ($\delta^{15}N$ = 7.6±0.2, $\delta^{13}C$ = -23.7±0.4). We found a significant association between mercury exposure and stable isotope values indicative of ingestion of and contamination from marine mammals. Mean total mercury (ng/g; ±SE) in blood samples from condors in central California (n=31) (150.8±39.5) was nearly two orders of magnitude higher than for condors from southern California (n=10) (2.0±0.2) (t-test, p = 0.04), indicating that condors foraging on marine mammals are also ingesting significantly greater amounts of mercury. Application of a Bayesian stable isotope mixing model (MixSIAR) to the data indicates wide variation (4 to 51%) among individual condors in their ingestion of marine mammals. We conclude that foraging on marine mammals may pose a risk to the recovery of California condors in central California. Our results highlight the challenges faced by endangered species trying to recover in a polluted environment, and they demonstrate the utility of combining stable isotope, behavioral, and toxicological analyses to determine the role of dietary choices in wildlife contaminant exposure.

POSTER 35

DECIPHERING THE SULPHUR CYCLE: GEOCHEMICAL PROCESSES CONTROLLING THE ORIGIN OF DISSOLVED SULPHATE IN AQUEOUS ENVIRONMENTS OF THE HAMERSLEY BASIN, WESTERN AUSTRALIA

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Sulphur compounds, ubiquitous in the Hamersley Basin, provide valuable insights into the hydrological and biogeochemical function of aqueous environments. The objective of this study was to distinguish between the various sources of dissolved sulphate in waters of the Hamersley Basin. Isotope geochemistry, with a focus on dissolved sulphate signatures ($\delta^{34}S_{SO4}$ and $\delta^{18}O_{SO4}$) was used to distinguish the origin of sulphate and enabled identification of water impacted by pyrite oxidation.

Sulphate is a by-product of pyrite oxidation and elevated groundwater concentrations, relative to chloride, can often represent a precursor to Acid and Metalliferous Drainage (AMD). Aqueous environments containing pyrite within subsurface material have high sulphate concentrations (>1000 mg/L) and low $\delta^{34}S_{SO4}$ signatures (+1.2‰ to +4.6‰) which are similar to the signature of solid pyritic rock samples (-1.9‰ to +4.4‰). Groundwater from regions without pyrite had variable sulphate concentrations and relatively enriched signatures (+10.8‰ to +16.3‰) indicating meteoric inputs and/or the presence of sulphate minerals.

Mass balance modelling of end-member signatures was used to infer recharge characteristics and decipher the processes leading to variations in the observed signatures. Isotope geochemistry was demonstrated to be a robust tool to reveal groundwater impacted by pyrite oxidation and a set of proxies was developed to categorise Hamersley waters into iso-groups, according to AMD susceptibility.

POSTER 36

INSIGHTS INTO CHIMPANZEE FEEDING BEHAVIOUR FROM FAECAL ISOTOPIC ANALYSIS

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Carbon and nitrogen isotopic values in body tissues and excreta have been analyzed to reconstruct variability in primate diet, at intra- and inter-specific level. For chimpanzees, *Pan troglodytes* sp., hair and collagen $\delta^{13}C$ values have revealed seasonality in diet and feeding canopy height, and hair $\delta^{15}N$ values have provided insights into hunting behaviour. The shorter-term dietary snapshot from faeces provides scope to investigate intra- and inter-site comparisons of primate dietary fluctuations. We investigated the potential of stable isotopic analysis of chimpanzee faecal samples, in particular, to see how findings reflect dietary intake of 10 adult chimpanzees (*P. t. schweinfurthii*) of the Kanyawara community in Kibale National Park, Uganda over a 6-month period (June-December 2008). Seasonal differences found in $\delta^{13}C$ and $\delta^{15}N$ values coincide with seasonal changes recorded in observed feeding on C_3 evergreen forest vegetation at the group but not individual level. Our findings lead us to consider the potential contribution of high-resolution faecal isotopic data to dietary assessment compared to the resolution available from other possible samples such as hair.

POSTER 37

EYE LENSES: A WINDOW TO CRYPTIC LIFE HISTORY BEHAVIOURS

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The crystalline lens of the vertebrate eye is an acellular, incrementally grown protinaceous structure, which has the potential to serve as a chronological record of chemical information covering the organism's whole life history. Despite the potential to document ontogeny biochemically, eye lenses have received relatively little analytical attention.

Here we review the structure, composition and growth of the vertebrate eye lens and present a novel method for recovering sequential samples of eye lens proteins for stable carbon and nitrogen isotope analyses. Using pilot data from the porbeagle shark (*Lamna nasus*) and black scabbard fish (*Aphonopus carbo*), we demonstrate faithful recovery of expected ontogentic variations in isotope ratios, consistency in isotopic values between individuals, and consistent differences in isotopic compositions between species. We report tissue-specific isotopic offset effects between lens, muscle and collagen samples, and explore the potential for eye lenses as a log of life-long diet and spatial ecology in migratory fish species.

REFERENCES

Bloemendal, H., de Jong, W., Jaenicke, R., Lubsen, N. H., Slingsby, C., & Tardieu, A. (2004). Ageing and vision: structure, stability and function of lens crystallins. *Progress in Biophysics & Molecular Biology*, *86*, 407–485

POSTER 38

A CALL FOR ROUTINE LIPID EXTRACTION FROM ANIMAL TISSUES USED FOR STABLE HYDROGEN ISOTOPE MEASUREMENTS

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Stable hydrogen isotopes (δ^2H) of tissues are useful tools for animal migration and trophic studies in aquatic and terrestrial ecosystems (Soto et al. 2013). However, δ^2H measurements of organism tissues have faced several analytical issues mainly associated with uncontrolled isotopic exchange between sample and ambient water vapour. Fish muscle, composed of protein and a significant proportion of lipids, is a tissue commonly sampled for stable isotope measurements in aquatic studies. C-H bound hydrogen in lipids are not exchangeable with ambient H_2O and are very depleted in ^{2}H relative to the protein component, which does exchange H atoms (Wassenaar and Hobson 2000). The variable content of ^{2}H-depleted lipids in most animal tissues requires their removal prior to H isotopic analysis, but published methods show inconsistency in this practice. We found a significant proportion of isotopic uncertainty is associated with untreated bulk tissue δ^2H analysis, and significant difference in δ^2H values between bulk and lipid-extracted samples were related to variable lipid content. To ensure comparable and traceable isotope-ratio determination of non-exchangeable δ^2H in ecology, we recommend that laboratories consider incorporating lipid removal procedures for affected samples of interest.

REFERENCES

Soto D.X. Wassenaar L.I. Hobson K.A. 2013. Stable hydrogen and oxygen isotopes in aquatic food webs are tracers of diet and provenance. Functional Ecology 27: 535-543.

Wassenaar L.I. Hobson K.A. 2000. Improved method for determining the stable-hydrogen isotopic composition (δD) of complex organic materials of environmental interest. Environmental Science and Technology 34: 2354-2360.

POSTER 39

INTRODUCING THE NEW ECOVISION FROM ISOPRIME LIMITED, A COMPLETE SOLUTION FOR ECOLOGICAL IRMS RESEARCH

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We present the very latest in Isotope Ratio Mass Spectrometer (IRMS) technology from Isoprime Ltd, the completely new VisION, an IRMS platform designed with the application-specific requirements of the prospective user at the heart of its design. As an applications-focused platform, we will specifically present the benefits of our ecological-research focused bundle, the EcoVisION.

From our position as a dedicated and leading global supplier of IRMS instrumentation, we have carefully evaluated how today's scientists use IRMS in the modern laboratory to generate high quality isotope data, ultimately informing and developing their respective scientific community's understanding of stable isotope systems. Using this insight we believe that IRMS needs to be more accessible, more efficient and more powerful than ever before leading to the creation of a completely new IRMS experience. In particular, we find a growing interest in the power of IRMS from a wide variety of scientist's who would otherwise believe IRMS instrumentation to be inaccessible, whether due to perceived complexity of the required instrumentation, or simply believing that IRMS is too demanding in terms of investment for their laboratory. We aim to deliver the powerful tool of stable isotope analysis to these new users with a new IRMS experience whilst bringing tangible benefits to those experienced laboratories who require high powered yet fully automated IRMS for turnkey analysis; this is our vision of the future of IRMS, the VisION.

We will demonstrate how the powerful new features of VisION such as IonOS software and CentrION Monitoring Gas System will lead to a new way of working with IRMS, allowing new and experienced users alike to benefit from time and effort-saving automation features. These automation features will facilitate the high throughput demands of ecological research, maximising the efficiency with which results can be generated, without lengthy contact time with the instrument required to prepare it for such analyses. We will also demonstrate how the EcoVisION is uniquely focused upon specific ecological research solutions which will enable modern IRMS ecological scientists to generate accurate and precise results quickly with the highest confidence.

POSTER 40

ADVANCES IN THE SIMULTANEOUS MEASUREMENT OF 18O AND 13C BY PYROLYSIS

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The $\delta^{18}O$ and $\delta^{13}C$ of tree ring cellulose was measured simultaneously by pyrolysis at 1450°C with a precision of ±0.15‰ for oxygen and ±0.12‰ for carbon. Constantly high quality of $\delta^{18}O$ measurement was obtained by covering the autosampler with a Plexiglas hood and flushing with argon in order to prevent ambient humid air entering the autosampler.

Despite the high temperature and pure glassy carbon used in the reaction tube, the ^{13}C signal is lightly dampened due to C remaining in the system. Therefore, a linear correction was established through double-measurements with both, pyrolysis and the common oxygen combustion by selecting a number of samples at equidistant $\delta^{13}C$ values along the whole range of observed $\delta^{13}C$, according to Woodley et al. 2012. Further data acquisition of $\delta^{13}C$ in cellulose extending this range in $\delta^{13}C$ requires more double-measurements to obtain a reliable correction. In a measuring campaign, about 10 000 samples of 10 different sites across Central Europe were measured, that covered a range of ca. 10‰ $\delta^{13}C$. An initial reference curve was established at a minimum range of 6‰, and re-measurements of a small selection of samples after each ca. 5000 samples ensured constant quality of pyrolysis $\delta^{13}C$ data.

In a further study, whole wood $\delta^{18}O$ and $\delta^{13}C$ was measured from different tree species. Here, both isotopes showed the same precision as for cellulose. However, the ^{13}C signal varied more strongly, perhaps due to species specific wood components, and requires a different correction for the dampened signal as compared to cellulose. More test studies are needed for validating whole wood measurements by pyrolysis.

REFERENCES

Woodley E.J., Loader N.J., McCarroll D., Young G.H.F., Robertson I., Heaton T.H.E., Gagen M.H., Warham J.O. 2012. High-temperature pyrolysis/gas chromatography/isotope ratio mass spectrometry: simultaneous measurement of the stable isotopes of oxygen and carbon in cellulose. Rapid Communications in Mass Spectrometry 26: 109–114.

POSTER 41

AN INDICATOR OF WATER AVAILABLITY: LEAF $\delta^{13}C$ OF TWO TYPICAL C_3 TREE SPECIES OF SOUTH AUSTRALIA

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The carbon isotope ratio $^{13}C/^{12}C$ of leaves has been demonstrated as a useful tool to reveal the time-accumulating information of environmental conditions such as water availability. It is generally agreed that $\delta^{13}C$ value is a good climate indicator across a mean annual precipitation gradient of 300 to 1000 mm. However, most previous studies were based on one-time sampling disregarding seasonal variability and only mean annual precipitation was used as water stress indicator. Other factors regulating water availability were usually not considered. In the current study, we monitored one-year leaf $\delta^{13}C$ of selected two typical tree species, *Eucalyptus leucoxylon* and *Acacia pycnantha* in a native vegetation catchment with mean annual precipitation of 716 mm in South Australia. Under the similar micro-climate conditions with different water availability due to lithology and position of two contrasting hillslopes, we collected monthly leaf samples for carbon isotope analysis. The results show seasonal, spatial, and inter-species variations in $\delta^{13}C$. For the two species, the leaf carbon $\delta^{13}C$ shows a clear seasonal variation with a magnitude of 1.5‰. Trees on the south-facing slope have more negative $\delta^{13}C$ (about 2.5‰) and a quicker decrease in wet season than on north-facing slope because of differences in soil wetness. Also significant difference in $\delta^{13}C$ seasonal response between two species has been observed. These results suggest that leaf $\delta^{13}C$ is a good indicator of water availability which agrees with previous studies, however, rather more reflects variability in local conditions than regional climate patterns. The results also indicate that at least seasonal observations should be made for ecosystem level studies and a better water stress indicator than precipitation only is needed.

ISOSCAPES AND SPATIAL PATTERNS

42	Douglas Bearham	Cross shelf variation in the growth and stable isotope ratios of the mussel *Mytilis edulis* across a depth gradient near Perth, Western Australia
43	Jordan Iles	Spatial variation of biogeochemical tracers in dryland streams across an arid-zone catchment
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47	Yaeko Suzuki	Stable isotope ratios and trace elements compositions in seaweeds (*Undaria pinnatifida*) from Japan, China, and Korea: Interannual variations between 2011 and 2013

POSTER 42

CROSS SHELF VARIATION IN THE GROWTH AND STABLE ISOTOPE RATIOS OF THE MUSSEL MYTILIS EDULIS ACROSS A DEPTH GRADIENT NEAR PERTH, WESTERN AUSTRALIA.

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The purpose of our investigation was to use stable isotope analysis to evaluate the degree of coupling between pelagic primary production and the benthos in an oligotrophic system. We hypothesized that increasing depth would produce a greater reliance on pelagic primary production rather than benthic production. Common blue mussels (*Mytilus edulis*) were obtained from a bivalve hatchery and deployed to nine sites across the south-western Australian continental shelf at depths of 3 m, 5 m, 10 m, 15 m, 20 m, 25 m, 30 m, 35 m and 40 m. Deployments occurred in the Austral summers of 2008/2009 and 2009/2010. After three months, the mussels were retrieved and morphometric and stable isotope measurements were obtained. Monthly water quality measurements for particulate organic matter (POM), Chlorophyll a, POC and stable isotopes ($\delta^{13}C$ and $\delta^{15}N$) were also obtained.

All *M. edulis* showed the same pattern of decreasing isotopic values with water depth from the coast to offshore. The 3 m to 10 m sites had $\delta^{13}C$ between -21‰ to -18‰ in contrast, sites from 15 m to 40 m had $\delta^{13}C$ -21.5‰ to -23.5‰. POM $\delta^{13}C$ correlated strongly with *M. edulis* $\delta^{13}C$ values (2008/09: R^2=0.86; 2009/10 R^2=0.93) and growth (2008/09 R^2=0.87; 2009/2010 R^2=0.87). POM concentrations were not predicted by chlorophyll a concentrations suggesting phytoplankton concentrations were not driving variability in POM values. During the 2009/10 sampling period POM δ13C ratios were positively correlated with POC:chl a. However, in 2008/2009 no clear relationship was observed.

We found no evidence of selective feeding by *M. edulis* in this trial. Sites from 20 m-40 m exhibited similar mussel growth characteristics and a similar relationship between phytoplankton composition and POM concentrations. These data suggest the primary production utilized by the suspension feeding *M. edulis* was changing from benthic to pelagic sources with a significant difference indicated between all sites 10 m and shallower compared to sites 15 m and deeper.

POSTER 43

SPATIAL VARIATION OF BIOGEOCHEMICAL TRACERS IN DRYLAND STREAMS ACROSS AN ARID-ZONE CATCHMENT

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Dryland streams in the Pilbara region of Western Australia are becoming progressively impacted by changes in land-use due to mining and agriculture. The processing of organic matter and nutrients within these streams may be altered due to these impacts. Streams in the Pilbara are represented by a range of hydrological regimes, and during the drier periods of the year retract to pools of variable persistence. The degree of persistence of these stream pools is somewhat dependent on pool hydrology being groundwater supplemented or evaporative in nature. These hydrological factors represent an important set of drivers controlling the dynamics of dissolved organic matter and nutrients within dryland streams. The aim of this study was to understand the relationships between hydrology and aquatic processes by investigate basin-wide patterns in the distribution of nutrients, isotopic tracers and organic matter in the aquatic system. Specifically we sought to answer to what degree of spatial variability streams in the Fortescue catchment show, and what biogeochemical parameters are most useful in explaining the variability observed?

Between May 2013 and April 2014, we surveyed dryland pools of varying size, habitat type and hydrology along a 450 km section of the Fortescue River of the Pilbara region of northwest Australia. Pool hydrology was investigating using stable isotopes surface water ($\delta^2H + \delta^{18}O$) and dissolved inorganic carbon ($\delta^{13}C$-DIC). Major components of dissolved organic matter (DOM) present in pools were assessed by the construction of excitation-emission matrixes measured by fluorescence spectroscopy. Surface water samples were collected for nutrient analysis and a range of supporting physico- and bio- chemical parameters in all pools were also measured. Preliminary analyses suggest that pools are most similar to each other according to catchment position (Upper versus Lower catchments). Although we also found that more evaporated pool water (more positive $\delta^{18}O$) correlated to higher dissolved organic nitrogen (DON) concentrations (Pearson's $r = 0.72$, $P < 0.001$), and $\delta^{13}C$-DIC (Pearson's $r = 0.70$, $P < 0.001$). DOM fluorescence components also demonstrate significant variation in sources and concentrations of DOM supporting aquatic food webs. This work could potentially be applied to understand how changes to land-use affects the dynamics of organic matter and nutrient cycling.

POSTER 44

ECOHYDROGRAPHY CONSTRAINS PELAGIC ZOOPLANKTON TROPHODYNAMICS IN THE OLIGOTROPHIC RED SEA

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One of the most understudied oceans, the oligotrophic Red Sea (RS), offers a unique basin-wide study system of biogeography and biogeochemical processes due to its natural, latitudinal environmental gradient. Its ecohydrography is closely governed by atmospheric, oceanographic, and biological processes owing to monsoon-driven intrusions of Indian Ocean water, thermohaline- and eddy-induced up-welling, and fixation of N. Yet, little is known about the configuration of oceanic zooplankton food webs in the RS through bottom-up processes and the principal pathways by which zooplankton mediate macronutrients from primary producers toward higher trophic levels.

Geographic patterns in $\delta^{13}C$ and $\delta^{15}N$ signatures (isoscapes) were often attributed to divergent ^{15}N abundances in source end members such as deep water N sources with a higher $\delta^{15}N$ than N fixed by diazotrophs such as *Trichodesmium* sp. (Cyanobacteria) with typically lower $\delta^{15}N$ values. This study assessed the isotopic compositions for a broad range of zooplankton taxa mostly at the genus level and those of particulate organic matter (POM) with environmental data (salinity, temperature, chlorophyll *a*), nutrient stoichiometry (TN:TP:Si ratios), and phytoplankton composition. Samples were collected during a survey in spring 2012 following the axial trough of the RS from a site in the South off the Farasan Archipelago (16°28'N) toward the North off Duba (26°57'N). Our research questions are based on the prediction that nutrient richness across the latitudinal gradient alters the configuration of multivorous zooplankton food webs, wherein the contribution of atmospheric and diazotroph N end members with depleted $\delta^{15}N$ signatures in the diet of zooplankton decreases towards the South where the inflow of Indian Ocean water contributes N sources with a higher $\delta^{15}N$.

As predicted, the present study revealed that $\delta^{15}N$ of POM and zooplankton taxa generally increased from North to South. Bayesian mixing models indicated that contributions by nitrate-fuelled phytoplankton, POM, and diazotrophs (i.e. *Trichodesmium* sp.) to the diet of zooplankton varied among sites; with larger contributions from diazotrophs in the North, POM in the South, but phytoplankton in the central RS. Consistency in the variation among most functional groups and taxa of zooplankton with patterns of nutrients and phytoplankton composition highlights that underlying ecohydrographic features help explaining patterns in isoscapes at macroecological scale.

POSTER 45

THE IMPORTANCE OF UPWELLING TO OCEANIC TOP PREDATORS

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The role of upwelling regions in supporting high primary productivity and basal consumers is well known, but the significance of these transient effects in supporting migratory pelagic apex predators is difficult to quantify. These predators are vulnerable both to fishing pressure and environmental variation throughout their ranges, therefore determining the extent to which they rely on seasonal upwelled production is essential for their effective management and conservation. The stable isotope composition of primary production using upwelled nutrients differs from that using nutrients derived from air-sea gas exchange. Successive consumers integrate the isotopic composition of primary productivity from their feeding areas, providing a natural marker for upwelling-derived nutrients at high trophic levels.

The Gulf of Panama is subject to strong, seasonal upwelling each year, but the Gulf of Chiriquí, immediately to the northwest, is not. Spatial and temporal differences in nutrient source and upwelling strength provide isotopic contrast that can be used to test for the incorporation of upwelling-derived nutrients in both low trophic level (TL) pelagic animals (zooplankton, anchoveta, large gelatinous zooplankton, chub) and high TL fish (tuna, dorado, sierra mackerel) in each area. By relating the isotopic composition of apex predators to low TL animals, which closely integrate the isotopic values of primary production, the assimilation of upwelling-derived nutrients into tissues can be quantified. The proportional reliance of predators on upwelling zones, and the nutrient flow within these systems can be assessed from these results.

A quantitative measure of the importance of upwelling-derived nutrients to apex predators, linked to measures of variation at lower levels of the ecosystem, will enable prediction of likely responses of these predators to future variation in upwelling strength under different climate scenarios.

POSTER 46

SPATIAL DIFFERENCE IN $\delta^{15}N$ IN MUSSELS IN AN URBAN, MICRO-TIDAL ESTUARY

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Stable isotopes have widely been used to identify sources of human impact in ecosystems. Increased nitrogen concentrations in waterbodies have been associated with higher nitrogen $\delta^{15}N$ values, which can then be detected in organisms, and mussels have been identified as long-term bioindicators of such nutrient pollution. The purpose of this study was to identify the spatial variability of nitrogen concentration in an urban, microtidal estuary, and to test if $\delta^{15}N$ of the blue mussel (*Mytilus edulis*) can be used as a bioindicator of nitrogen variability in this system.

Rainfall during the study period was low, leading to high salinity throughout the estuary indicating a strong marine influence. Despite this, we found spatial differences in nitrogen concentrations between seven sites in the Swan River estuary, Western Australia. Although sites with higher nitrate concentrations yielded also higher nitrate $\delta^{15}N$ values, it was unlikely that higher nitrate concentrations were the result of human pollution, because nitrate $\delta^{15}N$ values were well within the range of natural values. Mussel $\delta^{15}N$ was constant over 7 months within each site, but there were stable differences in mussel $\delta^{15}N$ between sites throughout the study, and there was a negative correlation between the $\delta^{15}N$ values of nitrate and mussels.

These results indicate that in systems, in which the $\delta^{15}N$ value of nitrate does not indicate human pollution, the differences in the $\delta^{15}N$ of mussels rather reflect differences in site specific nutrient cycling caused by physicochemical conditions or biological factors than nitrogen concentration alone.

STABLE ISOTOPE RATIOS AND TRACE ELEMENTS COMPOSITIONS IN SEAWEEDS (UNDARIA PINNATIFIDA) FROM JAPAN, CHINA, AND KOREA: INTERANNUAL VARIATIONS BETWEEN 2011 AND 2013

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Most seaweeds usually inhabit the littoral zone, which affects the physiological status and the source of nutrients in their growth process. Thus, seaweeds are potential indicators to monitor the ecological characteristics of the littoral zone. In this study, we determined the carbon and nitrogen isotopic ratios ($\delta^{13}C$ and $\delta^{15}N$) and the concentrations of twelve elements (Mg, P, Ca, V, Mn, Fe, Zn, As, Rb, Sr, Cd, Ba) in seaweeds from Japan (Sanriku and Naruto), China, and South Korea to compare the ecological characteristics in each area. In addition, we collected seaweeds in the same area from 2011 to 2013 and evaluated interannual variations of their stable-isotope ratio and trace-element.

There was no significant interannual variation in the $\delta^{13}C$ and $\delta^{15}N$ values and the concentrations of the twelve elements for all areas over the three years. The $\delta^{15}N$ values were 2.8 ± 1.7 ‰ (means ± 1σ) for Sanriku, 10.6 ± 1.4 ‰ for Naruto, 3.3 ± 1.4 ‰ for China, and 3.8 ± 1.5 ‰ for South Korea. The wakame seaweeds from Naruto had relatively higher nitrogen isotope values than those from other areas. The Naruto area is located between the Seto Inland Sea and the Pacific Ocean. The values of $\delta^{15}N$ in the particulate organic matter and zooplanktons in the Seto Inland Sea tend to increase with population growth in the neighbor towns. The high nitrogen isotope values of the Naruto seaweeds would be dependent on ^{15}N -enriched anthropogenic nitrogen. The wakame seaweeds from Sanriku, the coastline along northeast Japan, had relatively lower concentrations of all elements. Although the Sanriku area was damaged by the tsunami caused by the massive earthquake on March 11, 2011, there was no significant difference in the stable isotope values and trace element compositions of Sanriku seaweeds before and after the earthquake. The Chinese seaweeds had relatively higher Ba concentration. The South Korean seaweeds exhibited high V and Rb concentrations. On the basis of the $\delta^{13}C$ and $\delta^{15}N$ values along with the concentrations of the twelve elements, the wakame seaweeds were divided into four groups: Sanriku, Naruto, China, and South Korea.

DECODING PAST ENVIRONMENTS - TEMPORAL VARIATIONS AND TIME MACHINES

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POSTER 48

NEW QUATERNARY PALAEOCLIMATIC RECORDS AS PRESERVED IN THE STABLE ISOTOPE SIGNATURES OF *CYCLOPHORUS* SHELLS FROM VIETNAM

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Terrestrial and aquatic shells are frequently collected in archaeological middens, forming stratified deposits from which environmental time-series records may be recovered. Previously a good relationship has been demonstrated between the $\delta^{18}O$ of shell aragonite and rainfall (Goodfriend, 1992; Balakrishnan *et al.,* 2005) proving shells form useful archives.

Here we tested the technique on a 12 ka anthropogenic Quaternary sequence from Trống Cave, Tràng An Massif, Ninh Binh Province in Vietnam. Terrestrial snails (*Cyclophorus*) are abundant amongst the sediment at the site, as snails were the pre-historic humans' main summer food source. Samples for isotopic analysis were collected from 2.5 m of sediment in stratigraphic layers, with dating control derived from charcoal fragments. Aragonite samples of 2-3 mm were sectioned from the lips of the shells, in order to recover the growth most recently deposited prior to death.

The $\delta^{18}O$ signal in the shells shows clear variation through time and appears to reflect major global climatic variations, including the North Atlantic Heinrich 1 event, which is also seen in published regional speleothem $\delta^{18}O$ records. We hypothesis that the main controls on the $\delta^{18}O$ of the shells may be a mixture of changes in the isotopic values of rainfall, and habitat changes driven by climate, with work on the $\delta^{18}O$ of modern shells now being undertaken to test the ecological basis of this theory.

REFERENCES

Goodfriend, G.A., 1992. The use of land snail shells in paleoenvironmental reconstruction. Quaternary Science Reviews, 11(6), pp. 665-685.

Balakrishnan, M., Yapp, C.J., Theler, J.L., Carter, B.J. and Wyckoff, D.G., 2005. Environmental significance of $^{13}C/^{12}C$ and $^{18}O/^{16}O$ ratios of modem land-snail shells from the southern great plains of North America. Quaternary Research, 63(1), pp. 15-30.

POSTER 49

VERTICAL HABITAT SHIFT OF VIVIPAROUS AND OVIPAROUS DEEP-SEA CUSK EELS REVEALED BY OTOLITH STABLE ISOTOPIC COMPOSITIONS

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Distributions of deep-sea fishes are well dependent on their reproductive strategies and ontogenetic migration of early life stage. However, traditional ocean samplings only provide a snapshot of fish distribution in the sea. By analyzing oxygen and carbon isotopes coupled with microstructure of the otolith, this study revealed vertical migration of viviparous and oviparous deep-sea cusk eels. Otolith $\delta^{18}O$ can act as a proxy of water temperature due to its temperature-dependent equilibrium fractionation during otolith (aragonite) formation. The negative linear relationship between otolith $\delta^{18}O$ and ambient water temperature allows it to be used for estimating the historical resident depths of fish. Viviparous and oviparous larval fishes were presumed to have distinct life history strategies, which may inhabit near the adult living depths and may hatch in pelagic zone and then migrate to deeper water, respectively. Ophidiid (oviparous) and Aphyonid (viviparous) fishes were collected from the deep sea areas around Taiwan. The otolith isotope compositions revealed that both oviparous and viviparous fishes exhibited the lowest $\delta^{18}O$ values at the core region (corresponding to larval stage) and higher values at the edge (caught adult), indicating that both viviparous and oviparous cusk eels experienced pelagic larval stage and the vertical settling distance ranged from 200 m to > 1000 m. The coincident increasing $\delta^{13}C$ values (decreasing metabolism) and obvious 1st transparent zone of otolith (settlement check) further verified this settlememt process from pelagic zone to sea bottom, as well as validated the application of otolith isotopes for exploring life history of deep-sea fishes.

REFERENCES

Lin H.Y. Shiao J.C. Chen Y.G. Iizuka Y. 2012. Ontogenetic vertical migration of grenadiers revealed by otolith microstructures and stable isotopic composition. Deep Sea Research Part I: Oceanographic Research Papers 61: 123-130.

POSTER 50

LIGHT STABLE ISOTOPES FROM ORGANIC AND INORGANIC FAUNAL TISSUES AS ENVIRONMENTAL TRACERS IN THE SOUTHERN AFRICAN C_3 ENVIRONMENTS

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This study aims to test the nature and extent of correlations between environmental variables such as mean annual rainfall, seasonality of rainfall, relative humidity, temperature and $\delta^{13}C$, $\delta^{15}N$ and $\delta^{18}O$ in wild fauna from the winter rainfall area of South Africa. Most previous studies of isotopic ecology in Africa have been carried out in summer rainfall regions. This study focuses on the winter rainfall zone in the extreme south-western part of Africa, where important archaeological sites record the lifeways of early modern humans. This study of contemporary fauna will provide a baseline for the interpretation of stable isotope analyses of archaeological and fossil animals from this region, a key tool in the reconstruction of palaeoclimates and palaeoenvironments. It will also contribute to a better understanding of isotope systematics in large mammals.

We have analysed $\delta^{13}C$ and $\delta^{15}N$ in bone collagen and $\delta^{13}C$ and $\delta^{18}O$ in tooth enamel of 27 species of indigenous wild mammals obtained mostly from game parks and nature reserves. The C_3 end point as recorded in tooth enamel and bone collagen of browsers varies according to vegetation type. The most enriched values (ca. 5‰ more positive than in other areas) are probably due to browsers feeding on succulents in the Albany thicket vegetation type. Carnivores show more marked enrichment in ^{15}N with decreasing mean annual precipitation than herbivores. $\delta^{15}N$ and $\delta^{18}O$ are more strongly correlated for water dependent herbivores ($r^2 = 0.56$, n=47) compared with water independent species ($r^2 = 0.22$, n=87).

Comparison of $\delta^{13}C$ of different skeletal elements from the same animal yields a wealth of information about isotopic fractionation during metabolism and tissue synthesis. The enamel apatite-collagen spacing ($\Delta_{apa\text{-}col}$) is larger in herbivores (7.4±2.3‰, n=135), than in carnivores (5.1±1.8‰, n=14) and omnivores (5.2±1.1‰, n=36), and larger in grazing herbivores (8.8±1.8‰, n=53) than browsers (6.7±2.5‰, n=26). This may point to differential efficiency of digestion.

POSTER 51

CLIMATE IN YOUR DINNER: HIGH-RESOLUTION PALAEOCLIMATE DATA FROM ARCHAEOLOGICAL WOMBAT ENAMEL

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Archaeological research within Australia has historically focussed on broad population-scale data, resulting in individual people and events being overlooked. This population focus is driven by the limitations of preservation, with organic artefacts such as timber and bone infrequently preserved. A regional exception is southwestern Tasmania, where cave sites located along major river systems, including Warreen Cave and Bone Cave, have yielded exceptional stratified faunal collections, ranging in age from 35,000 BP to 11,500 BP, spanning the Last Glacial Maximum (LGM).

These faunal assemblages identify that two major prey species were being utilised by Pleistocene Aboriginal people — Bennetts wallaby (*Macropus rufogriseus*) and the Tasmanian Common wombat (*Vombatus ursinus tasmaniensis*). As the Common wombat has continuously growing, rootless teeth, a high-resolution isotopic record ($\delta^{13}C$ and $\delta^{18}O$) of local climate variability is preserved for the last 18-24 months of the wombat's life. Modern wombat teeth, assessed as part of this study, have demonstrated that signals from seasonal storm events are captured within the enamel. By analysing archaeological wombat teeth, it is possible develop a site-specific palaeoclimate record which is regionally specific and temporally focussed on site occupation. This presentation will outline the preliminary results of this study, discussing insights into specific climatic conditions affecting Tasmanian Aboriginal people during the LGM.

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