Climate & Oceans

NZMSS
METSOC
JOINT CONFERENCE
AUCKLAND 2009

Ministry of
Fisheries
Te Tautiaki i nga tini a Tangaroa

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METEOROLOGICAL SOCIETY of NEW ZEALAND

Welcome to the joint New Zealand Marine Sciences and Meteorological Societies conference "Climate and Oceans"

It is an honour and pleasure for Auckland to host the annual conference of the New Zealand Marine Sciences Society, and New Zealand Meteorological Society this year. This joint event has a theme of "climate and oceans" to reflect the interests of both societies and one of the most topical issues in society today. However, being the annual meeting of both societies, the conference also includes presentations outside this theme but consistent with the broader scope of the societies taking part. Such annual conferences provide an essential service that enables New Zealand scientists, both professional and student, from industry, government, NGO and academia, to meet and share scientific progress over the past year.

The keynote speakers cover issues of particular interest at present, namely sea level rise, if iron fertilisation of oceans may reduce atmospheric carbon dioxide, impact of climate change on fisheries and aquaculture, linking global to local scale climate effects on seabed ecology, and insights from long-term time series studies. Special open fora provide opportunities for delegates to discuss these hot topics issues in greater detail with a panel of experts.

Delegates come from universities (50%), research institutes (30%), national and regional government (12%), as well as private consulting companies, not-for-profit NGO, industry, and retired scientists. About 35% of all delegates are graduate students.

Several steps were taken to keep costs down this year with success. These included raising more sponsorship (almost $30,000 cash and $10,000 in-kind), not purchasing conference bags, keeping conference to three days and three evening events, hiring one conference administrator rather than a company, and careful negotiation with several caterers and others (refreshments, lunches and evening events comprised about 60% of the conference expenses). Recommendations will be made to the NZMSS Council to further limit costs in future years and streamline conference organisation. We welcome suggestions for future conferences. Next year's NZMSS conference will be in Wellington and celebrates the society's 50th anniversary.

Please learn from the over 200 talks and posters being presented at the conference. But more importantly, take this opportunity to discuss research and related issues with the 250 delegates attending, including about 80 graduate students. Meeting people personally removes the first barrier to future cooperation and collaboration. So do not be shy, enjoy meeting people as well as the presentations, and ask good questions that may stimulate further research directions.

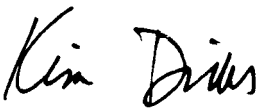
Acknowledgements

Organising an event like this has involved a large number of people and organisations in the Auckland area. The conference Organising Committee comprised 21 people: Ann McCrone and Clinton Duffy (DoC); Gabriel Machovsky Capuska and David Raubenheimer (Massey); Jim Salinger and Kim Dirks (Met Soc & UoA); Mary Livingston (MFish); Kyle Morgan and Paul Kench (UoA SGGES), Mark Costello (Chair), Richard Taylor, Mark Fitzpatrick, Elliot Brown, Jenni Stanley (UoA Leigh Marine Sciences); Megan Stewart (ARC); Sandra Hinni, Emily Jones and Dan McClary (Golder); Steve O'Shea (AUT); Sheryl Miller (NIWA); Tom Trnski (Auckland Museum). We especially thank: Kerry O'Connell who managed the conference abstract submissions and finances, and advised from experiences from the 2008 conference she helped organise; Steve edited the conference Programme and Abstracts book; Mary and Ann organised sponsorships; Jenny explored options for conference t-shirts; Sandra, Emily, Megan and Katherine organised the catering; Gabriel organised the open forum discussion panels; Sheryl, Megan, Kim and Mary reviewed the abstracts acceptability; Megan and Richard scheduled the talks; Megan and Kim organised the evaluation of student prizes; Kyle, Elliott and Mark organised the graduate party, poster boards, internet passwords and other things; Brian Paavo managed the conference website; Ann, Jenny, Kyle and Mark also prepared information for delegates and the website. The graduate support team handling the presentations, manning the Registration Desk and other activities will include: Mark, Gabriel, Jenny, Elliot, Leonardo Zamora, Alicia Mallo, Sonny Lee, Alice Yee Gui, Corinne Klein, and Javed Khan. All these people took time away from their busy day-jobs and research to make the meeting a success. It has been a real team effort.

We thank the staff at the University of Auckland Business School, Lecture Theatre Management Unit, and Centre for Pacific Studies, for their helpful cooperation in organising the facilities. We thank Spicers Restaurant for catering the lunches and breaks, DeLucas Catering for the icebreaker reception, and Feast Catering Company for the conference dinner. The university's Music School recommended the musicians for the conference dinner.

We are also grateful to the conference delegates who have agreed to be judges for the prizes for best presentations. This is not an easy job and is much appreciated by the both the sponsors of the prizes and the conference organisers. We thank the session chairpersons for keeping people to the timetable and facilitating questions and discussion, and the plenary speakers for their special effort to make presentations of interest to a wide audience.

Mark J. Costello, NZMSS and Chair Organising Committee



Kim Dirks, Meteorological Society

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Conference timetable

Wednesday 2 September

	Large theatre (Room 290-098)	Medium theatre (Room OGGB3)	Small theatre (Room OGGB5)
0830	Registration desk open	Registration desk open	Registration desk open
0900	Refreshments & Registration	Refreshments & Registration	Refreshments & Registration
Chair	*Mark Costello*		
0945	Stuart McCutcheon (University Vice Chancellor):		
1000	Hon. Nick Smith MP (Minister Climate Change)		
1030-1130	John Church: Sea-level rise: understanding, expectations and mitigation		
Session	**CLIMATE CHANGE**	**ECOLOGY – SEDIMENTS**	**ECOLOGY – EPIBIOTA**
Chair	*Kim Dirks*	*Abigail Smith*	*Richard Taylor*
1145	Knowing which way the wind blows: Sam Dean	Factors influencing toheroa (*Paphies ventricosa*) on Northland beaches: Shade Smith	Sponge assemblage structure in the lagoons at Palmyra Atoll, Central Pacific: Ingrid Knapp
1200	How might weather patterns change under climate warming? Brett Mullan	The green-lipped mussel in soft-sediment systems in NE New Zealand: Ian McLeod	Virus assemblages of hermatypic corals and environmental variables in the Central Pacific: William Arlidge
1215	Atmospheric observations and models estimate regional sources and sinks of CO2: Sara Mikaloff-Fletcher	Functional role of *Helice crassa* in differing sediment environments: Hazel Needham	Temporal and spatial sponge assemblage variability in temperate waters: Jade Berman
1230		LUNCH	
1330	Pumping Iron to Save the Planet? Cliff Law		
Session	**CLIMATE CHANGE**	**ECOLOGY – SEDIMENTS**	**ECOLOGY – EPIBIOTA**
Chair	*Kim Dirks*	*Abigail Smith*	*Richard Taylor*
1400	Predicting patterns of future warming from Pleistocene gyral circulation and sea-surface temperatures: Bruce Hayward	Seagrass restoration: success of a small-scale transplantation trial in Whangarei Harbour: Fleur Matheson	Nutrients and diet composition of sponge assemblages on Wellington's south coast: Alejandra Perea Blázquez
1415	Observations of climate-related variability and change in the global ocean and the South Pacific: Phil Sutton	Mass mortality of cockles in the Whangateau Harbour: consequences & causes: Karen Tricklebank	Symbiosis reestablishment in *Aiptasia* sp.: Dorota Starzak
1430	Seasonal and interannual transport of carbon to the deep ocean and marine production: Scott Nodder	Creatures of the mud – mangrove forest in Tauranga and Auckland: Sharon De Luca Abbott	Contribution of symbiotic dinoflagellates to the osmotic balance of their anthozoan hosts: Michael Cowlin
1445	Dramatic reduction in UV radiation observed in New Zealand from Australian bushfire plume: Ben Liley	Cow poo swims the distance: tracking faecal contaminants in the Motueka River plume: Chris Cornelisen	Effects of thermal and oxidative stress on health of symbiotic dinoflagellates: Anne Wietheger
1500	The National Climate Database – what is it?: Errol Lewthwaite	Seagrass condition and environmental parameters in two New Zealand estuaries: Virginie Dos Santos	The *Aiptasia* sp. – *Symbiodinium* sp. symbiosis – infection dynamics and cell proliferation: Daniel Logan
1515	Remote sensing as a proxy for climate change in the subtropical convergence: Katherine Baer	Changes in ecosystem functioning on sandflats disturbed by terrigenous sediment: Drew Lohrer	Fiat lux: shining a light on coralline algal diversity: Tracy Farr

Wednesday (contd) 2 September

1530	BREAK		
Session	**OCEAN ACIDIFICATION - BIOLOGY**	**ECOLOGY - SEDIMENTS**	**ECOLOGY - EPIBIOTA**
Chair	*Bruce Hayward*	*Drew Loher*	*David Schiel*
1600	Marine culture tanks for ocean acidification studies: Christina McGraw	Intertidal sediment affects perennial benthic algae recruitment and diversity: Tania Hurley	Barcoding algae: evaluating cox1 variation for species delimitation in *Cystophora*: Joe Buchanan
1615	Estimating acid dissociation constants of carbonic acid in seawater: Hugh Doyle	Effects of suspended sediments on juvenile fish - murky waters for snapper? Meredith Lowe	Shining some light on Biodiversity-Ecosystem Function in benthic algal assemblages: diversity matters: Leigh Tait
1630	Effects of ocean acidification on New Zealand macroalgae: Christopher Cornwall	Implications of sediment transport on heavy metal contamination and bivalve bioturbation: Julia Simpson	Ecology of encrusting species in intertidal boulder-fields: Kiran Liversage
1645	New Zealand seas – levels rising, pH falling? Hugh Grenfell	Tidal-creek dynamics, function and terrigenous-sediment fate in estuaries: Andrew Swales	Does predation by shrimp control the distribution of the New Zealand saltwater mosquito on the rocky shore? Shane Geange
1700	Subantarctic water is an increasing sink for atmospheric carbon dioxide: Kim Currie		Ecological role of an omnivorous seastar *Patiriella regularis* in intertidal cobble fields: Shiree Palmer
1715	PANEL DISCUSSION on climate change science		
1800 1930	POSTERS AND RECEPTION		

Thursday 3 September

	Large theatre (Room 290-098)	Medium theatre (Room OGGB3)	Small theatre (Room OGGB5)
0900	Martin Cryer. The implications of climate change for fisheries and aquaculture management in New Zealand.		
Session	**FISHERIES**	**ECOLOGY**	**METEOROLOGY**
Chair	*Mary Livingston*	*Conrad Pilditch*	*Jim Renwick*
0930	Fisheries stock assessment for New Zealand scallops: James Williams	Mussel stress: physiological responses when the tide goes out: Davon Callander	Monsoon onset and withdrawal over the Maldives: Zahid
0945	Intraspecific variation of movement behaviour and differential exploitation of snapper: Darren Parsons	The effect of current velocity and density on Austrovenus stutchburyi clearance rates: Hannah Jones	Modelling of Antarctic Polar stratospheric cloud formation due to orographic gravity waves: Steve George
1000	Assessing the performance of NZ fisheries to primary production constraints: Ben Knight	Vulnerability of embryos in the intertidal to summertime ultraviolet radiation and conditions at low tide: Nicole Phillips	Improving Regional Climate Model simulations of New Zealand climate: Abha Sood
1015	New Zealand's largest recreational finfish fishery (snapper) and the inner Hauraki Gulf ecosystem: Mark Morrison	Ephemeral in space and time: diversity following disturbance on the subtidal-intertidal fringe: Paul South	Are extreme wind patterns over New Zealand changing? Abha Sood
1030	BREAK	BREAK	BREAK
Session	**ECOLOGY - FISH**	**ECOLOGY - SEDIMENTS**	**METEOROLOGY**
Chair	*Martin Cryer*	*Conrad Pilditch*	*Mike Revell*
1100	Habitat of adult and juvenile snapper in the inner Hauraki Gulf: Tanya Compton	Ecological consequences of discharges from coastal cooling systems: Fabiana Moreira	Effects of thin cirrus clouds on MISR cloud-height retrievals: Abhnil Prasad
1115	Fish-habitat relationships in central New Zealand: Russell Cole	Patterns of amphipod biodiversity on Chatham Rise and Challenger Plateau: Matthew Knox	Long term ten minute synthetic wind data for 15 New Zealand wind farms: Richard Turner
1130	Habitat shifts of snapper within an estuary: Natalie Usmar	The influence of sea bed structure on benthic invertebrate diversity: Severine Dewas	Solar energy anywhere in New Zealand: Ben Liley
1145	Population structure of triplefin fish based on microsatellite loci: Muriel Rabone	Biomineralisation in an Urban Environment: A Carbonate Budget for Otago Harbour: Abigail Smith	Climate drives home insulation and heating needs in New Zealand: Ben Liley
1200	Feeding relationships of mid-slope fish species from northeastern Chatham Rise: Matthew Jones	Does mineralogy or ecology control deepsea coral and squat lobster distributions around New Zealand? Helen Bostock	The influence of the Southern Oscillation on tropospheric temperature: Chris de Freitas
1215	"Attractive sinks": degraded habitats reduce egg production of whitebait in major rivers: Michael Hickford	Cadmium isotope in oysters and seawater of the South Island: Melanie Gault-Ringold	Precipitation events during the recent drought on the Canadian Prairies: William Henson
1230	LUNCH	LUNCH	LUNCH
1300	NZMSS AGM (Chair Colin McClay)	LUNCH	LUNCH

Thursday (contd.) 3 September

Session	**ECOLOGY - FISH**	**ANTARCTICA**	**METEOROLOGY**
Chair	*Mark Morrison*	*William Henson*	*Georgina Griffiths*
1415	Seasonal and latitudinal variation in diet of the butterfish *Odax pullus:* Jethro Johnson	Method for retrieval of Top-Of-Atmosphere albedo over polar regions using MISR: Joseph Corbett	An integrated probabilistic hydrological nowcast scheme: Paul Shucksmith
1430	Indirect effects of fish on kelp beds: Alejandro Perez-Matus	Atmospheric forcing of Antarctic sea ice on weekly to monthly: James Renwick	Atmosphere-ocean energy fluxes over a coral reef, southern Great Barrier Reef: Andrew Sturman
1445	Latitudinal variation in life history traits of *Odax pullus* across New Zealand: Elizabeth Trip	Summertime surface-layer winds over the Darwin-Hatherton Glacial system, Antarctica: Peyman Zawar-Reza	Tornado wind induced damages to buildings in Taranaki: Richard Turner
1500	The effects of angling stress on key haematological and oxygen equilibrium parameters of snapper: Brendan Dunphy	Detection and characterization of siderophores in Sub-Antarctic waters: Imelda Velasquez	Downslope winds – an explanation for roof damage in Cobden, Greymouth in July 2008: Mike Revell
1515	What controls the distribution of reef fish at the subtropical Kermadec Marine Reserve? Tyler Eddy		Estimating 3D wind fields in mountain waves using sailplane flight data: Ni Zhang
1530	break	break	break
Session	**CONSERVATION**	**ANTARCTICA - BIOLOGY**	**METEOROLOGY**
Chair	*Ann McCrone*	*Steve O'Shea*	*Roger Davies*
1600	Effect of Marine Reserve protection on blue cod and rock lobster: Daniela Díaz Guisado	Oxidative damage & antioxidant defence in Antarctic urchin embryos from UV-B during ozone depletion: Kathryn Lister	A mesoscale model intercomparison of coastal refractivity: Sally Garrett
1615	Incidental capture of seabirds in recreational fisheries in New Zealand, Berkenbusch, Katrin	Diversity and distribution of sea cucumbers south of the Antarctic convergence: Niki Davey	Cloud motion from MISR satellite data using novel stereography and model data: Aaron Herber
1630	Regional scale marine habitat mapping in northern New Zealand: Stacey Byers	Responses of Antarctic benthos to pulsed food supply experiments in incubation chambers: Luca Chiaroni	Coastal atmospheric results from the Kahu Unmanned Aerial Vehicle system in the Bay of Plenty: Duncan Cook
1645	Patterns and processes in rocky-reef benthos of Wellington's Taputeranga Marine Reserve area. Tamsen Tremain Byfield	Rocky reef communities of the Bounty and Antipodes Islands: Debbie Freeman	Towards variational assimilation of rain radar data in New Zealand: Luke Sutherland-Stacey
1700	Ecosystem-based management of coastal reefs: understanding diversity and function before trying to manage it: David Schiel	Phylogenetic relationships of Antarctic hyperiidean amphipods using the mtCOI gene: Lisa Bryant	The LUNG: a new approach to greenhouse gas flux measurements: Tony Bromley
1715		POSTERS	
1930		GRADUATE PARTY	

Friday 4 September

	Large theatre (Room 290-098)	Medium theatre (Room OGGB3)	Small theatre (Room OGGB5)
0900	Shark habitats, migrations and diving behaviour revealed by electronic tagging: Malcolm Francis, NZMSS Award 08		
0930	Effects of UV-B radiation on oxygen consumption of a temperate and tropical sponge. Heather Murray		
Session	**CONSERVATION**	**DISPERSAL AND CONNECTIVITY**	**PHYSICAL OCEANOGRAPHY**
Chair	*Ali MacDiarmid*	*Shane Lavery*	*Scott Nodder*
0945	Taking stock of the New Zealand southern right whale: Emma Carroll	Global phylogeography and taxonomy of the giant kelp *Macrocystis:* Erasmo Macaya	A New Zealand region ocean climatology: Matt Walkington
1000	Quantitative fatty acid signature analysis and diet of New Zealand sea lions: Laureline Meynier	Phylogeography of New Zealand's coastal benthos: them's the breaks: Phil Ross	Ocean colour classification: Tracey Osborne
1015	Human-induced changes in behaviour in New Zealand sea lions at Sandfly Bay, Otago: Natalie Nolan	Biogeography of squat lobsters in the southwest Pacific: Kareen Schnabel	Pitfalls of ship-based measurements: Murray Smith
1030	Marine biosecurity surveillance in New Zealand: Justin McDonald	break	Towards more accurate water sample salinity data: Matt Walkington
1045	break	break	break
Session	**MANAGEMENT APPROACHES**	**DISPERSAL AND CONNECTIVITY**	**AIR QUALITY**
Chair	*Ali MacDiarmid*	*Shane Lavery*	*Andy Sturman*
1100	Western scientific knowledge and Mātauranga Māori in ecosystem-based management: Leane Makey	Population genetics of the short-tailed stingray, *Dasyatis brevicaudata:* Agnes Le Port	Effect of the sea breeze on air pollution in the Auckland Region: Basit Khan
1115	Regional information needs and resources - a management perspective: Helen Kettles & Laura Allum	How long 'til we get there, how far can we get in that time? Dispersal of macrophyte propagules: Emily Lane	Background aerosol input to urban air quality: Mike Harvey
1130	Using spatial conservation optimisation tools for ecosystem-based management of the Kaipara Harbour: Leane Makey	Larval swimming and substrate choice modify the dispersal of sea urchin *Evechinus chordatum:* Niall Broekhuizen	Part 1: Volcanic plumes from Mt Ruapehu: radar, ash, pollutants and health impacts: Luke Sutherland-Stacey
1145	Coastal water quality for ecosystem heath, management, monitoring and the future: Lesley Bolton-Ritchie	Southern Connections: population connectivity assessed with molecular and oceanographic tools: Sharyn Goldstien	Part 2: Volcanic plumes from Mt Ruapehu: radar, ash, pollutants and health impacts: Kim Dirks
1200	Regional council monitoring and research – a national network of information? Megan Stewart-Carbines	Nested simulations of the Southland Current: Mark Hadfield	Trends in atmospheric controls on PM10: Tim Appelhans
1215	Urban-derived contaminants in Wellington Harbour sediments: Juliet Milne	Spatial variability in dispersal of juvenile bivalves in Whangarei Harbour: Carolyn Lundquist	Condensation nuclei measurements through the Western Pacific: Tony Bromley
1230	lunch	lunch	lunch
1330	Global climate phenomena, local-scale environmental variability and biotic interactions influence macrofaunal temporal dynamics at a variety of scales: Judi Hewitt		

Friday (contd.) 4 September

Session	**LONG-TERM STUDIES and MONITORING**	**DISPERSAL AND CONNECTIVITY**	**BIOSECURITY**
Chair	*Megan Stewart-Carbines*	*Carolyn Lundquist*	*Sharon Goldstien*
1400	A long-term study of a small rocky reef: implications for community dynamics: Bill Ballantine	Does coral recruitment depend on local or distant sources of larvae? Pelayo Salinas de León	Larval competency & natural dispersal of the invasive ascidian *Didemnum vexillum:* Lauren Fletcher
1415	Continued	The range at which pre-settlement fish can detect ambient reef sound: Craig Radford	Reproduction, early life history and substratum selectivity of the invasive tunicate *Styela clava*: Sarah Nutsford
1430	Archaeological, historical & contemporary evidence for a 700 year snapper fishery in the Hauraki Gulf: Alison MacDiarmid	Sex pheromones in the paddle crab *Ovalipes catharus:* Kristel Van Houte-Howes	Demography of the invasive tunicate *Styela clava* in New Zealand: D'arcy Webber
1445	Tests of point-null hypotheses misrepresent data, Cole, Russell	Induction of settlement in crab megalopa by ambient underwater reef sound: Jenni Stanley	Contrasts in the recent introductions of two tunicates to northern New Zealand: Bruce Hayward
1500	Changes in underwater life at the Poor Knights Islands over the past 50 years: Taylor, Richard	PANEL DISCUSSION on dispersal and connectivity in the ocean	Temperature and salinity tolerances of larvae of an invasive crab, *Charybdis japonica*, in NE New Zealand: Amy Fowler
1515	Decadal trends in temperate marine reserves: Nick Shears		Mediterranean fanworm (*Sabella spallanzanii*) elimination programme - Lyttelton Port: Peter Stratford
1530	BREAK	BREAK	BREAK
Session	**LONG-TERM STUDIES and MONITORING**	**AQUACULTURE**	**BIOSECURITY**
Chair	*Mary Livingston*	*Mark Fitzpatrick*	*Mike Hickford*
1600	Long term trends in marine water quality in the Auckland region: Jarrod Walker	Implications of bacterial films that promote mussel settlement for aquaculture, Maitrayee Ganesan, Annapoorna	The successful establishment and spread of an introduced fish: Jeremy Barker
1615	Towards a National Marine Environment Monitoring Programme in New Zealand: Mary Livingston	From farm to fork: how a stress free harvest can influence the quality of frozen Chinook salmon: Denham Cook	Primary production in macroalgal beds and the presence of *Undaria pinnatifida* make a difference? Derek Richards
1630	PANEL DISCUSSION on Long-term data needs	Effect of microalgal and formulated diets on the performance of green-lipped mussel spat: Yue Gui	Cogitations from a Marine Biosecurity Perspective: Simon Phillips
1645		Mussel waste as a food source for juvenile sea cucumber and polyculture implications: Matthew Slater	MITS: Marine Invasives Taxonomic Service: Serena Cox
1700	NMCC - A means of gathering scientific maritime information? Rachael Butler		From the ocean to the lab – new organisms and you: Angela Kidd
1715	CLOSING CEREMONY		
	Removal of posters		
1900	**CONFERENCE DINNER: Fale Pasifika**		

General Information

Conference Venue
The venue is Owen G Glenn Building (OGGB) at The University of Auckland's city campus at 12 Grafton Road, Auckland.

Registration desk
The registration desk, in the OGGB (see attached map), will open on Wednesday from 8.30am through to Friday. If you require any assistance during the conference, please ask at the Registration desk, or ask those on the conference organising committee or our student helpers (wearing labelled name tags).

On arrival, please collect your Programme and Abstract book, name badge and lanyard, presentation evaluation forms (if you are judging talks or posters for prizes), at the Registration desk. We are not providing conference bags, pens, brochures or other paraphernalia in an effort to keep costs down and minimise waste and clutter. Please bring your own as required. A table will be available for people to leave brochures for others to collect.

Name badges
Delegates are requested to wear their name badges during all conference sessions and social functions. If you need assistance during the conference, ask those on the conference organising committee (wearing **blue** name tags) or our student helpers (wearing **green** name tags). Please return lanyards and badge holders after the conference so they can be recycled.

Oral Presentations
Oral presentations are allotted 15 minutes in total for presentation, including time for questions. Speakers are asked to identify themselves to their session chairperson before the start of the session. All talks must be loaded onto the computer in the lecture hall during the break immediately preceding their session. A presentation attendant will do this for you, and open and close presentations between speakers. Presentations may be uploaded at any break, and before your session starts.

Session chairpersons will adhere strictly to the schedule to allow people to move easily between concurrent and consecutive sessions. Chairpersons should inform speakers they have 2 min left when they are 10 min into their presentation. If a speaker is absent their time slot will not be used, and subsequent talks will remain at the times printed in the schedule.

Poster Presentations
Posters will be displayed during the entire conference beside the lecture theatres. Dedicated poster sessions will be held on Wednesday from 5.15–7.30 pm, and Thursday from 5.15–5.45 pm. During this session poster presenters should stand by their posters to answer any questions.

Panel Discussions
There will be open forum discussions on the topics of Climate Change, Dispersal and Connectivity, and Long-term Monitoring. The chairs will invite a panel to come to the front of the room and take questions from the audience. Delegates are asked to provide questions in advance by dropping them into a Panel Discussion Question Box at the Registration desk beforehand. This will enable to chair to plan the time available for discussion better.

Opening Social
An icebreaker Social will be held in association with the Poster Session on Wednesday 2nd September.

Keynote presentations
A few keynote speakers have been invited to make presentations of interest to a wide audience. After their presentations, please make your way to the lecture theatre where your preferred session is on promptly.

Annual General Meetings
The AGM for the New Zealand Marine Sciences Society will be held on Thursday from 1pm to 1.45pm in the lecture theatre OGGB5.

Morning/Afternoon Teas

Refreshments will be provided adjacent to the lecture theatres and Poster display area from 10.30−11.00 am and 3.30−4.00 pm; except on Wednesday when refreshments will be available as people arrive from 9–9.30 am. Please leave the lecture theatres quickly after the session immediately preceding tea, and stand clear of the coffee/tea service stations once you have been served to allow others easy access. It is not permitted to bring food or drink into the lecture theatres.

Lunches

Buffet lunches are also included in the registration fee. They will be provided next to the lecture theatres 12.30−1.30 pm each day.

Graduate Party

A graduate organised party is being held in the Strata Cafe on the university campus from 7.30pm on Thursday 3rd September. All delegates are welcome. It will include complimentary food and refreshments.

Conference Dinner

The conference dinner will be held at Fale Pasifica, adjacent to the Owen G. Glenn building, from 7.00–11.30 pm on Friday. The dinner is being catered by Feast Catering and entertainment will be provided by students from the university's Music School. Conference prizes and other awards will be presented during the evening.

Due to popular demand, there will be an informal dinner for Meteorological Society delegates on Thursday night. Venue to be agreed by consensus. If you are interested, please see Kim Dirks.

Special dietary requirements

If you have any dietary requirements that we are not aware of please see the registration desk staff as soon as possible. If you have advised us of your special dietary requirements on the registration form, these have been forwarded to the caterers.

Internet access

Delegates may use computers in computer Labs beside the lecture theatres to check their powerpoint presentations and email, and connect via wireless if they have their own laptop. However, they need to sign out a password from the Registration Desk. They can use this for the duration of the conference.

Cell phones

Please ensure that cell phones are turned off, or in silent mode, during all presentations.

Transportation

Taxi: On-the-spot taxi services operate directly from the Auckland Domestic Airport. For approximate costs visit the following websites: Cheap Cabs, Auckland Taxi, President Taxi, Taxi Info.

Airport Shuttles: On-the-spot shuttles run door-to-door from the Auckland Domestic Airport to all over Auckland City. Costs are charged per group and provide a cheaper alternative to taxis. Prices differ between companies. For prices visit the following websites: Super Shuttles, Kiwi Shuttle.

Airbus: An airport bus travels from the Auckland Domestic Airport to Auckland CBD and provides backpackers rate. For prices and a route map please consult their website: Airbus Express.

Local Bus: For local bus, ferry and train information to the different areas of Auckland City, please visit the Maxx website. Maxx: Auckland Regional Transport.

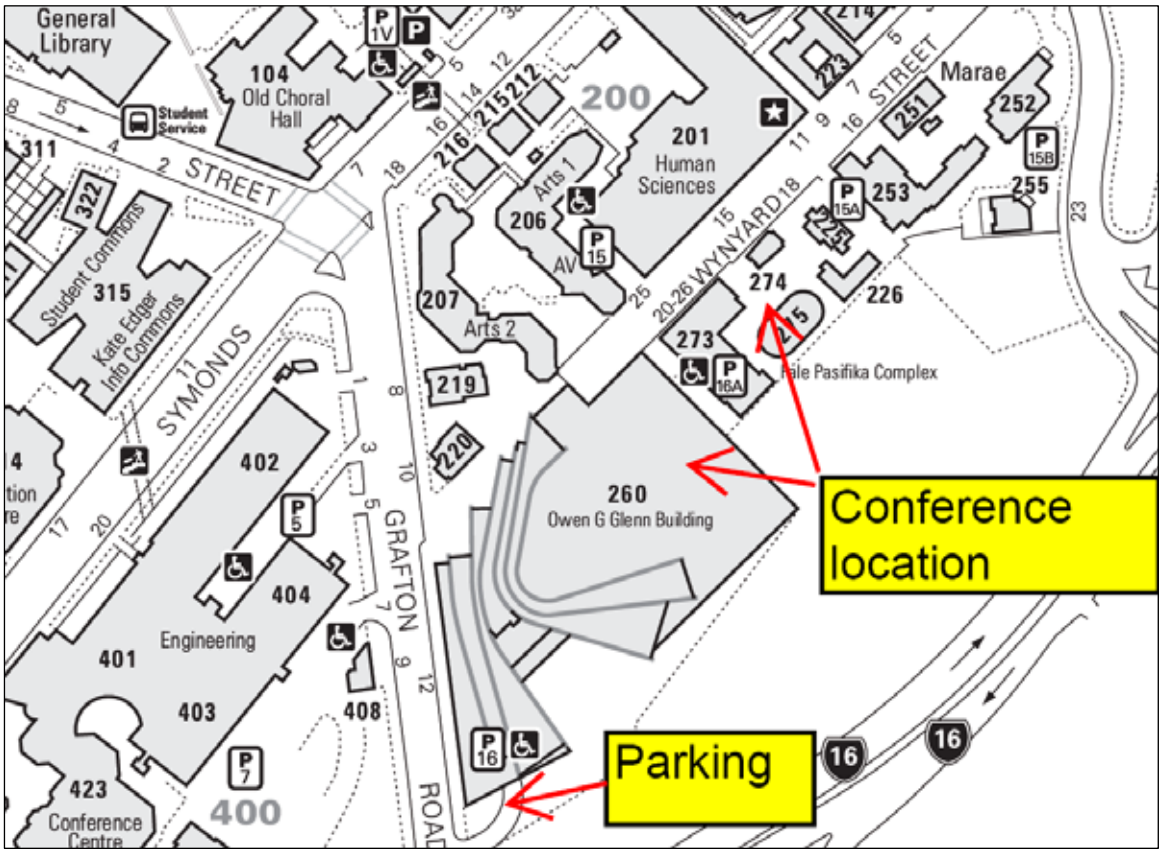
City Circuit Bus: Is a free public transport option for the Inner CBD. The bus travels along Queen Street down to Britomart on the waterfront, to Albert Park, Symonds Street and along Wellesley Street to the Sky Tower. The City Circuit operates seven days a week, every ten minutes between the hours of 8am to 6pm.

Car parking: there is a large car park under the Business School's Owen G Glenn Building and is accessible from Grafton Road in central Auckland.

- *Car park hours of business:* The car park is open as follows: Monday−Saturday 7am−11.30pm, Sunday 12pm−5pm
- *Casual hourly parking*: the car park can be used on a casual basis with costs as follows: Monday−Friday until 5pm: $4 per hour; weekdays after 5pm, and weekends: $5 per day.

Parking charges can be paid by credit card or cash. The car park is managed by Care Park Ltd who are contactable on 0800 CARE PARK (New Zealand only) or info@carepark.co.nz.

The site venue is depicted below; signage will be located around the venue to direct you to appropriate locations.



Things to do in Auckland

Below are some activities within easy reach of the University

Auckland Explorer Bus

The Auckland Explorer Bus is a Hop-On, Hop-Off sightseeing tour with full commentary visiting Auckland's Big 14 Attractions. Buses leave every 30 minutes from 9am from the Ferry building (10am in winter) or from 9.45am from the Sky Tower. The $30 adult all day pass allows you to get on and off all day with the same pass, or $15 child, $70 family. The tour covers a number of Auckland attractions, including Auckland Museum, Parnell Village, Kelly Tarlton's, Auckland waterfront, Mount Eden and Auckland Zoo, just to name a few. No booking is required but you can pay on our website, at the Ferry building or Sky Tower or to the driver. Free hotel/motel pick-up is also available 0800 439 756. www.explorerbus.co.nz

Auckland Regional Council

The Auckland Regional Council Parks network was established in 1965 and is made up of 26 different parks, covering more than 40,000 hectares of land with recreational, historic and ecological value. Access to all our parks is free of charge.
www.arc.govt.nz/parks/

Auckland Museum

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CONFERENCE PRESENTATIONS

Wednesday

08:30–onwards
Registration desk open

09:00–09:30
Refreshments and registration

09:45–11:30

Room 290-098 Welcome

09:45–10:00
Mark Costello
Chair Organising Committee

Stuart McCutcheon
Vice Chancellor, University of Auckland

10:00–10:30
Hon. Nick Smith
Minister of Climate Change

Wednesday

10:30–11:30

Room 290-098 Plenary

John Church
- john.church@csiro.au

Centre for Australian Weather and Climate Research – A partnership between CSIRO and the Bureau of Meteorology, CSIRO Wealth from Oceans Flagship And Antarctic Climate and Ecosystems Cooperative Research Centre, GPO Box 1538, Hobart Tasmania 7001

Sea-level rise: understanding, expectations and mitigation

Sea-level rise is one of the high profile aspects of climate change. The rate of sea-level rise has accelerated from the 19th to the 20th century and during the 20th century, when the average rate of rise was 1.7 mm yr^{-1}. Since the late 1980s the rate of rise has been over 3 mm yr^{-1}. It is not yet clear whether this is a further sustained acceleration. Sea level is not expected to rise uniformally around the globe but the distribution measured by satellite altimeters since 1993 is dominated by climate variability. Contributions to 20th and 21st century sea-level rise come from ocean thermal expansion, the melting of non-polar glaciers and ice caps and contributions from the ice sheets of Greenland and Antarctica. By 2095, compared to 1990, the IPCC projections are for a rise of 18 to 59 cm, plus an additional allowance of 10–20 cm (or more) from a dynamic response of the ice sheets. Sea level is currently tracking near the upper end of these projections, i.e. a rise of about 80 cm by 2100. Sea level may diverge above or below the upper end of these projections. An important issue is whether or not greenhouse gas concentrations will pass a threshold during the 21st century resulting in melting of the Greenland Ice Sheet exceeding precipitation, leading to an ongoing decay of the Greenland Ice Sheet and a sea level rise of metres from this source alone. Stabilisation of greenhouse gas concentrations at 450 ppm CO_2 - equivalent, requiring urgent, significant and sustained reduction in emissions, gives about a 50% chance of avoiding this threshold. In addition there is growing evidence of a dynamic response of the Greenland and West Antarctic Ice Sheets which could lead to a 21st century sea-level rise exceeding present projections. Sea-level rise will continue for centuries after stabilization of greenhouse gas concentrations. The 20th century sea-level rise has already led to more frequent flooding events of a given level. By 2100, tens of millions of people may be vulnerable each year to coastal flooding events associated with sea-level rise and extreme events. Appropriate mitigation measures and planning and adaptation actions can significantly reduce the number of people affected.

Wednesday

11:45–12:00

Room 290-098 Climate Change

Session Chair: Kim Dirks

Knowing which way the wind blows

Sam Dean, Brett Mullan, James Renwick
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NIWA, Wellington

In this paper we explore some of the uncertainties around projections for changes in precipitation over New Zealand as a result of anthropogenic global warming. Recent projections for New Zealand over the next century are based principally on the output of global climate models run as part of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, and combine large scale precipitation changes with circulation influences. In winter the climate models suggest precipitation increases in sub-polar regions and decreases in the sub-tropics. New Zealand lies on the boundary between these two regimes. The models are also in agreement that the westerly winds are likely to increase in the seasons of winter and spring. All else being equal current climate suggests that this will lead to an increase in precipitation on the west coast of both main islands and an associated decrease in the east. However, the models have indicated much greater uncertainty in the expected changes in the wind direction and strength for the seasons of Summer and Autumn. Here we investigate the underlying causes of the changing atmospheric circulations and consider whether a knowledge of these mechanisms can offer more insight into the likely changes in precipitation for regional New Zealand.

Wednesday

11:45–12:00

Room OGGB3 Ecology, Sediments

Session Chair: Abigail Smith

Factors influencing the abundance of toheroa (*Paphies ventricosa*) on Northland beaches: perspectives from the beach

Shade Smith[1], James Williams[2]
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[1]EAM Environmental Consultants, Napier; [2]NIWA, Auckland

Toheroa (*Paphies ventricosa*) are large infaunal surf clams which historically supported regionally important cultural, recreational, and commercial fisheries. The once extensive and abundant populations of toheroa on exposed surf beaches in Northland, Wellington, and Southland have declined substantially to levels where harvests are no longer permitted. The reasons for these population declines are poorly understood.

As part of a project to investigate factors that could influence the mortality and recruitment of toheroa, historical qualitative and anecdotal information on toheroa and the beaches they inhabit were gathered from people closely associated with Northland beaches. The key informant technique was used to gather the information. Informants expressed a range of views on factors that they felt influenced toheroa abundance and variability in recruitment. The range of factors expressed were analysed thematically with six themes identified, including the deleterious effects of vehicles, negative features of the customary permit system, attitudes on the loss of a stewardship ethic among Mäori, adverse effects from land use and land use practices, attitudes about the effects of cyclical weather patterns, and negative effects from the preferential harvest of large toheroa.

Natural processes were thought to have the largest influence on mortality and variability in recruitment, however, it was thought the cumulative effects of anthropogenic influences were likely to severely limit the ability of toheroa populations to recover from large scale natural mortality events or periods of poor recruitment. Informants also outlined measures aimed at restoring toheroa populations, including increased enhancement work, using better informed permit issuers, and the creation of harvesting free and vehicle free reserves. The results of this study will be discussed in relation to improving our understanding of toheroa population dynamics.

Wednesday

11:45–12:00

Room OGGB5 Ecology - Epiobiota

Session Chair: Richard Taylor

Sponge assemblage structure in the lagoons at Palmyra Atoll, Central Pacific

Ingrid Knapp, James Bell
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Centre for Marine Environmental & Economic Research, School of Biological Sciences, Victoria University

Palmyra Atoll is located at the North-western end of the Line Islands in the Central Pacific (5°53'N, 162°05'W), 1930 km south of Hawaii. The atoll consists of approximately 50 islets with 4 shallow lagoons surrounded by an extensive reef system. The atoll was essentially unaltered until the Second World War when the U.S. Navy enlarged the islets, dredged the lagoons, built an entrance channel for ships and a road to connect the islets. Sponges are rare on the outer reef systems at Palmyra, but can be found extensively within the lagoons. The anthropogenic changes made to the atoll over 50 years ago not only altered the lagoon system, but disrupted the water flow system between them, potentially resulting in the sponge-dominated ecosystem evident today. Here we describe the results of sponge surveys conducted at Palmyra Atoll including the identification and distribution of 2 non-indigenous species. Surveys were conducted over 12 sites across all 4 lagoons to assess the sponge species assemblages. At each site ten 1x1m quadrats were used to calculate sponge densities and area coverage per species as well as available boulder substrate. Multivariate statistics indicate significant variability in sponge assemblages between lagoons and sites and we suggest that these differences are potentially attributable to the alterations made to the lagoons during the war. These are the first recorded baseline surveys of sponge assemblages at Palmyra Atoll and will provide useful information for future research into the lagoon restoration and management.

Wednesday

12:00–12:15

Room 290-098 Climate Change

Session Chair: Kim Dirks

How might weather patterns change under climate warming?

Brett Mullan
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NIWA, Wellington

There is a popular myth that storms will become more frequent and/or more intense under global warming, but relatively few scientific analyses on this aspect of climate change. There is indeed growing observational support for increased extreme rainfall in a warmer climate, albeit not for New Zealand as yet. But what about the weather systems themselves? A changing mix of future weather patterns – for example, more westerly events but fewer easterlies – would have important implications not only for local land climate but also for coastal impacts such as wave setup and shoreline erosion.

This study makes use of daily mean sea-level pressure data from global climate models described in the IPCC Fourth Assessment report. Snapshots of once-daily pressure patterns are classified into one of 12 "Kidson weather types", which can be grouped more broadly into regimes characterised as troughs, zonal flow and blocking. The frequency of occurrence of different weather types in the model control climates (1971-2000) is a good way of validating these global models. Since the mix of weather types is also correlated to rainfall patterns, future changes in weather types can be used as a rainfall "downscaling" technique.

The presentation will include a discussion of model validation of New Zealand 20th century climate, and well as projected changes in weather patterns at the end of this century under different IPCC emission scenarios. The work forms part of a larger project on assessing future projections of New Zealand climate, including changes in climatic hazards such as drought and strong winds.

Wednesday

12:00–12:15

Room OGGB3 Ecology, Sediments

Session Chair: Abigail Smith

The green-lipped mussel, *Perna canaliculus*, in soft-sediment systems in northeastern New Zealand

Ian McLeod[1], Richard Taylor[1], Darren Parsons[2], Mark Morrison[2]

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[1]University of Auckland; [2]NIWA, Auckland

Reefs of *Perna canaliculus* formerly covered extensive areas of the Firth of Thames and supported a significant fishery. Overfishing using destructive techniques led to the commercial extinction of these reefs in the 1960s and they have not recovered.

Remnant mussel reefs were located and their extent and densities, size structures, condition, morphometrics, and productivities were described for the first time. Mobile invertebrate assemblages associated with mussel reefs had on average four times the average density, seven times the biomass, six times the productivity, and greater species richness than bare sediment areas. The mussel reef assemblage of species was significantly different from that of adjacent, bare areas; the assemblage has the highest secondary productivity of any marine habitat yet recorded in New Zealand, 977 g AFDW m^{-2} y^{-1}, of which 729 g AFDW m^{-2} y^{-1} was contributed by the mussels, and 248 g AFDW m^{-2} y^{-1} by mobile invertebrates; mussel-associated fish assemblages were not species rich but had a ten-fold higher density of fish than adjacent areas.

Calculations based on historical ranges of mussels in Firth of Thames reveal mobile invertebrate productivity has likely reduced by 390–33,000 T AFDW y^{-1} — a wide range estimate due to widely varying estimates of mussel densities in earlier studies. This productivity could have supported 200–16,000 T wet mass y^{-1} of small predatory fish. Historical mussel reefs could have filtered the entire volume of Firth of Thames in less than a day (upper density estimate), whereas remnant mussel reefs would take ~ two years. Mussel reefs could have had important impacts on benthic-pelagic coupling.

An *in situ* experiment along a putative turbidity gradient showed that adult mussels could survive, grow, and maintain condition within their former range in the Firth of Thames. Results from this experiment indicate the recruitment limitation is the likely reason for the lack of recovery of mussel reefs.

Wednesday

12:00–12:15

Room OGGB5 Ecology - Epiobiota

Session Chair: Richard Taylor

Survey of viral community assemblages associated with hermatypic corals in relation to environmental variables in the Central Pacific

William Arlidge, Simon Davy, Joanne Davy

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School of Biological Sciences, Victoria University

The current study focuses on surveying marine virus community assemblages in relation to environmental variables on Coconut Island, Hawaii. Direct comparison of marine virus like particle (VLP) community assemblage in relation to distance from the coral colony in the water column was looked at, with additional data on variability in VLP abundance across an individual colony through time included in the study. Samples were taken from the coral mucus layer secreted by the corals, and the surrounding seawater (20cm) above the colony. VLP abundance was quantified using epifluorescene microscopy (EfM), utilising the nucleic acid stain SYBR Gold, with the current study begin the first time that epifluorescence has been applied to enumeration of VLP from coral mucus. VLP diversity was determined using transmission electron microscopy (TEM) and catergorised according to morphological shape. Collection of samples was undertaken with snorkel, using sterile syringes and fixed immediately after collection. Samples were then fixed to slides or spun down to copper grids for EfM and TEM respectively. Results and their implications will be discussed. The basic survey of marine virus community assemblages associated with corals will provide important information on virus abundance and diversity across the two sites, giving a more holistic view of the coral organism, the effects of environmental variables on viral communities, and the overall health of coral reef ecosystems.

Wednesday

12:15–12:30

Room 290-098 Climate Change

Session Chair: Kim Dirks

Combining atmospheric observations and models to estimate regional sources and sinks of atmospheric CO_2

Sara Mikaloff-Fletcher[1], Andrew R. Jacobson[2,3], Kenneth A. Masarie[2], Britton Stephens[1], Sylvia Nichol[1], Gordon Brailsford[1],Kim Currie[4]

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NIWA: [1]Wellington, [4]Dunedin; [2]National Oceanic and Atmospheric Administration, Earth Systems Research Laboratory (NOAA-ESRL), Colorado, USA; [3]Cooperative Institute for Research in the Environmental Sciences (CIRES), University of Colorado, USA

Human beings have emitted 251 Pg C to the atmosphere between 1960 and 2006 from fossil fuel burning and cement production, yet atmospheric CO#$_2$ observations indicate that only 56% of these emissions have remained in the atmosphere. This implies that the oceans and the terrestrial biosphere take up nearly half of anthropogenic fossil fuel emissions. Some climate change mitigation strategies rely on protecting or enhancing these natural sinks to reduce atmospheric CO#$_2$ levels. Despite the first order importance of the natural carbon cycle in determining future atmospheric CO#$_2$ concentrations and planning global and regional carbon budgets, there are still major gaps in our understanding of their magnitude, variability and potential climate feedbacks.

NIWA, NOAA, CSIRO, and other agencies monitor atmospheric CO#$_2$ at a globally distributed network of observing sites. This observing network includes weekly flask samples, continuous analyzer data, tall towers, column integrated data from upward-looking instruments, and samples collected on aircraft or ships. In order to integrate this diverse range of observations with independent bottom-up estimates of the sources and sinks of atmospheric CO#$_2$, NOAA-ESRL recently developed a data assimilation system called CarbonTracker. This model estimates regional air-sea and air-land fluxes CO#$_2$ fluxes that are optimally consistent with the atmospheric CO#$_2$ observations and process-level understanding of the sources and sinks using an atmospheric transport model coupled to an ensemble Kalman filter. CarbonTracker has been shown to be consistent with a wide collection of carbon inventories and evaluated against aircraft observations.

The CarbonTracker model was initially developed with a focus on North America, and has been successfully adapted for Europe and Asia. We present the first results from CarbonTracker-Australasia, a new version of the CarbonTracker model developed with an emphasis on New Zealand, Australia, and the Southern Ocean. This version of the model incorporates NIWA observations not included in previous versions of the model and a recently created nested high-resolution grid over Australia and New Zealand.

Wednesday

12:15–12:30

Room OGGB3 Ecology, Sediments

Session Chair: Abigail Smith

Variation in the functional role of *Helice crassa* in differing sediment environments

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[1]University of Waikato; [2]NIWA, Hamilton

Burrow builders, by creating tunnels in the sediment, alter the surface area over which biogeochemical processes occur. The construction and maintenance of burrows also mixes and oxygenates sediments, collectively enhancing microbial activity and remineralisation rates. The degree to which bioturbation alters these processes is dependent on the density, morphology and permanency of burrow structures; factors that are likely to vary with sediment type. This study assessed the burrow properties of a dominant intertidal mud crab, *Helice crassa*, quantifying crab demographics and burrow properties across a sediment gradient from cohesive mud to medium sand. Crab and burrow density varied as a function of grain size, with greatest numbers of both occurring in muddy locations. Burrow to crab ratios ranged from 3.5 to 5.0 in mud and 1.1 to 3.4 in fine sand. Within mud almost 40% of monitored burrows were still present after 62 days, whilst all burrows in sand had collapsed after only 5 days. Resin casts displayed seven distinct burrow forms; however, morphology did not vary significantly with sediment type or burrow size. In muddier sediments burrows were generally shorter and, with increased density, showed a reduction in volume. Conversely, those in sandier sediments were deeper with a greater volume, despite being more transient. These factors suggest that the primary effects of *H. crassa* bioturbation are dependent on sediment properties. In sand, where burrow turnover is rapid, *H. crassa* primarily influences sediment turnover and vertical mixing. In muddy sediments, where burrow density is greatest and structures are stable, their main impact is through extension of the sediment surface area over which nutrient exchange can occur. *Helice crassa* is therefore capable of altering the pathway of solute and particle fluxes dependent on its sediment environment, influencing the functioning of both benthic and pelagic ecosystems in differing ways.

Wednesday

12:15–12:30

Room OGGB5 Ecology - Epiobiota

Session Chair: Richard Taylor

Temporal and spatial sponge assemblage variability in temperate waters

Jade Berman, James Bell
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Centre for Marine Environmental & Economic Research (CMEER), Victoria University

In order to understand how ecosystems function it is important to understand patterns of spatial and temporal variability, and the forces that drive such patterns. Biological communities are intrinsically variable, therefore measuring this variability is essential for effective conservation and management of marine environments. Sponges have many functional roles within benthic ecosystems and therefore changes in their abundance or assemblage structure are likely to influence other benthic organisms and ecosystem characteristics.

To date, there have been conflicting reports regarding the stability of sponge assemblages, for example, past research from the Mediterranean, the Atlantic and Caribbean has shown sponges to be temporally stable, yet more recent work from the Atlantic, Caribbean and the Pacific suggest that more rapid changes in sponge assemblages are common.

Here we compare the patterns of temporal variability in sponge assemblages within temperate habitats in the two hemispheres. We analysed changes in New Zealand and Welsh (UK) sponge assemblages to determine if there are any consistencies in the rates of assemblage change at seasonal and inter-annual scales between these regions separated at oceanic scales. We describe how identifying similarities and differences in assemblage variability can help elucidate the factors controlling patterns of natural variability in sponge assemblages.

Wednesday

12:30–13:30

OGGB - LUNCH

Wednesday

13:30–14:00

Room 290-098 Plenary

Pumping Iron to Save the Planet?

Cliff Law[1], Phil Boyd[2]
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[1]NIWA Wellington; [2]NIWA Centre of Excellence, Department of Chemistry, University of Otago

Various geoengineering options are currently being considered to arrest the build-up of CO2 in the atmosphere. Of these, ocean fertilisation by the addition of iron or other nutrients is receiving considerable attention, with commercial organisations actively promoting this option. Provisionally the evidence from the 12 mesoscale experiments to date appears promising, as these have stimulated phytoplankton growth to various degrees by the addition of iron, occasionally with resulting blooms evident in satellite images. However evidence of the subsequent transfer of the additional particulate carbon from the iron-induced bloom into the deep ocean is limited and so the efficacy of iron fertilisation is uncertain. The feasibility of large scale fertilisation, in terms of practicality and verification, presents major challenges, and the potential side-effects including enhanced trace gas production, oxygen depletion and far-field nutrient depletion remain areas of concern. Until recently international legislation on ocean fertilisation has been lacking, although efforts are now underway to include this in the London Convention on Dumping. This talk will critically examine the results of previous iron addition experiments in the context of ocean fertilisation, and the issues relating its application as a geoengineering option to increase ocean carbon sequestration.

Wednesday

14:00–14:15

Room 569 Climate Change

Session Chair: Kim Dirks

Effect of submerged plateaux on Pleistocene gyral circulation and sea-surface temperatures east of New Zealand – predicting patterns of future warming

Bruce Hayward[1], George Scott[2], Martin Crundwell[2], Ashwaq Sabaa[1], Helen Neil[3]
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Pleistocene records of sea surface temperature (SST) indicate that predicted future warming east of New Zealand is unlikely to be uniform. In the mid-latitude open ocean, warm surface water masses cool and move equatorward during glacial coolings, and polarward during interglacial warmings resulting in relatively simple, predictable SST changes. Our studies of 1100 planktic foraminiferal faunas from 4 cores extending back 1 million years, provide proxy records of SST (artificial neural network estimates) through 13 glacial-interglacial cycles. These show that SST changes were highly variable east of New Zealand with interglacial to glacial ranges of mean annual SSTs of 3–16°C near the head of Bounty Trough, but only 10–19°C along the north side of Chatham Rise. We infer that this variability results from the interaction between surface currents and fronts with the complex submerged topography. The Subtropical and Subantarctic Fronts appear to have remained aligned with the Chatham Rise and southeast side of Campbell Plateaux respectively through all cycles. Strong jetting of surface waters northwards (during glacials) and southwards (during interglacials) through Mernoo Saddle (west end of Chatham Rise), and northwards (during glacials) through Pukaki Saddle (between Campbell and Bounty Plateaux) is inferred to have produced much of the observed SST variability. Our results suggest that in the next few centuries surface waters in the west Bounty Trough will warm more than those east of the North Island.

Wednesday

14:00–14:15

Room OGGB3 Ecology, Sediments

Session Chair: Abigail Smith

Seagrass restoration: success of a small-scale transplantation trial in Whangarei Harbour

Fleur Matheson[1], Jacquie Reed[2], Virginie Dos Santos[1,3], Vonda Cummings[4], Graeme McKay[5] and Marie Jordan[5]

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NIWA: [1]Hamilton, [4]Wellington, [5]Ruakaka; [2]Northland Regional Council, Whangarei; [3]University of Waikato

Seagrass meadows once covered 14 km^2 of Whangarei harbour. Anthropogenic pollution and dredging activities caused these meadows to retreat and since the 1970s seagrass has been restricted to isolated intertidal pockets. Recent research suggests that water and sediment quality at some former sites has improved and is sufficient to support seagrass growth once more. Options for restoration of seagrass to former sites have been considered and transplantation from remnant patches was regarded as the best option. The largest remnant seagrass bed near One Tree Point was selected as a donor site and a former site near Takahiwai as the receiving site. Replicate plots of seagrass were transplanted from One Tree Point to Takahiwai in April 2008 using three methods: 1) sprigs, 2) sods, and 3) artificial seagrass mats with sprigs. The transplantation plots and sites have been monitored every three months with assistance from the local *kaitiaki roopu*. In the year following transplantation seagrass cover in sprig and sod transplant plots increased from < 30% immediately after transplantation to > 75% in April 2009. Transplant plots using artificial seagrass mats with sprigs were less successful apparently due to shading from the artificial plant canopy. Seagrass cover at the wider Takahiwai site more than doubled from 15 % to 39 % between April 2008 and April 2009 with approximately half of this increase attributed to the transplants and the remainder to natural recovery. Complete recolonisation of donor plots at the One Tree Point site occurred in 9 months. The results after one year suggest that the transplantation activity has been highly successful. However, monitoring will continue for at least one more year to determine longer-term success.

Wednesday

14:00–14:15

Room OGGB5 Ecology - Epiobiota

Session Chair: Richard Taylor

Rate of utilisation of nutrients and diet composition of sponge assemblages on Wellington's south coast

Alejandra Perea Blázquez[1], Kylie Price[2], Simon Davy[1], James Bell[1]

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[1]Victoria University, [2]Malhagan Institute of Medical Research, Wellington

Little is known about the ecology and functional roles of the New Zealand sponge fauna compared with other temperate regions. The aims of our research were to investigate interactions between sponges and the water column, their importance to nutrient dynamics, effects on water column nutrient concentrations, food supply, and ecosystem functioning.

Due to their high abundance, high filtration capacity, and heterogeneous diet, sponges may be important in influencing nutrient dynamics in New Zealand coastal ecosystems. We describe our results for abundant and widely distributed sponge species from two sites along Wellington's south coast within the Taputeranga Marine Reserve. These sites were selected due to the high abundance and diversity of sponges that are found living on the rocky subtidal substrates.

Feeding efficiencies were calculated for each species with regards to each group of micro-planktonic organisms found in seawater samples collected *in situ* and analysed by flow cytometry. Concentrations of nutrients [silicate (SiO_2), nitrite (NO_2^-) nitrate (NO_3^-), ammonia (NH_3) and phosphate (PO^{3-}_4)] removed by sponges from the ambient and exhalent water samples was determined. We describe how the results from this work will help answer two main questions. Are any differences between the amount and type of food processed between different study species apparent? Is there variability in the nutrient uptake and production among different species? We suggest that the amount of material removed by sponges from the water column coupled with their high filtration rates means that they are likely to have important impacts on coastal marine ecosystems where they are abundant.

Wednesday

14:15–14:30

Room 290-098 Climate Change

Session Chair: Kim Dirks

Argo: observations of climate-related variability and change in the global ocean and the South Pacific

Phil Sutton[1], Dean Roemmich[2]
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[1]NIWA; [2]Scripps Institution of Oceanography, USA

The International Argo Programme is now 10 years old. Its primary goal, as conceived in 1999 is to create a global network of profiling floats providing temperature and salinity profile measurements of the upper 2000 m of the ocean, plus mid-depth drift velocities, to integrate with other elements of the climate observing system.

Global coverage of the Argo Programme has been achieved since 2004, and since late 2007 Argo has reached its target of over 3,000 active floats providing more than 100,000 T/S profiles per year. A NZ/US collaboration plays a major role in Argo through deployment of floats in the remotest regions of the ocean. The impact of Argo on the sampling of the oceans is especially significant south of 30°S, and even more dramatic during historically poorly sampled winter months. In a single winter Argo obtains more T/S profile data south of 30°S than in all winters combined from the pre-Argo history of oceanography.

Argo has already provided a wealth of information on changes in the South Pacific and the global ocean, including observations of decadal change from comparing Argo with historical data, and changes within the 5-year period of global Argo implementation. Here we review recent work that uses Argo data to address global change in ocean heat content and steric sea level, salinity in relation to the hydrological cycle and ocean circulation, and show new results for the South Pacific. The dominant role of the southern hemisphere in decadal global ocean warming is emphasized.

Wednesday

14:15–14:30

Room OGGB3 Ecology, Sediments

Session Chair: Abigail Smith

Mass mortality of cockles in the Whangateau Harbour: consequences and possible causes

Karen Tricklebank[1], Roger Grace[2], Conrad Pilditch[3], Graham Marsden[4] and Lesley Rhodes[5]
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[1]Leigh Marine Laboratory, University of Auckland, and Private Consultant; [2]Private Consultant; [3]University of Waikato, Hamilton; [4]Whangateau Resident, [5]Cawthron Institute, Nelson

An unusual mass mortality of cockles (*Austrovenus stutchburyi*) occurred in the Whangateau Harbour during the months of January through to April 2009. The Whangateau Harbour lies about 70 km northeast of Auckland city and is often regarded as being one of the healthiest and most valuable estuaries in the wider Auckland region. It supports an important recreational cockle fishery, with most harvesters travelling from the city to gather shellfish. Monitoring of cockle populations by undergraduate students and by local community groups has shown a dramatic reduction in the density and biomass of cockles in the Harbour since this mortality event. A number of lines of investigation are being followed to help determine a possible cause for the mortality.

Wednesday

14:15–14:30

Room OGGB5 Ecology - Epiobiota

Session Chair: Richard Taylor

Symbiosis re-establishment in *Aiptasia* sp.

Dorota Starzak[1], Rosanne Quinnell[2], Simon Davy[1]
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[1]Victoria University, Wellington; [2]The University of Sydney, Australia

The symbioses between anthozoan cnidarians (i.e. corals, sea anemones, zoanthids and gorgonians) and dinoflagellate symbiont (commonly referred to as zooxanthellae) of the genus *Symbiodinium* are responsible for the formation of coral reefs which, in turn, maintain a rich biodiversity in shallow tropical waters and thus are vital in sustaining the coastal communities in these regions. In recent years there has been an increase in the frequency and severity of global episodes of coral bleaching (coral whitening due to mass expulsion of symbiotic algae and/or loss of photosynthetic pigments from individual zooxanthellae) resulting in degradation and mortality of coral reefs. To understand mass-bleaching events more insight is necessary into the physiological and molecular interactions involved in breakdown of symbiotic associations; there is a need to understand how the cnidarian-dinoflagellate symbiosis is initiated, integrated and maintained. This study examines the photosynthetic performance of symbionts and the translocation of carbon from symbiont to host during the course of symbiosis re-establishment, to assess the autotrophic potential of the association during recovery from bleaching. Symbiont-free anemones of the genus *Aiptasia* were used and reinfected with different *Symbiodinium* strains. Over the course of eight weeks maximum photosynthetic and dark respiratory oxygen fluxes were measured by micro-respirometer. The translocation rate of photosynthetically fixed carbon from the symbionts to the host was also estimated, by assuming that fixed carbon not utilised in algal growth was available for release. These various fluxes were then used to infer the potential contribution of different strains of zooxanthellae to the host's daily respiratory carbon requirements during symbiosis re-establishment. The various photo-physiological patterns observed will be described, as will the implications for the recovery of corals from bleaching events.

Wednesday

14:30–14:45

Room 290-098 Climate Change

Session Chair: Kim Dirks

Seasonal and interannual variations in the vertical transport of organic and inorganic carbon to the deep ocean

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Since 2000, deep-ocean moorings have been deployed in subtropical and subantarctic waters to the east of New Zealand, collecting data on the physical, biological and chemical processes in the water column (e.g., stratification, vertical mixing, pelagic biological community changes, downward particle flux). In tandem, remotely sensed data from the same time provide insights into surface biological (e.g., ocean colour) and physical processes (e.g., sea-surface temperature and height). We are now linking these important data-sets to evaluate the temporal and spatial variations in marine ecosystems, and to determine relationships between surface productivity and export flux of particulate organic and inorganic carbon to the deep ocean. In subtropical waters, a strong seasonal cycle in surface chlorophyll biomass, dominated by a persistent diatom-dominated algal bloom in spring, is coupled with high rates of organic matter export, whereas a moderate autumn biomass peak is possibly lagged with organic flux by an order of months. In contrast, in subantarctic waters, the annual peak in biomass occurs in summer and is not mirrored by high export rates; rather, the highest export of organic matter occurs in spring, even though spring surface productivity is only moderate. These trends seem to persist over inter-annual timescales, although there is considerable variability, especially in the flux data, related to the processes by which organic material is “repackaged” and exported to depth, with carbonate and siliceous zooplankton potentially playing significant roles. Locally validated proxies for organic carbon concentrations in surface waters, derived from remotely sensed data, enable the deep ocean export flux data to be put into broader temporal and spatial contexts. The relationships of these long-term trends in surface productivity and particle flux to climate-scale drivers of marine production will be discussed and evaluated.

Wednesday

14:30–14:45

Room OGGB3 Ecology, Sediments

Session Chair: Abigail Smith

Creatures of the mud — mangrove forest invertebrate infaunal assemblages in Tauranga and Auckland

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Many estuaries inhabited by mangroves are subject to numerous human-induced adverse influences, such as stormwater and industrial discharges and the dumping of rubbish and debris. Furthermore, mangroves have been ill-regarded by many New Zealanders as worthless, smelly and undesirable places. Consequently, mangrove forest ecology remains not well studied.

Estuaries in Tauranga and Auckland have been studied by Boffa Miskell between 2006 and 2009 for a variety of resource consent and monitoring projects. Soft-sediment invertebrate infaunal assemblages were sampled by way of extracting organisms from sieved sediment cores. Surface sediment grain-size composition was also analysed.

Multivariate analysis of the collective data helps to characterise the infaunal communities and answer some of the current gaps in our understanding of the ecological values of the invertebrate communities that inhabit mangrove forests. We discuss these ecological values in light of current political pressure for Regional Councils to issue resource consents to enable the removal of mangrove forests in Tauranga and Auckland.

(contd) … this investigation will be presented and implications of these findings discussed.

Wednesday

14:30–14:45

Room OGGB5 Ecology - Epiobiota

Session Chair: Richard Taylor

The contribution of symbiotic dinoflagellates to the osmotic balance of their anthozoan hosts

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Victoria University

It is well documented that osmotic stress can elicit a breakdown in the anthozoan-dinoflagellate symbiosis (e.g. coral-zooxanthellae symbiosis), causing the expulsion of the dinoflagellate symbionts from the host, otherwise known as bleaching. In addition, there has been recent speculation that other stressors that elicit bleaching, i.e. temperature, UV etc, may cause bleaching though an osmotic stress mechanism due to the inhibition of photosynthesis. Despite this, virtually nothing is known about osmoregulatory mechanism of the intact symbiosis.

Coral bleaching caused by climatic change and other anthropogenic perturbations is the biggest threat facing coral reefs and the massive abundance of diversity and biomass that they support. Loss of a host's source of photosynthetic carbon results in reduced productivity and even death, which on coral reefs may ultimately have catastrophic impacts on reef framework-building, and thus associated biodiversity. It is therefore imperative that we improve our understanding of the physiological mechanisms that cause bleaching, and how the intact anthozoan-dinoflagellate symbiosis mediates osmotic stress.

Anthozoans are osmoconformers, maintaining internal osmolarity the same as that of the external environment. The anthozoan-algal symbiosis is defined by the transfer of osmotically active compounds, mainly from the algal symbiont to the host in the form of sugars and free amino acids (FAAs). These photosynthetically derived compounds acting as compatible organic osmolytes (COOs) may reduce the need for the host to a) use detrimental inorganic ions, or b) produce its own COOs to maintain osmotic balance. Thus it was hypothesised the translocation of these potential COOs from algal symbionts may contribute to the osmoregulatory mechanism of the anthozoan host.
Using a model species, the symbiotic anemone *Anthopleura aureoradiata*, research was carried out to assess how osmotic stress affected quantity and composition of intracellular FAA pools between symbiotic and aposymbiotic specimens. This data was then combined with respiration data, as a proxy for stress, to establish extent to which the difference in FAA pools and presence of algal symbionts influenced the host's ability to cope with osmotic stress. Results from ..

Wednesday

14:45–15:00

Room 290-098 Climate Change

Session Chair: Kim Dirks

Dramatic reduction in UV radiation observed in New Zealand from Australian bushfire plume

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We report on effects of the catastrophic fires that ravaged Victoria, Australia in February 2009, as observed 2,500 km away at in Lauder, Central Otago (45°S, 170°E), New Zealand.

Visible effects at Lauder were strongest around 03:00 UTC on 8 February 2009, when the sky became a very dark orange colour. Reduction in sunlight at UV wavelengths was even more dramatic, with UV intensities reduced to record low values — less than 0.1% of corresponding clear sky values for sun-burning UV irradiance.

Back trajectory analyses clearly identified the Australian bushfires as the origin of the effects seen at Lauder. Some of the aerosol was entrained into the stratosphere, where it persisted for several weeks and circled the globe, as seen in elevated lidar backscatter signals at 17 km altitude and confirmed by further back-trajectory analyses.

(contd.) …tissue during the survey, and between <20 and 170 MPN/100 g tissue seven days later. Microbial source tracking (MST) markers (using end-point PCR assays) indicated that faecal contamination in water and mussel samples was primarily of ruminant origin (cows, sheep). We applied three different human-specific markers; however, these were not detected in any of the water or mussel samples. The detection of an MST marker specific to faecal bacteria (*Bacteroides*) from farmed animals within the guts of filter-feeding mussels living ~ 6 km offshore highlights the close connection between land use and New Zealand's highly valued coastal resources.

Wednesday

14:45–15:00

Room OGGB3 Ecology, Sediments

Session Chair: Abigail Smith

Cow poo swims the distance: tracking faecal contaminants in the Motueka River plume

Chris Cornelisen, Paul Gillespie, Marek Kirs, Paul Barter, Eric Goodwin, Reid Forrest, Ben Knight, Roger Young, Aaron Quarterman
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Cawthron Institute, Nelson

The sustainability of New Zealand's coastal ecosystems and resources is strongly linked to the nature and intensity of land use in adjacent catchments and the resulting input of non-point source pollution and associated contaminants. Land-derived contaminants concentrate and mix at the land-sea interface, making it difficult to determine their source(s) and the extent to which they affect the coastal environment. As part of the Motueka Integrated Catchment Management programme, we conducted a biophysical survey of the Motueka River plume during a moderate flood event (peak ~ 400 m^3/s) to delineate the plume and assess the source and fate of faecal contaminants entering Tasman Bay. Water quality indicators; i.e. faecal indicator bacteria (FIB), nutrients and turbidity were measured in the river during the event and in surface waters of the Bay following the event. The plume was delineated by towing a remotely operated CTD that continuously measured salinity, temperature, turbidity, and irradiance along transects between the river mouth and New Zealand's largest Aquaculture Management Areas (AMAs), located ~ 6 km from the river mouth. Moored cages containing mussels for monitoring accumulation of faecal bacteria along with two physical moorings with CTDs and current meters were placed along the main transect. River water samples in upper and lower regions of the catchment revealed *E.coli* counts up to 9000 MPN/100 ml and *Enterococci* counts up to 7000 MPN/100 ml during peak flow. Salinity, temperature and turbidity data from CTD transects revealed that the plume extended well into Tasman Bay and corresponded with water quality indicator data. Elevated FIB in surface waters of ~ 100 MPN/100 ml at the furthermost stations indicated that faecal bacteria were transported as far as the AMAs. Mussels from moored cages as well as those attached to a surface float within an AMA had counts of 1300 to 2200 MPN/100 g …

Wednesday

14:45–15:00

Room OGGB5 Ecology - Epiobiota

Session Chair: Richard Taylor

Effects of thermal and oxidative stress on health of symbiotic dinoflagellates

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Victoria University

This study aimed to determine whether the differing thermal sensitivities of symbiotic dinoflagellates (*Symbiodinium* spp.) from corals and other host invertebrates are related to differing capacities to tolerate oxidative stress. *Symbiodinium* strains were selected from geographical areas with differing thermal regimes (e.g. tropical, subtropical, temperate).

To test the effects of thermal stress, these different strains were kept at temperatures of 25–35°C. Oxidative stress caused by Reactive Oxygen Species (ROS) was induced by adding hydrogen peroxide, rose bengal or methyl viologen to suspensions of *Symbiodinium* cells. Photosynthetic health was assessed by Imaging Pulse Amplitude Modulated (IPAM) fluorometry and results were corroborated by measurements of oxygen production (photosynthesis), respiration rate, and chlorophyll *a* and c_2 content.

Photosynthetic health and capacity declined in all types of *Symbiodinium* when faced with increasing temperatures and increasing ROS concentrations. Nonetheless, the dissimilar strains differed in the extent of their reactions. The results showed that 4 mmol of hydrogen peroxide decreased the photosynthetic health (Fv/Fm) of a tropical *Symbiodinium* type by 87 % over four hours while the same treatment had a minimal effect (11 % decrease) on the photosynthetic health of *Symbiodinium* from the temperate anemone *Anthopleura aureoradiata*.
Our preliminary data suggest that *Symbiodinium* strains display different susceptibilities to oxidative stress that are consistent with their thermal susceptibilities and biogeographic ranges. We will discuss the implications of our findings in terms of coral survival and biogeography as our climate warms.

Wednesday

15:00–15:15

Room 290-098 Climate Change

Session Chair: Kim Dirks

Description of the nature and purpose of the National Climate Database

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NIWA, Wellington

The National Climate Database is a "nationally significant database" funded by the government and operated by NIWA. The database stores a variety of climate information from climate stations around New Zealand, the Pacific and Antarctica. The database includes about 6500 stations from 1850 to the present with some stations being updated hourly. It is designed for storing and accessing the long term, high quality data that is necessary to understand and measure the climate of New Zealand.

Since the introduction of free web access to the database two years ago, use of the database has grown rapidly. Users include scientists, engineers, consultants, farmers, councils, companies reliant on climate information and interested individuals.

This talk will provide an overview of the Climate Database including:

Data sources: NIWA's climate network and other accessed networks.

Data organisation: how observational data is organised, processed statistical data sets, virtual climate network grid and quality control.

Data extraction: free web access through CliFlo <http://cliflo.niwa.co.nz/> and fee for service specialised products.

Current and future developments.

Wednesday

15:00–15:15

Room OGGB3 Ecology, Sediments

Session Chair: Abigail Smith

Seagrass condition and environmental parameters in two New Zealand estuaries

Virginie Dos Santos[1,2], Fleur Matheson[1], Conrad Pilditch[2], Arnaud Elger [3]

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[1]NIWA, Hamilton; [2] University of Waikato; [3]University Paul Sabatier, Toulouse, France

Seagrass decline has occurred worldwide including in New Zealand. Globally, coastal sedimentation and eutrophication are considered to be the main contributors to seagrass decline; however there are other potential stressors, often operating at the local or regional scale, including outbreaks of wasting disease, damage from herbicides and other chemicals, physical damage from fishing, harbour development and recreational activities, competition from invasive plants and overgrazing by waterfowl (e.g. black swans).

Here we assess seagrass condition and a range of environmental parameters considered indicative of the above stressors in two New Zealand estuaries: Tauranga (east coast) and Aotea (west coast) harbours. Five sites in each harbour have been studied. Seagrass meadows in Aotea harbour are extensive and a large proportion of the catchment is forested. Seagrass meadows in Tauranga harbour have declined by one-third since the 1950s, although some extensive meadows remain. The five sites selected in Tauranga harbour were perceived to provide a strong gradient in seagrass condition and exposure to anthropogenic stressors, while the five sites in Aotea were considered more homogeneous. The first results of co-inertia analysis have confirmed these perceptions. The results of more extensive multivariate analysis of the dataset will be discussed.

Wednesday

15:00–15:15

Room OGGB5 Ecology - Epiobiota

Session Chair: Richard Taylor

The *Aiptasia* sp./*Symbiodinium* sp. symbiosis — infection dynamics and cell proliferation

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Victoria University

The regulation of both host and symbiont cell growth and division is essential to the initiation and maintenance of a stable symbiotic relationship. We describe the spatial and temporal patterns of symbiosis establishment in the symbiotic sea anemone *Aiptasia* sp., as determined by confocal microscopy, when infected with cultured clade B *Symbiodinium* sp. dinoflagellates (type FlAp2). Furthermore, once the symbiosis reaches a stable state at 4 weeks post-reinfection, we describe: 1) the asynchronous nature of host and symbiont cell division; 2) the relationship of host and symbiont cell division rates to host body zones, as determined by BrdU (Bromodeoxyuridine) labelling, and 3) the relationship of symbiont cell division to light/dark cycles.

The *Aiptasia*/*Symbiodinium* symbiosis is widely used as a model system for the study of cnidarian / dinoflagellate symbiosis, and data gained from the study of this system will provide insight into the processes that govern the stability of other such symbioses, for example in coral bleaching events. We will therefore discuss the significance and wider implications of our model-system data in this presentation.

Wednesday

15:15–15:30

Room 290-098 Climate Change

Session Chair: Kim Dirks

Seasonal and spatial variability of chlorophyll-a in the Subtropical Convergence

Katherine Baer[1], Kim Currie[2], Christina McGraw[1], Philip Boyd[2], Keith Hunter[1]

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The Subtropical Convergence (STC) is an oceanographic frontal system characterised by the convergence of subtropical and sub-Antarctic water masses. Studies from the STC region off eastern New Zealand reveal high seasonal variability in surface CO_2 (pCO_2) partial pressure. While some of this variability may be attributed to thermodynamic processes from mixing, temperature gradients and wind events, data also indicate that biological production is a major driver in spatial and temporal variability of air-sea pCO_2 fluxes.

To determine the relative productivity and distribution of marine biota in the STC, monthly ocean colour plots from the NASA Sea-viewing Wide Field-of-View Sensor (SeaWiFS) were used to estimate chlorophyll-a pigment concentration. Accuracy of these mesoscale colour plots was verified by comparing *in situ* and flourometrically determined chlorophyll-a and hydrographic data obtained from bi-monthly sampling trips across the STC.

Combined analyses provide a better understanding of the dynamics of phytoplankton productivity and biological uptake of carbon in the STC. These plots also help quantify the relative contribution of biological production as a driver for CO_2 uptake in the STC in relation to other thermodynamic and biogeochemical processes. As changes in surface pH and pCO_2 flux are consistent with dissolved inorganic carbon uptake at Redfield ratios, the ocean colour plots also serve as a proxy to seasonal variations in surface pH and air-sea pCO_2 gas exchange within the STC region. By examining changes in the oceanic carbonate system and the response of physical, chemical, and biological feedbacks, it is possible for scientists to predict future oceanic conditions in a high atmospheric CO_2 environment.

Wednesday

15:15–15:30

Room OGGB3 Ecology, Sediments

Session Chair: Abigail Smith

Changes in ecosystem functioning on sandflats disturbed by thin deposits of terrigenous sediment

Drew Lohrer[1], Ivan Rodil[2], Luca Chiaroni[1], Judi Hewitt[1]

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During rain events Whangapoua Estuary (Coromandel Penninsula) receives high loadings of eroded terrestrial soils. Previous studies have shown that deposits as thin as 5 mm can reduce the abundance and diversity of estuarine sandflat macrofauna. Here, we investigate the broader consequences of such disturbance, specifically the influence of terrigenous sediments on ecosystem functions mediated by sandflat organisms: sandflat primary production and nutrient cycling. Deposits of terrigenous sediment were applied at three sites in the inner, middle and outer Whangapoua Estuary. Sediment treatments increased mud and organic matter content and the amount of ammonium being released from sediment to overlying water. Macrofaunal abundance, gross primary production and photosynthetic efficiency (production per unit of chlorophyll *a*) were all significantly reduced in treated plots; a marked increase in N to P ratios in porewaters of sediment-treated plots was also apparent, likely due to increased presence of charged clay particles in terrigenous material, which tends to bind phosphate. Consequently, microphyte primary producers living on the sediment surface in sediment-treated plots were likely phosphate limited, whereas microphytes in controls were likely N limited. Consistent with this hypothesis, gross primary production and photosynthetic efficiency were positively correlated with ammonium uptake in the control plots, but these correlations were not significant in treated plots. This breakdown of fundamental functional relationships (e.g., positive correlations between microphyte primary production and ammonium uptake) in disturbed plots has now been observed in three separate experiments involving three different disturbance types (anoxia, metal contaminants, and now terrigenous sediments). Thus, we are now better positioned to predict the effects of disturbance on valued habitats and ecosystem goods and services.

Wednesday

15:15–15:30

Room OGGB5 Ecology - Epiobiota

Session Chair: Richard Taylor

Fiat lux: shining a light on coralline algal diversity

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[1]NIWA, Wellington; [2]University of Otago

Coralline algae are common and abundant from the poles to the tropics, in the coastal and near-shore environment. While they are often dominant organisms in an environment, covering a high proportion of habitat, they are frequently dismissed as "pink paint", or lumped as "coralline crust", belying the diversity that occurs. Reflecting this, modern treatments documenting the diversity of these organisms in New Zealand have been lacking. Coralline algae are significant for their role in recruitment of invertebrates, as nursery habitat for fishes, and as biodiversity hotspots. Recent research has focused on their vulnerability to the impacts of sedimentation, and to acidification associated with climate change. To fully understand the impacts of human-mediated changes on coralline algae we need good baseline data and an ability to monitor communities and species of interest. A critical first step is to document and describe calcified algae: without an understanding of the species present, measurement of change and understanding of species-specific responses will not be possible. Our group, funded by the Ministry of Fisheries, has produced identification guides to the common coralline algae of central New Zealand (2005) and northern New Zealand (2009). The guides are accessible tools for scientists, students, and resource managers, and highlight the diversity within coralline algae in New Zealand. Using a powerful combination of molecular and traditional methods has enabled rapid progress on this group of organisms. By shining a light on coralline algae, documenting their diversity in New Zealand, and producing tools for their identification, we provide a resource from which researchers and decision-makers can draw, and which can inform future research on the the ecosystem services that these algae provide and the roles and importance of coralline algae in global carbon processes.

Wednesday

15:30–16:00

OGGB Afternoon tea

Wednesday

16:00–16:15

Room 290-098 Ocean Acidification/Biology

Session Chair: Bruce Hayward

Marine culture tanks for the study of ocean acidification

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Since the industrial revolution, the oceans have absorbed one third of the anthropogenic CO_2 released into the atmosphere. This absorption of CO_2 has led to changes in seawater chemistry, including a decrease in pH of 0.1. If CO_2 emissions continue to rise, seawater pH will drop a further 0.3–04 units by the end of the century. This acidification of the oceans is reducing the amount of carbonate in the seawater, which is used by calcifying organisms to build their shells and skeletons. However, the impact on many important New Zealand organisms is unknown.

Research into the impacts of ocean acidification is currently limited by the lack of culture systems capable of long-term study of calcifying organisms under conditions that realistically mimic the changing chemistry of the future oceans. In response, new culture tanks were developed that consider not only the requirements of the individual organism, but also seawater chemistry. These automated culture tanks are capable of adjusting the pH of the seawater every 10 minutes, allowing both short and long-term changes in pH to be studied. This fine-scale control was possible through automation and incorporation of a colourimetric pH sensor, which is much more accurate and precise than standard pH electrodes. The system was tested by controlling and monitoring the simultaneous dissolution of 10 foraminifera samples and is currently being used in the ongoing culture of calcifying algae.

Wednesday

16:00–16:15

Room OGGB3 Ecology - Sediments

Session Chair: Drew Loher

Sedimental journeys in the intertidal zone: interactions with perennial benthic algae affect recruitment and diversity

Tania Hurley, David Schiel

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Marine Ecology Research Group, University of Canterbury

Sedimentation has a major impact on coastal reefs and is increasing worldwide because of multiple anthropogenic stressors and possibly climate change. Sediments interact with benthic species, particularly perennial turfing and fucoid algae. Because fucoids facilitate diversity in much of the intertidal zone, impacts on their growth and survival underlie many of the biological processes structuring these communities. To test the relationships between sediments and algal communities, five field sites were established around the Kaikoura peninsula, across 3 sedimentation gradients from low to high. Sediment traps monitored over 13 months showed considerable spatial and seasonal variation in sediment flux. However, the benthic sediment environment remained relatively stable and was tightly controlled by the biomass of turfing coralline algae. To determine the interaction of turfs and sediments in structuring communities, experimental disturbances were done by manipulating sediment depth, height of turf and fucoid canopies to test community responses. Over 13 months, two distinct effects were seen. First, direct effects of sedimentation favoured ephemeral algae and also those with tough thalli. Secondary to this was an alteration of species interactions due to the shifts in community composition. Lab-based experiments showed important species differences in their abilities to recruit to primary substrata in the presence of a sediment layer. This study shows that if sedimentation increases, as predicted by most climate change scenarios, there is likely to be a a shift in community structure, as habitat-defining fucoids decline through recruitment failure, and tough filamentous and turfing algae become dominants, punctuated with episodic ephemeral blooms.

Wednesday

16:00–16:15

Room OGGB5 Ecology - Sediments

Session Chair: David Schiel

Barcoding brown algae: evaluating cox1 variation for species delimitation in *Cystophora*

Joe Buchanan, G. Zuccarello
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School of Biological Sciences, Victoria University

We used a barcoding approach to evaluate the utility of *cox*1 mtDNA for species delimitation in brown algae. The *cox*1 region is widely used for species identification in animal studies but is problematic or untested in other kingdoms of life.

We assessed interspecific and intra-specific variation in *cox*1 sequences from 120 specimens of *Cystophora* (Phaeophyceae: Fucales), including thirteen Australian and New Zealand species. Our barcoding results were evaluated against morphological species assignments and an ITS/*cox*1 phylogeny.

While *cox*1 variation successfully delimited some early diverging species, three *cox*1 haplotypes were shared by several specimens of *Cystophora retroflexa, C. congesta, C. subfarcinata* and *C. cuspidata*. Even with some taxonomic revisions, these results cast doubt on the utility of *cox*1 as a barcoding region for brown algae.

Wednesday

16:15–16:30

Room 290-098 Ocean Acidification/Biology

Session Chair: Bruce Hayward

Estimating the acid dissociation constants of carbonic acid in seawater

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Department of Chemistry, University of Otago

The ocean absorbs approximately 30% of all CO_2# produced from the burning of fossil fuels. This has resulted in an increase in the concentration of carbonic acid and a decrease in the pH of seawater, a process known as ocean acidification. The estimated change in sea surface pH from the pre-industrial period to the modern day is approximately 0.1 pH units, which corresponds to a 30% increase in hydrogen ion concentration.

If reliable estimates of the two acid dissociation constants of carbonic acid (K_1#, K_2#) are available, the thermodynamics of the CO_2# system in seawater are fully characterized by determination of two of the four measurable analytical parameters (total alkalinity, A_T#; total dissolved inorganic carbon, DIC; partial pressure of carbon dioxide, pCO_2#; and pH). However, discrepancies in field and laboratory studies have shown that reliable estimates of K_1# and K_2# are still unavailable. Differences between calculated pCO_2# data taken from the Bermuda Atlantic Time-Series Study (BATS) have been compared with measurements of atmospheric pCO_2# taken at Mauna Loa, Hawaii. Depending on which set of K_1# and K_2# constants is used a different conclusion is reached as to whether or not the surface ocean at BATS is in equilibrium or undersaturated with the atmosphere.

High-precision A_T# methods were used to show that the inaccuracy in published estimates of K_1# and K_2# are partly due to underestimation of the effect of boric acid and also errors in the calculation methods used to obtain K_1#. New experimental methods and data analysis techniques were developed to estimate K_1# and K_2# in the presence of boric acid. These improvements significantly increase both the precision and accuracy of the estimates of these constants in seawater.

Wednesday

16:15–16:30

Room OGGB3 Ecology - Sediments

Session Chair: Drew Loher

The effects of suspended sediments on juvenile fish — are there murky waters ahead for snapper?

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University of Auckland; NIWA, Auckland

New Zealand estuaries are under increasing pressure from anthropogenic change and degradation, in addition to increasing occurrence and severity of storm events associated with climate change. Increased sedimentation and turbidity is now a characteristic of many lowland reaches of New Zealand rivers, and estuaries.

Short term tank experiments on juvenile snapper were conducted to examine the effect of turbidity on prey feeding rates. A decrease in foraging success was evident with increasing suspended sediment (SS) levels. Longer term sub-lethal experimental effects included increased coughing and gulping, paler colouration, higher respiration rates and decreased activity; increased weight loss, mortality, and gill deformation occurred at higher turbidity levels.

Field-caught juvenile snapper (50–100mm) were collected from 7 northern North Island estuaries. Concurrent measures were taken of suspended sediments, secchi distance, temperature, and salinity. To assess inter-harbour differences in growth and condition, a relative condition index was calculated; a negative relationship was found with increasing SS loads. Significantly higher levels of gill deformation, along with higher parasite loads were recorded with increasing sediments. Results suggest a negative mechanism is operating on juvenile snapper fitness related to suspended sediment loads. Dietary analysis indicated that increasing turbidity levels caused a change in feeding strategy from active selection of pelagic prey, to larger, slower moving benthic prey.

These findings indicate that the ongoing large-scale environmental changes seen in estuaries may be having strong impacts on the functioning of fish nurseries, and need to be taken into account when considering management regimes for these areas, including linkages to catchment-level effects.

Wednesday

16:15–16:30

Room OGGB5 Ecology - Sediments

Session Chair: David Schiel

Shining some light on biodiversity-ecosystem function in benthic algal assemblages: diversity matters in primary production

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Marine Ecology Research Group, University of Canterbury.

Relationships between biodiversity and ecosystem function are of increasing importance as multiple stressors impact natural assemblages. Although effects of plant biodiversity on primary productivity have been central to the debate about the importance of biodiversity, research results are often contradictory. Many BEF studies have focused on synthetic plant assemblages in mesocosms, with fewer experiments in naturally occurring ecosystems or communities. Furthermore, the trend in this literature has been to test the impacts of random losses of species on ecosystem function, rather than testing the effects of predictable species loss. With this in mind, we present experimental tests of the impacts of predictable losses following disturbances of habitat-dominating fucoids on primary productivity within naturally occurring assemblages in southern New Zealand.

Macroalgae are important components of temperate reefs, yet little is known about their primary productivity dynamics and the potential effects of species losses on that productivity. Our results show a positive effect of macroalgal biodiversity on primary productivity. The three-dimensional structure of macroalgal assemblages plays a significant role in light utilisation, In particular, once critical sub-canopy light levels are reached there is significantly enhanced primary production as understory species sequentially “turn on”. Novel *in situ* experiments showed that this effect occurs in numerous assemblages, and highlight considerable differences from what is currently known about the role of diversity in primary production and its crucial relationship to light intensity. The loss of habitat-dominating species, which often facilitate diversity by shielding understory species, therefore has a considerable effect on a primary function of shallow coastal reefs.

Wednesday

16:30–16:45

Room 290-098 Ocean Acidification/Biology

Session Chair: Bruce Hayward

The effects of ocean acidification on New Zealand macroalgae

Christopher Cornwall[1], Christopher Hepburn[2], Keith Hunter[3], Kim Currie[4], Catriona Hurd[1]
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University of Otago, Departments: [1]Botany, [2]Marine Science, [3]Chemistry; [4]NIWA, Wellington

CO_2 concentrations in the world's oceans are increasing at rates 100 times higher than those experienced previously. This process, known as ocean acidification, is caused by anthropogenic CO_2 emissions. The resulting decrease in seawater pH has consequences for many marine organisms.

Macroalgae dominate near-shore temperate rocky reefs, and provide habitat for many ecologically and economically important species. However, their responses to ocean acidification may be varied. Calcareous macroalgae may be negatively affected, as their skeletons are prone to dissolution at low pH. Conversely, non-calcareous macroalgae may be positively affected due to an increased availability of both CO_2 and HCO_3^-, which are used in photosynthesis. Additionally, some species of macroalgae are capable of only using CO_2, while others can utilize HCO_3^- for photosynthesis.

Physiological responses for macroalgae placed in seawater at pH 8 (present-day) and pH 7.5 (predicted for the year 2220) were recorded. We discuss these physiological responses of New Zealand macroalgae to lowered seawater pH, and then predict how different macroalgal habitats may vary in their response to ocean acidification.

Wednesday

16:30–16:45

Room OGGB3 Ecology - Sediments

Session Chair: Drew Loher

Effects of heavy metal contamination on bivalve bioturbation: iplications for sediment transport

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To better understand the potential effects of heavy metal contamination on sandflats in an urbanised New Zealand estuary, we investigated burial rates of *Austrovenus stutchburyi* collected from two sites with differing metal concentrations in Tamaki Estuary, Auckland. In addition, annular flumes were employed to investigate the density dependence of *Austrovenus* burial and whether cockle burial/movement influenced rates of sediment erosion/resuspension. Results indicated no effect of sediment contamination (i.e., site of collection) on burial rates of *Austrovenus*. However, burial tended to be fastest (and cockles moved greater lateral distances) when held in flumes at lower densities. Sediment erodability increased significantly with increased *Austrovenus* densities, although the effect of *Austrovenus* on critical erosion threshold was negligible. While further studies are required, the results of this study which focus on bioturbation lend support to the theory that *Austrovenus* is a key engineering species in soft-sediment estuarine ecosystems, and losses of this species could have detrimental impacts at large spatial scales.

Wednesday

16:30–16:45

Room OGGB5 Ecology - Sediments

Session Chair: David Schiel

Ecology of encrusting species in intertidal boulder-fields

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Intertidal boulder fields are an important but little-studied habitat on rocky coasts, and our knowledge of the processes generating high levels of variability in the distributions of many boulder-field inhabiting species is poor. The aim of this study was to investigate the distributions of spirorbid tube-worms and encrusting coralline algae (ECA), the two most abundant encrusting taxa in intertidal boulder fields, and use manipulative experiments to determine the mechanisms causing variation in their abundances. Measurements of the distribution of ECA on boulders indicated that it was mostly confined to the microhabitat occurring around the edges of boulders. We predicted this pattern was caused by differential recruitment of ECA to boulder edges, and tested this prediction by monitoring recruitment to newly cleared boulders in three boulder-fields on the New South Wales coast. After two months, almost all ECA recruitment had occurred on the edges of boulders, indicating that recruitment is a major driving force behind patterns of ECA distribution in boulder fields.

Measurements of the distribution of tube-worms on boulders showed that they occurred in greatest densities in the microhabitat at the undersides of boulders. However, on newly cleared boulders, less recruitment occurred at the underside compared to the edge. This indicates that mechanisms other than recruitment likely cause the patterns of tube-worm distribution. Post-recruitment processes such as predation and competition are being investigated as possible causes of the opposing patterns of tube-worm distribution occurring on natural vs newly cleared boulders. The information gained about these key species is important in ensuring efficient management of the biodiversity and natural resources present in boulder fields.

Wednesday

16:45–17:00

Room 290-098 Ocean Acidification/Biology

Session Chair: Bruce Hayward

New Zealand seas – levels rising, pH falling?

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What are the present and historic rates, and variability around NZ, of relative sea-level rise, and does the recorded accelerated rise parallel increases in greenhouse gases? Does green-house-gas-related acidification of the oceans impact shelled marine organisms in pH-sensitive environments?

A study of the NZ record of sea-level rise in the last 500 yrs is underway using salt-marsh foraminifera to provide estimates of pre-tide-gauge sea levels. Aims include extending the NZ tide gauge record (post 1900), characterise sea-level variability, improving predictions of future sea-level change, and investigating a hypothesis that the present period of rapid rise coincides with increases in greenhouse gases. Work at Pounawea in the Catlins indicates sea level was rising slowly (0.3±0.3 mm yr^{-1}) before 1900, but during the 20th century increased to 2.8±0.5 mm yr^{-1}. Age models have been constructed using ^{14}C, $^{206}Pb/^{207}Pb$, Pb/Sc, ^{137}Cs, charcoal and palynology. A similar story is emerging further south with studies at Waikawa Harbour (20th century rate *c*. 3.5 mm yr^{-1}) and Mokomoko Inlet (4–5 cm in last 10–15 yrs; ~0.3+/-0.1mm yr^{-1}); and in NW Nelson at Whanganui Inlet.

In most NZ estuaries a zonation from calcareous benthic foraminiferal faunas in the lower parts (high salinity and pH), to agglutinated faunas in the upper estuary (low salinity and pH) is apparent. Increased ocean acidification has been recorded over the last 150 years. At Whanganui Inlet, NW Nelson we do not have an adequate age model as yet but preliminary results show selective loss of some higher magnesium calcite benthic foraminifera (miliolids) and ostracods upcore that could be attributed to decreasing pH.

Wednesday

16:45–17:00

Room OGGB3 Ecology - Sediments

Session Chair: Drew Loher

Tidal-creek dynamics, function and terrigenous-sediment fate in estuaries

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Land-use intensification has increased fine-sediment loads to estuaries, elevating water turbidity and sedimentation rates, with a shift to increasingly muddy intertidal environments and associated ecological effects. Tidal creeks connect catchments to receiving estuaries and terrigenous sediments are mainly delivered by episodic storms. Thus, tidal-creek dynamics during storms will ultimately determine sediment fate. Furthermore, these infilled creeks exchange most of their water volume, so that conditions are "reset", each tide. The question of whether tidal creeks function as sediment conduits or sinks is addressed using data from a three-year field experiment conducted in a small (0.5 km^2) tributary creek of Whitford Bay (Auckland). Although storms, represented < 3% of the flow record they delivered ~85% of the total catchment suspended sediment load, of which 70% was silt. The immediate fate of silt delivered to the creek depended on storm timing, whether high or low tide. During large storms, salt-wedge stratification developed in the channel near high tide. Mixing of the buoyant silt plume with the underlying estuarine water occurred intermittently when the flow became supercritical. The salt-wedge decayed rapidly on the ebb tide, although silt remained in the surface layer due to the large vertical density gradient. Silt concentrations in the creek declined exponentially over several tides after storms with an estimated 70% of this reduction due to creek deposition. Tidal return flows coupled with low settling velocities render storm timing less important than expected for a system with complete tidal exchange. Flood-tide dominance retains sand in the channel whereas infrequent large storms drive ebb-directed sand transport. Creek sedimentation has been offset by rising sea level so that loss of accommodation space has occurred gradually. These observations suggest that tidal-creeks presently function as sinks, thereby mitigating the effects of fine-terrigenous sediments.

Wednesday

16:45–17:00

Room OGGB5 Ecology - Sediments

Session Chair: David Schiel

Does predation by shrimp control the distribution of the New Zealand saltwater mosquito, *Opifex fuscus*, on the rocky shore?

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Opifex fuscus is an endemic New Zealand mosquito that inhabits exposed rocky coasts. The coastal environment is an uncommon habitat for mosquitoes, with less than 5% of described mosquito species regularly breeding in brackish water. On the Wellington south coast, females lay their eggs in rock pools above high tide. While larvae inhabit most rock pools beyond the splash zone at high tide, within the splash zone their distribution is patchy. Having identified *O. fuscus* as capable of tolerating salinities ranging from 0–47 ppt, previous research has unsuccessfully invoked a range of other abiotic variables to explain this patchy distribution. Here, I demonstrate that the patchy distribution of *O. fuscus* larvae within the splash zone may be due to predation by the endemic New Zealand glass shrimp, *Palaemon affinis*. Using surveys, I show that within the splash zone, *O. fuscus* larvae occupy rock pools in which shrimp are absent (Chi-squared test: $p = 0.028$). Then using a laboratory study, I confirm predation of *O. fuscus* larvae by shrimp, and quantify the rate of predation across a range of shrimp sizes. Over 24 hrs, small shrimp (16 mm) consumed 8 larvae, while large shrimp (57 mm) ate up to 236. Finally, I present results from a BACIPS-type field experiment where I introduce shrimp to rock pools inhabited by *O. fuscus* larvae, and monitor resultant changes in larval density. Taken together, these results suggest that predation by *P. affinis* controls the lower distribution *O. fuscus* larvae.

Wednesday

17:00–17:15

Room 290-098 Ocean Acidification/Biology

Session Chair: Bruce Hayward

Subantarctic water is an increasing sink for atmospheric carbon dioxide

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The oceans have taken up approximately 30% of the carbon dioxide produced from anthropogenic sources. The magnitude of the oceanic sink is dependent upon the difference in concentration between the atmosphere and the surface seawater ie # DCO#2 = pCO#2 (seawater) – pCO#2 (atmosphere), and the air-sea flux varies both spatially and temporally.

Data from a time-series station in sub-Antarctic water in the South West Pacific Ocean indicate that the carbon dioxide concentration in the atmosphere has increased at a faster rate than that in the surface seawater, and therefore the carbon dioxide sink in this area has increased over the past 10 years.

Wednesday

17:00–17:15

Room OGGB5 Ecology - Sediments

Session Chair: David Schiel

The ecological role of an omnivorous seastar (*Patiriella regularis*) in intertidal cobble fields

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Cobble fields are common habitats in New Zealand's low intertidal/high subtidal zone, yet little is known about the ecological roles and interactions of the many species that live there, including the common, omnivorous cushion star *Patiriella regularis*. In this study we used field surveys from three sites in Wellington Harbour and laboratory experiments to examine the ecological role of *P. regularis* in low intertidal cobble fields, particularly focusing on possible competitive interactions with other organisms.

Patiriella regularis was abundant in our surveys, with a mean density in Wellington Harbour of 0.26 (SE = 0.03) individuals per cobble, and 6.4 (SE = 0.8) individuals per m^2. Various species of chiton were also abundant, with a mean density of 0.40 (SE = 0.04) chitons per cobble and 18.8 (SE = 3.0) individuals per m^2. The distribution of both *P. regularis* and chitons were similar with the majority of occupied cobbles containing only one individual (*P. regularis* = 77%, chitons = 63%). There was also a negative correlation between chiton density and the density of *P. regularis* on cobbles ($r = -0.515$, $p < 0.001$). The most abundant species of chiton was *Chiton glaucus*, which made up 70% of chitons found in low intertidal cobble fields in Wellington Harbour. These distribution patterns suggest that for *P. regularis* both intraspecific and interspecific competition with *C. glaucus* may be occurring, and we tested the relative importance of each in laboratory experiments.

Evaluating the role of species interactions and the relative strengths of intra- and interspecific competition gives us a better understanding of ecological processes driving patterns and species distributions in low intertidal cobble fields and allows us to make comparisons with other coastal habitats.

Wednesday

17:15–18:00

Room 290-098.

Panel Discussion: Climate Change

Chair: Mark Costello

Wednesday

17:15–18:00

OGGB

Poster Session

18:00–19:30

OGGB

Poster session and reception

Thursday

09:00–09:30

Room 290-098 Plenary

The implications of climate change for fisheries and aquaculture management in New Zealand

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Increasingly, science is telling us that climate change is real and that it could be very serious. In the oceans, temperature, sea level, and acidity seem certain to rise, but we can also expect changes in salinity and currents whose effects are harder to predict. The global scale of these predictions makes them disturbing, at least in an abstract sense, but it is all too easy for resource managers to miss the practical implications unless the science and predictions are communicated in a way that managers can absorb. It seems clear that fisheries and aquaculture could be seriously affected by climate change, but developing appropriate policy response requires guidance on questions like:

1) How soon can we expect to see changes in marine systems and how significant are the likely effects?
2) What zones, fishery management areas, species, or processes will be most affected by climate change or are most at risk?
3) Which sectors or stakeholders in aquaculture and fisheries will be most affected and how?
4) What steps can we take to adapt to change or mitigate the effects or is "business as usual" on fisheries and aquaculture management a realistic option?
5) What science and monitoring is in place to warn us of gradual or impending changes and are these programmes sufficient to underpin resource management policy and decision-making?
6) Can overseas or Antarctic research inform the development of management approaches that are robust to change caused by climate or ocean change?

In planning ahead for science, we need to have these questions in mind. Most of the Ministry's science budget is necessarily spent on stock assessments and the direct effects of fishing, and it is an action point in the Fisheries 2030 Vision to improve knowledge in these areas through long-term research plans. However, the Ministry can afford only a modest amount for more strategic research and relies on the marine science community as a whole to provide the underpinning knowledge of how coastal and ocean systems function and how they are likely to change in response to climate change. The challenge before all of us is to work together to ensure that the right science is done, that it complements any ….

Thursday

09:30–09:45

Room 290-098 Fisheries

Session Chair: Mary Livingston

Fisheries stock assessment for New Zealand scallops (*Pecten novaezelandiae*)

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This paper describes current approaches to fisheries stock assessment for New Zealand scallops (*Pecten novaezelandiae*), which support regionally important commercial fisheries and an intense non-commercial interest throughout the country. In over 50 years of exploitation, New Zealand's scallop stocks have undergone large fluctuations, yet our understanding of the processes that have resulted in such variations is still limited. Fundamental biological processes (reproduction, growth, mortality, and recruitment) are known to be strongly influenced by climatic/environmental conditions, and changes in these conditions can alter the population dynamics of marine species. Such oceanographic forcing probably affects New Zealand's scallop stocks, but so far this remains relatively unstudied.

To get sustainable yield from such variable stocks it is necessary to alter the catch every year. Perhaps surprisingly for a single species, widely different approaches to fisheries management are employed in each region, ranging from a fully regulated strategy in the northern fisheries, to a rotational/enhancement strategy in the southern (Challenger) fishery, to the virtually unregulated Chatham Island fishery. Recent assessment of northern stocks has been based on a Current Annual Yield (CAY) approach using $F_{0.1}$ as a suitable reference rate of fishing mortality, which is considered both appropriate and conservative. Annual pre-season research surveys are required to estimate recruited biomass and for stock assessment to estimate CAY. Commercial catch limits are adjusted each survey year following a review of the survey results and stock assessment, and after consultation with fishery stakeholders.

(contd) … international and operational research underway, and that it is communicated and interpreted in a way that enables wise management of our natural resources for the benefit of all New Zealanders.

Thursday

09:30–09:45

Room OGGB3 Ecology - Sediments

Session Chair: Conrad Pilditch

Mussel stress: physiological responses when the tide goes out

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Mussel communities dominate many exposed rocky shores in New Zealand and the west coast of North America. The ability to understand how increases in temperature affect mussels, therefore, is critical in predictions of how rocky intertidal communities might respond to warmer seas.

Many intertidal organisms live at or near their thermal tolerance limits, and so changes in the thermal climate are likely to alter their distributions. Mussels are useful in such studies on thermal stress because they may be key habitat-responders and their loss or reduction would greatly reduce intertidal diversity because of the wide range of taxa that rely on them for shelter from hydrodynamic forces and predators. Through a comparative experimental approach, this study uses mussels from field sites on the west coast of the United States (Oregon) and the west and east coasts of the South Island of New Zealand. Translocation experiments within each region are being carried out to compare survival, growth and stress responses of several mussel species (*Mytilus californianus*, *Mytilus galloprovincialis*, *Mytilus trossulus* and *Perna canaliculus*). These experiments alter the thermal, desiccative and nutritional environment as well as the physiological state of the mussels, requiring them to adapt their cellular functions to cope. Here we discuss the expression of genes that may be involved in the stress response such as molecular chaperones, protein degradation genes, transcription regulators and cell cycle regulators. This study will highlight physiological responses to thermal stress of ecologically critical marine invertebrates across large spatial scales.

Thursday

09:30–09:45

Room OGGB5 Meteorology

Session Chair: Jim Renwick

Monsoon onset and withdrawal over the Maldives

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Defining the timing of monsoon onset is critical as it defines ploughing and planting times for the agricultural societies in monsoon regions such as the Maldives. An objective definition of the monsoon season depends on objective definition of the monsoon onset (first onset date) and withdrawal (last withdrawal date) of the southwest monsoon. Conventionally, the SW monsoon season for the Maldives is May to November, with the official normal monsoon onset date for the Maldives 17 May. However, an exact prescription of the monsoon season is lacking. The objective of this study is to define monsoon onset and withdrawal dates objectively for the Maldives. Methods that identify the monsoon's withdrawal date are few, while different parts of the Asian monsoon have defined onset dates using different methods. Here rainfall and wind, and outgoing longwave radiation-based criteria are defined to determine monsoon onset and withdrawal dates (hence defining the monsoon season or length of rainy season (LRS), objectively). Based on the OLR index, the 15 year average onset date was 4 May (SD 11 days); the 15 year average withdrawal date was 23 November (SD 13 days); the average onset date for the whole of the Maldives based on rain and wind criteria was 12 May (an 8 day difference compared with the OLR index average onset date), while the average withdrawal date was 23 November, the same as the average withdrawal date based on the OLR index. The mean LRS for the Maldives based on the OLR index is 204 days (SD 18 days); mean LRS based on rain and wind criteria is 8 days shorter (196 days, SD 12 days). It is believed that the defined criteria will assist to determine the onset and withdrawal dates of the monsoon, and hence define the monsoon season for the Maldives objectively in the future. Furthermore, objective determination of onset and withdrawal dates of the southwest monsoon will be beneficial for agriculture and for the management of floods and water resources of the Maldives.

Thursday

09:45–10:00

Room 290-098 Fisheries

Session Chair: Mary Livingston

Intraspecific variation of movement behaviour and differential exploitation of snapper (*Pagrus auratus*: Sparidae)

Darren Parsons[1], Mark Morrison[1], Jeremy McKenzie[1], Bruce Hartill[1], Richard Bian[1], Chris Francis[2]

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NIWA: [1]Auckland, [2]Wellington

Different species often utilise space in a different fashion, and variation in movement behaviour can also occur within a species. Despite this, in marine fisheries management, the movement behaviour of exploited species is often assumed to be monotypic. If intraspecific variation in movement behaviour is being ignored, there may be detrimental consequences for the productivity and health of fisheries and the surrounding ecosystem. In this study, we used dart tagging to explore the possibility of differential snapper movement behaviours at different locations within the Hauraki Gulf. Just under 10,000 snapper were tagged, with >800 of these tags being returned by recreational and commercial fishermen (as of 1 June 2009). To allow for unbiased comparisons of snapper movement probabilities from the different tagging areas, we used a maximum likelihood approach to correct for spatial variation in fishing effort and snapper population density. Results suggest that snapper from shallow inshore and reefy areas are much more residential than snapper from deeper areas (>20 m) of predominantly soft sediment. We also observed differences in extraction rate between these tagging areas, potentially linked to differences in movement probabilities. These results suggest that stock assessment models which assume monotypic fish behaviour are likely to lead to erroneous conclusions. An additional management concern is that marine protected areas may experience varying levels of protection success in different areas/habitats, if the size of protected areas is not scaled to the specific movement dynamics of exploited species in each area. Finally, if fishing effort varies by area/habitat type, then a process of fishery-induced selection may lead to the removal or reduction of certain behaviour types, and all the life history characteristics and ecosystem interactions associated with that behaviour.

Thursday

09:45–10:00

Room OGGB3 Ecology - Sediments

Session Chair: Conrad Pilditch

The effect of current velocity and density on *Austrovenus stutchburyi* clearance rates

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Austrovenus stutchburyi (New Zealand cockle) is an intertidal suspension-feeding bivalve, commonly found in high density (*c*. 600 ind. m^{-2}) beds. Previous studies have shown that grazing by such beds can exert a significant top-down control on phytoplankton biomass, and if lost can cause large shifts in ecosystem structure and function. Estimates of bivalve filtration rates are therefore crucial in quantifying their impacts on energy flow in coastal environments.

Laboratory derived filtration rates are often based on small numbers of animals feeding in isolated chambers under unrealistic flow conditions. Consequently, when extrapolated bed filtration capacity is overestimated. Here we used annular flumes to replicate boundary layer flows, and measured the effects of cockle density (0–1000 ind. m^{-2}) and flow speed (2–15 cm s^{-1}) on bed filtration rates. Treatments consisted of three flow speeds and six cockle densities spanning ranges typically observed on tidal flats. These treatments also allowed us to investigate the possible interaction between bottom roughness generated by cockles (feeding currents and bed topography) and vertical mixing in the boundary layer. We hypothesised that at low flow speeds and high cockle densities the bed roughness might generate greater turbulence and vertical mixing, replenishing food supply to the cockles, and thereby increasing filtration rate.

Preliminary results indicate a strong interaction between flow speed and cockle density on bed filtration rates. High density beds have the capacity to filter *c*. 100–250 L m^{-2} hr^{-1}, and bed filtration rate increases substantially with increasing flow speed.

Thursday

09:45–10:00

Room OGGB5 Meteorology

Session Chair: Jim Renwick

Mesoscale modelling of enhanced Antarctic polar stratospheric cloud formation due to orographic gravity waves

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The role of Polar Stratospheric Clouds (PSCs) in polar ozone depletion was first identified over twenty years ago. Heterogeneous chemical reactions on PSC particles are the central process in chlorine activation and consequent ozone depletion. Three categories of PSCs are generally recognized: type Ia, composed of solid phase nitric acid trihydrate (NAT); type Ib, composed of supercooled ternary solution (STS); and type II, composed primarily of ice. The three categories of PSC form in the stratosphere at progressively colder temperatures, and each type is in evidence during the Antarctic seasonal "ozone hole".

Threshold PSC formation temperatures applied to Met Office atmospheric analysis fields allows one to estimate the evolution of PSC areal coverage. Recent analysis of POAM II aerosol extinction data have shown enhanced, early season (June/July) PSC formation beyond that predicted from the Met Office analysis. CHAMP RO temperature measurements have indicated that this enhancement is due to temperature perturbations associated with small-scale structure; the hypothesis being that these structures are the stratospheric manifestation of orographically induced gravity waves.

This presentation will report on the results of mesoscale atmosphere simulations (using WRF — the Weather Research and Forecasting Model) over the Antarctic peninsula; a known orographic gravity wave "hotspot". Estimates of the seasonal evolution of PSC formation will be calculated using appropriate temperature thresholds. Further work on the offline-coupling of WRF to a PSC microphysical model will also be addressed.

Thursday

10:00–10:15

Room 290-098 Fisheries

Session Chair: Mary Livingston

Assessing the performance of NZ fisheries to primary production constraints

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Fisheries impacts are under increased global scrutiny. As an island nation with a large exclusive economic zone (EEZ), we are blessed with an area producing ~ 600 Tg of organic carbon annually, approximately five times our estimated annual terrestrial carbon production. However, we also require a large amount of this carbon production to sustain our fishing industry and wider marine ecosystem.

We investigated the use of an energy based fishing pressure index (FPI) as a rapid assessment tool to investigate temporal and spatial harvest trends in fishing stocks in relation to primary production in NZ's EEZ. Calculation of the FPI is undertaken by comparing satellite derived spatial estimates of net primary production (NPP) with estimates of primary production required to support a given catch (PPR) using the simplified trophic model applied by Pauly & Christensen (1995). Historic comparisons of PPR to NPP in NZ's EEZ highlight a reduction in fishing pressure from 20% of NPP required to support catches in 1998 to below 10% in 2006, which suggests NZ fisheries are generally operating within their energy limits for the stocks under consideration, about the same as the global average of 8% estimated by Pauly & Christensen (1995). However, analysis of the data at finer spatial scales shows that in 2006 some fished areas may have exceeded local energy limits. The talk considers the efficacy of applying this technique at finer scales with regard to the active management of NZ's migratory hoki (*Macruronus novaezelandiae*) fishery which accounted for 54% of the total commercial catch PPR in 2006. So overall, how does NZ rate, are we guilty of overfishing? The study suggests that from a broad-scale energy perspective we are not, we are probably "better than most" and our performance appears to be improving; however, there remain gaps in our knowledge that should be addressed before we can state with confidence that our fisheries are sustainable in a broader ecological context.

Thursday

10:00–10:15

Room OGGB3 Ecology - Sediments

Session Chair: Conrad Pilditch

Vulnerability of embryos in benthic intertidal egg masses to summertime ultraviolet radiation and conditions at low tide

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The Southern Hemisphere is exposed to high intensities of UVR during summer. Few studies, however, have focused on risks to New Zealand's marine fauna, or how UVR may interact with other stressors in this challenging environment. A variety of marine species deposit egg masses intertidally, exposing embryos to myriad physical stresses, including UVR. Using field surveys and outdoor experiments, we examined the potential interactions between UVR, desiccation and tidal pool conditions on embryonic mortality of three molluscan species: two pulmonates (*Benhamina obliquata* and *Siphonaria australis*), and the mudflat-dwelling bubble-shell *Haminoea zelandiae*. For each species embryonic mortality was significantly greater in egg masses exposed to full sun compared to shade. For *S. australis*, there was also 2-fold greater mortality in egg masses in tidal pools or desiccated at low tide compared to those submerged in flowing seawater. For *H. zelandiae* desiccation increased embryonic mortality compared shallow tidal pools. These results were supported by outdoor experiments, when exposure to UVR and low tide conditions were manipulated. Vulnerability to low tide conditions (i.e. simulated tidal pools vs. desiccated), was species-specific. Egg masses of both limpet species had elevated embryonic mortality in simulated tidal pools compared to those submerged in flowing seawater, but desiccation only resulted in higher mortality for *S. australis*. In contrast, for *H. zelandiae* there was an interaction between exposure to UVR and low tide conditions. Results from this study suggest that the egg masses of these three species are vulnerable to UVR, but with species-specific vulnerability to other intertidal stressors and possible interactions with UVR. Embryos of these species may be at risk of high mortality particularly during mid-summer when extreme conditions of UV intensity and high temperature coincide with low tide cycles.

Thursday

10:00–10:15

Room OGGB5 Meteorology

Session Chair: Jim Renwick

Improving regional climate model simulations of New Zealand climate

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NIWA has developed a regional climate model (RCM) based on the UK Met Office Unified Model V4.5, which is being applied to understand future changes in New Zealand climate. It is important to have a realistic simulation of the current climate and its variability, since this gives more confidence in future simulation results. Biases in temperature and precipitation have been noted in climate hindcasts by the RCM; for example, simulated precipitation tends to be significantly lower than observed over much of the North Island.

This study describes attempts to understand the RCM climate biases and to reduce them. Better representations of orography and land surface vegetation have been incorporated into the model. Intercomparison experiments have been made with different parameterization schemes for the atmospheric boundary layer and for mixed-phase precipitation. The influence of enlarging the RCM computation domain around New Zealand has also been studied. Results have been compared with observed temperature and precipitation regridded on to the same grid as used by the climate model.

Thursday

10:15–10:30

Room 290-098 Fisheries

Session Chair: Mary Livingston

Dynamics between New Zealand's largest recreational finfish fishery (snapper) and the inner Hauraki Gulf ecosystem

Mark Morrison[1], Darren Parsons[1], Ude Shankar[2], Bruce Hartill[1], Glen Carbines[3], Jeremy McKenzie[1], Richard Bian[1]

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We report on the dynamics of the inner Hauraki Gulf recreational snapper fishery, which contributes ~ 30% of the total recreational snapper catch from northeastern New Zealand. This area was split into 11 strata, representing areas of high/low recreational catch. Aerial over-flights and boat ramp interviews enabled estimation of catch and effort across strata by season (summer/winter). Snapper abndances in each stratum were estimated using night-deployed dropped underwater video (DUV) to count sleeping fish over four seasons; and a concurrent dart tagging programme used to assess fish movements. Fine-scale habitat characteristics were derived from video, and at broader scales through tidal current speed models, and bathymetry.

Total fishery extractions varied strongly between the two monitoring years, ranging from 400-800 tons. Important contributing factors appeared to be weather and water temperature. Much of the catch and effort was concentrated in relatively small spatial areas (e.g. Rangitoto, Motiuhe/Seargant, Ponui Channels). Tag returns revealed a strong winter seasonal movement, with connectivity by fish migration to both the outer Hauraki Gulf, and Bay of Plenty. A strong seasonal decline in adult snapper abundance (measured by UV) supported this conclusion. Combined tag, DUV, and catch data suggest that the inner Gulf is strongly connected to the wider ecosystem, and that intensive annual fish extractions may be supported by movements of snapper into the most heavily fished areas, at large spatial scales. We discuss the implications both for ongoing fisheries management, and towards developing a more ecosystem based understanding of how fisheries management might be structured.

Thursday

10:15–10:30

Room OGGB3 Ecology - Sediments

Session Chair: Conrad Pilditch

Ephemeral in space and time: diversity following disturbance on the subtidal-intertidal fringe

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Diversity curves are frequently used to characterize species assemblages and differences among areas. Within an area, however, there is a strong influence of fine-scale spatial and temporal heterogeneity that makes if difficult to understand diversity patterns without an a) long-term view, b) spatially structured sampling, and c) knowledge based on experiments of the underlying processes affecting diversity.

In a three-year experiment in *Durvillaea antarctica* habitat in southern New Zealand, the average standing diversity ranged from 15–35 species per m^2. However, over the course of the experiment, overall diversity reached >150 species. Most of these were ephemeral algae that came and went, often appearing in only one or a few replicates, while others clearly bloomed in response to disturbances. The timing of disturbance had long-lasting effects on diversity. Here we will discuss this work and its implications for understanding and managing diversity in coastal ecosystems.

Thursday

10:15–10:30

Room OGGB5 Meteorology

Session Chair: Jim Renwick

Are extreme wind patterns over New Zealand changing?

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Wind simulations are available for the New Zealand region from an ensemble of global circulation models forced by IPCC SRES emission scenarios. However, attempts to quantify changes in wind distributions, particularly for the extremes, are hampered by the low resolution of the climate models. This is an obvious shortcoming for the global climate models, but is also an issue for the NIWA regional model run at 30 km resolution.

This study describes approaches to estimating changes in wind extremes in the absence of very high resolution modeling. Mean sea-level pressure (SLP) data related to extreme winds have been extracted from the ECMWF ERA-40 reanalysis data set. A new technique for "trend empirical orthogonal function" analysis has been applied to both the extracted SLP data and the high percentile wind speed data. This methodology is designed to extract dominant trends in the data, which are described for the New Zealand region.

Preliminary results of future extreme wind changes will be presented, where trends in SLP patterns from the IPCC Fourth Assessment models are used as a proxy for high resolution wind speed data. These projections are complemented by analysis of wind percentile changes at the model grid-scale, and by analysis of changes in extra-tropical cyclone tracks and their intensities.

Thursday

10:30–11:00

OGGB - Morning tea

Thursday

11:00–11:15

Room 290-098 Ecology - Fish

Session Chair: Martin Cryer

Habitat usage of adult and juvenile snapper across the inner Hauraki Gulf, New Zealand

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Understanding the habitat usage of fishes across large spatial scales is essential to good management. Here, we describe the habitat usage of a commercially important fish species: snapper (*Pagrus auratus)*.

Snapper behaviour was observed nocturnally over intermittent periods during 2006 and 2007 across the inner Hauraki Gulf using dropped underwater video surveys (DUV). A boosted regression tree analysis identified that juvenile snapper had a higher probability of being observed with smaller DUV transect widths, whereas adults were observed more frequently with larger DUV transect widths. Interestingly, the model showed that juveniles and adults had clearly different responses to habitat. Juveniles were observed more frequently at low current velocities and high burrow densities. By contrast, adults did not have a preference for particular current velocities. Both adults and juveniles showed high probabilities of occurrence at low tide and at high benthic diversities. Our results show that the use of spatial modelling techniques, which have the power to combine a variety of physical and biotic parameters, can lead to the accurate characterisation of fish habitats, and by extension, their management.

Thursday

11:00–11:15

Room OGGB3 Ecology - Sediments

Session Chair: Conrad Pilditch

Ecological consequences of discharges from coastal cooling systems

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Growing concerns over dwindling energy and freshwater resources have resulted in the proliferation of industrial (nuclear, power and desalination plants). Together with commercial (Hotels and Casinos) and residential coastal buildings these extract billions of tonnes of seawater for cooling air-conditioned systems. Biocides are added to the seawater to prevent organisms growing in the pipes. After passing through the system the seawater is discharged into marine habitats. Halide-based oxidants traditionally have been used as biocides, however, these corrode the pipes and to be effective must be used in great quantities. To reduce financial and environmental costs, they have been replaced by amine-based biocides, yet there is little information on the ecological effects of either biocide in the marine environment. Legislative methods to assess the risk of these biocides rely mostly on data derived from a few laboratorial trials.

The ecological effects of seawater discharged from coastal buildings on assemblages living on pilings in Sydney Harbour, were examined. Mensurative experiments were used to test hypotheses about differences in the structure of assemblages living on wood pilings at discharge and control sites. Greater abundances of oysters occurred at control sites. To understand the mechanisms driving altered patterns of abundance, I tested hypotheses related to the recruitment and 'health' of oysters; results indicated no pattern related to recruitment.

This project is the first experimental field work investigating the ecological consequences of discharges of amine-based biocides. The findings are discussed in relation to the use of ecological field experiments to gain better understanding of the effects of these discharges, resulting in improved management of coastal habitats.

Thursday

11:00–11:15

Room OGGB5 Meteorology

Session Chair: Mike Revell

Effects of thin cirrus clouds on MISR cloud-height retrievals

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Cirrus clouds play a major role in the Earth's climate system. Thin, high cirrus are especially important. They have relatively low albedos, a strong greenhouse effect due to their high altitudes and low emission temperatures, and tend to warm the climate system. The Multi-angle Imaging Spectroradiometer (MISR) on the Terra satellite has been measuring the altitudes of these clouds consistently since 2000, and has detected a reduction in high-altitude cloud over the tropical Pacific Ocean that may indicate a significant response of the climate system to global warming. However, thin cirrus clouds are difficult to detect and the operational cloud-height product from MISR may miss thin cirrus when it overlies thicker, lower-level cloud.

To examine the effects of thin cirrus on MISR cloud-height retrievals, we have studied clouds with base heights from 12–20 km, cloud-base temperatures less than -20°C, optical depths << 1, and for latitudes 20°S–20°N, using merged datasets from the CERES broadband radiometer, also on Terra. Outgoing Longwave Radiation (OLR) measurements were extracted from these datasets and compared to the OLR from a column model of longwave radiative transfer that uses MISR cloud-top heights and reanalysis data as input parameters. We obtained, as expected, a strong correlation between low values of OLR and high values of cloud-top height. The differences between modeled and measured OLR are now helping us to understand the significance of thin cirrus and we will report on how this affects the observed reduction in high-cloud amount and its role in maintaining or altering surface temperature.

Thursday

11:15–11:30

Room 290-098 Ecology - Fish

Session Chair: Martin Cryer

Fish-habitat relationships in central New Zealand

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Components of a literature review, field experiments and geographically spread field experiments are presented to address the widely held view that the presence or absence of large brown macroalgae structures fish assemblages on temperate reefs. The database of experiments on which that view is based is relatively small, and comprises mainly macroalgal removals. The dual constraints of obtaining food (small invertebrates occupying seaweed fronds) and surviving predation appear the most likely mechanisms whereby such patterns are set, but recruits of several New Zealand fishes settle into habitats without macroalgae, which presumably provide minimal shelter or food. In shallow water, macroalgae are often associated with areas of high topographic complexity such as boulders, perhaps because boulder tops extend into regions of high wave action, and reduce success of echinoid grazing. We carried out an experiment near Nelson, in which macroalgae and rocks were added orthogonally in an environment that lacked both. The results of the macroalgae–no-macroalgae components of the experiment were not as clear-cut as those from studies in northeastern New Zealand, but frequency of sampling, definition of cohorts, and the size of the experimental manipulations likely contribute to discrepancies between the present study and previously published results. Survey data indicate inconsistent relationships between fish abundance and seaweeds between regions, further emphasising the difficulty of extrapolating from experiments. Whereas the necessity of experimentation has been expounded from a falsificationist world-view in the past, we consider that more intensive period of experimentation, with a greater variety of replicated experiments, is required before useful generalities concerning the role of macroalgae in controlling the local abundances of fishes on temperate reefs will emerge. However, a precautionary approach dictates that management should prevent actions that might harm macroalgae until a fuller understanding of their role emerges.

Thursday

11:15–11:30

Room OGGB3 Ecology - Sediments

Session Chair: Conrad Pilditch

Patterns of amphipod biodiversity on Chatham Rise and Challenger Plateau

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Amphipods were collected in using a hyper-benthic sled as part of the 2007 'Oceans Survey 2020' at several locations across Chatham Rise and Challenger Plateau. We compared the diversity of sea-bed amphipod communities between 200 and 1200 metres depth. The two study sites have differing ecological and physical parameters. Whereas Chatham Rise is physically heterogeneous and biologically productive due to the subtropical convergence, Challenger Plateau is a largely homogenous area of soft sediment apparently lacking physical structure and variation in depth. We hypothesised that the diversity of amphipods would be greater within and between stations on Chatham Rise than those on Challenger Plateau owing to greater habitat complexity.

Due to the overwhelming numbers (>10,000 individuals), high species level diversity (many of which are undescribed) and potential occurrence of cryptic species in the samples, identifications were carried out to family level. Since taxonomic families are generally assemblages of species with similar ecological resource requirements and foraging strategies, they are effectively a functional group and can be considered a 'taxon guild'. Family abundances and diversity (number of morphotypes) are described and compared across 20 stations on Chatham Rise and the Challenger Plateau. Initial results show distinct differences in community composition between the two study sites. Chatham Rise is also more variable in community makeup between stations and has greater overall amphipod abundance. In order to explain amphipod family distributional patterns, results were compared with known ecological and physical parameters of the study locations. These data suggest that greater physical heterogeneity increases amphipod abundance and biodiversity.

Thursday

11:15–11:30

Room OGGB5 Meteorology

Session Chair: Mike Revell

Long-term ten minute synthetic wind data for 15 New Zealand wind farms

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Wind data at 10-minute to hourly time scales are an important input into modelling the performance of wind farms and their impact on the national electricity system. The Electricity Commission engaged NIWA and MetService to create a multi-year synthetic wind dataset (SWD) for 15 actual or potential wind farm sites from different parts of the country for use in modelling the electricity system. The required properties of the SWD were that it: 1) be valid for turbine altitudes, 2) include multiple years, 3) cover 15 sites corresponding to either existing, proposed or potential wind farms, 4) preserve inter-area correlations and allow modelling of the impact of specific meteorological events, 5) reproduce well seasonal and synoptic variations and preserve inter-site correlations, 6) reproduce well the higher frequency fluctuations in wind speed and preserve inter-site correlations of these fluctuations, 7) reproduce reasonably the wind speed climatology for each site including the frequency of speeds below and above the turbine operating thresholds, 8) be at intervals of 10 mins with no missing gaps, and 9) be in a form that can be converted into simulated wind farm output.

As a result of day-to-day operational numerical weather modelling efforts and application of a statistical methodology, a 5-year MM5-based 10-minute SWD and 2-year NZLAM-based 10-minute SWD have been created that are suitable for use in modelling wind farm impacts on the New Zealand electricity system. In this presentation, we demonstrate that the SWD created meets the nine requirements by showing that histograms of wind-speeds and high frequency fluctuations at the 15 sites have been reproduced very well for eleven of them, and reasonably well for the other 4. Particular emphasis was paid to re-producing the tails of the histograms so that the frequencies of wind speeds outside the turbine operating ranges were accurately simulated. Attention was also paid to reproducing the observed inter-site correlations that result from the passage of frontal systems which are often associated with important rapid region-wide increases and/or decreases in wind speeds. The Electricity Commission has made the SWD publicly available.

Thursday

11:30–11:45

Room 290-098 Ecology - Fish

Session Chair: Martin Cryer

Habitat shifts of snapper (*Pagrus auratus*) within an estuary

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Snapper (*Pagrus auratus*) is New Zealand's most important commercial and recreational coastal finfish species. Within Mahurangi Harbour, density and distribution of snapper was quantified over spatial and temporal scales, associated with habitat. A beam trawl was used to target juvenile snapper (~1–10 cm), while a dropped underwater video (DUV), operated at night, targeted fish from 5–60 cm.

Juvenile snapper enter or are spawned within Mahurangi Harbour during warmer months, with densities highest in March. Analysis of beam-trawl data revealed 0+ juvenile snapper (< 10 cm) to be mostly associated with horse mussels; larger juveniles (> 4 cm) were also associated with bare areas; 0+ fish (from DUV) occupied mainly muddy to sandy substrata, with structure afforded by sponges and horse mussels; DUV also identified remaining year-classes (1+, 2+, 3+ and > 3+) to occupy coarser substrata, with shell hash the major secondary feature. With increased size/age came an increase in the night-time use of structure relative to bare areas. Larger fish utilised structure as a place to rest against or in, in the case of large pits; for small year-classes, the ratio of structure to bare area usage was highest at approximately 40 cm distance from structure. This may mean snapper feed during the dark, yet remain close to structure should it be required for shelter, or because structure is not needed as much at night for protection. Artificial reef experiments reveal juvenile snapper are attracted to artificial horse mussels, with and without epifauna, as opposed to bare areas or controls. Accordingly, horse mussel structure attracts small snapper.

Despite the potential of snapper to utilise any sort of structure as cover or for rest, most structure within the Mahurangi is biogenic, therefore susceptible to anthropogenic effects, especially sedimentation. The loss or decline of biogenic species may significantly impact the way snapper utilise the Mahurangi.

Thursday

11:30–11:45

Room OGGB3 Ecology - Sediments

Session Chair: Conrad Pilditch

The influence of sea-bed structure on benthic invertebrate diversity

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The large dog cockle, *Tucetona laticostata* (Quoy & Gaimard, 1835) is widely distributed throughout coastal waters of Hauraki Gulf. One location at which this species proves common is around Otata Island, one of a series of islands in the Noises complex, where this species resides partially buried in shell gravel.

The shells of *T. laticostata* collect in large post-mortem deposits on the sea bed at certain locations throughout Hauraki Gulf. One such location is off southwestern Otata Island, from 5–15 m depth. Interspersed amongst these *Tucetona* shell deposits are numerous rhodolith thalli. The *Tucetona* shell and rhodolith accumulations create mounds providing a habitat more complex than that of adjacent coarse sands.

Seasonal variation in species assemblages of these *T. laticostata* shell and rhodolith substrata are compared to those of adjacent coarse sands, for two areas at two different depths, sampled quarterly in 2007 off southwestern Otata Island. Both benthic invertebrate species richness and abundance within *T. laticostata* and rhodolith habitat almost always were higher than these same values from extensively fragmented shell- and rock coarse sand habitat; spatial and temporal variation in these communities are reported.

Anthropogenic threats to structurally complex *Tucetona*-shell and rhodolith-based biogenic substrata are discussed.

Thursday

11:30–11:45

Room OGGB5 Meteorology

Session Chair: Mike Revell

Solar energy anywhere in New Zealand

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For architects, designers of solar energy systems, and homeowners, it is useful to know how much energy is available at any site in New Zealand. The NIWA Climate Database contains measurements, from over 100 sites, of global irradiance — the energy flux onto a horizontal surface. The data, at hourly or, for some stations, 10-minute intervals, are available free on the internet alongside other climate data, and we have also used them to map the solar energy flux nationwide. This work made use of cloud cover from satellite data to interpolate between sites and estimate solar irradiance to any location, but there is a further consideration. The performance of active and passive solar energy systems depends not just on the amount falling on a horizontal surface, but on the separate diffuse and direct components. These are measured at only four sites in New Zealand. Using data from those sites, we have developed methods to estimate diffuse and direct radiation to good accuracy for any site with global irradiance measurements. In turn these are used to compute average radiation, by time of day and year, for a surface of arbitrary tilt and bearing, such as roofs, walls, windows, or solar panels. These data will be made available via a web interface that shows the solar track relative to the local landscape.

Thursday

11:45–12:00

Room 290-098 Ecology - Fish

Session Chair: Martin Cryer

Population structure in New Zealand triplefins (Trypteriigidae) based on microsatellite loci

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The triplefin family Tripterygiidae is remarkably diverse in New Zealand, with most of the 26 species having widespread, sympatric distributions. Despite this there is evidence for the restriction of gene flow among populations. Previous research based on phylogeographic analysis of mitochondrial haplotype diversity showed considerable variation between species in the amount of gene flow within regions: three species exhibited high levels of gene flow, three displayed evidence of isolation by distance and significant population structure and two showed strong phylogeographic structure. One of the latter species *Forsterygion capito*, and one with significant population structuring, *F. lapillum* will be investigated in the current MSc research. To examine the picture of population structure across smaller spatial scales, faster-evolving molecular markers are required, such as microsatellites, which are highly polymorphic nuclear loci. Microsatellite allele frequencies at 12 loci will be used to examine population structure in the species *F. lapillum* and *F. capito* to enable analysis of gene flow in these species across spatial and temporal scales relevant to larval dispersal and local adaptation. The previous research findings into population connectivity were due to a combination of factors including historical processes such as glaciation, oceanographic features, biological factors such as species-specific behaviour and larval biology, and post-recruitment selection. This research will clarify the relative importance of such factors, providing greater definition of population connectivity patterns within New Zealand triplefins, and will assist in elucidating their evolutionary history. Furthermore such research is significant in the context of understanding marine population connectivity in general, a field with important applications in fisheries management and design of marine protected areas.

Thursday

11:45–12:00

Room OGGB3 Ecology - Sediments

Session Chair: Conrad Pilditch

Biomineralisation in an urban environment: a carbonate budget for Otago Harbour

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Otago Harbour (45°50'S, 170°38'E) is a highly modified southern tidal inlet, serving the port city of Dunedin (population about 125,000) on the southeast coast of South Island, New Zealand. We develop a model carbonate budget in order to consider carbonate production in the context of human activity. A survey of organisms present, their average size, lifespan, and population density allows for the calculation of individual production rates. Fisheries data, sedimentological models, and historical records provide further data for the carbonate budget.

Carbonate production in Otago Harbour is dominated by *in situ* biomineralisation by molluscs and other invertebrates, while carbonate input by sediment transport into the Harbour entrance is secondary. Dredging, shellfishing, and transport out of the Harbour entrance are the major outputs of carbonate.

The balance between inputs and outputs, both past and present, show the effects of human occupation of this site, and suggest the possible future effects of changes in climate and seawater chemistry.

Thursday

11:45–12:00

Room OGGB5 Meteorology

Session Chair: Mike Revell

Climate drives home insulation and heating needs in New Zealand

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To assess the quality and value of home insulation, the New Zealand Energy Efficiency and Conservation Authority recently introduced a Home Energy Rating Scheme (HERS), using software that simulates energy fluxes in buildings. To model the effect of climate, the HERS system uses Typical Meteorological Years (TMYs) — files of hourly climate data over a year to represent averages, extremes, and correlations between climate variables that affect home energy balance. We characterised New Zealand by 18 climate zones, aligned with boundaries of Territorial Local Authorities, and generated TMYs for all zones in two standard formats. We present the classification of zones, and the algorithms used to derive the required parameters.

The resulting files are in use by HERS assessors, and generally available for use in building energy modelling software and related research. By modelling a sample of houses with the AccuRate NZ software used under HERS, we show the effect of a range of insulation standards within the different climate zones. Energy demand for heating varies by a factor of six or more from the lowest (Northland) to the highest (Central Otago). Intermediate sites are ordered mostly by latitude and altitude, with some variation in the relative importance of different heat loss controls. The importance of designing and building to climate is emphasised by the finding that a well-insulated house in central Otago can outperform poorly insulated houses in Northland.

Thursday

12:00–12:15

Room 290-098 Ecology - Fish

Session Chair: Martin Cryer

The food and feeding relationships of 12 mid-slope fish species from northeastern Chatham Rise, with notes on the diets of seven others

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The food and feeding relationships of 11 fish species from 901–1196 metres water depth from northeastern Chatham Rise (NECR) are described: long-nosed velvet dogfish (*Centrocymnus crepidater*), Baxter's dogfish (*Etmopterus baxteri*), shovel-nosed dogfish (*Deania calcea*), basketwork eel (*Diastobranchus capensis*), large-scaled brown slickhead (*Alepocephalus* sp. A), Cope's slickhead (*Xenodermichthys copei*), serrulate rattail (*Coryphaenoides serrulatus*) four-rayed rattail (*C. subserrulatus*) warty oreo (*Allocyttus verrucosus*), orange roughy (*Hoplostethus atlanticus*), and robust cardinal fish (*Epigonus robustus*).

Fish ate a variety of benthic and/or benthopelagic prey, with some species exhibiting ontogenetic dietary shifts; larger-bodied animals (often fish, prawns or squid) became more important in the diets of larger fish individuals. Dietary overlaps were generally low between species. Cluster analysis based on the wet weight of food items revealed five trophic guilds. Dietary analysis of the intestines of a further seven fish species with high rates of stomach eversion revealed food from mainly benthic sources. Predator/prey coupling is reported between the water column and sea bed for seven fish species.

The eversion of stomach contents through the rapid decompression of a fish's gas-filled swim-bladder can cause the loss of stomach contents. Traditional dietary studies have relied upon stomach contents alone to reconstruct fish diet, excluding those fish with everted stomachs. This has been a particular problem for the rattails (Macrouridae), morid cods (Moridae) and oreo dories (Oreosomatidae). Analysis of the whole gut of rattails from NECR revealed most species to be benthic feeders. Accordingly, trophic analyses that exclude fish on the basis of stomach eversion risk excluding the benthic feeding component of the food-web, leading to the perception that the benthos is unimportant to the functioning of deep-sea ecosystems.

Thursday

12:00–12:15

Room OGGB3 Ecology - Sediments

Session Chair: Conrad Pilditch

Mineralogy or ecology? What controls the distribution of deepsea corals and squat lobsters in the New Zealand region?

Helen Bostock[1], Kareen Schnabel[1], Gavin Dunbar[2], Kim Currie[3], Di Tracey[1]
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The distribution of both deep-sea corals and squat lobsters in the New Zealand region were examined and their carbonate mineralogy analysed. There are three calcium carbonate phases commonly found in nature: aragonite, calcite and magnesium (Mg) calcite (calcite which incorporates some $MgCO_3$). Deep-sea stony corals (Scleractinia) are aragonite, while the gorgonian corals such as bubblegum (Paragorgiidae) and bamboo (Isididae) corals are Mg calcite. The squat lobsters of the families Galatheidae and Chirostylidae are Mg calcite.

The surface waters of the world's oceans are currently super-saturated with respect to all of these carbonate minerals. Saturation decreases with increased solubility (aragonite is 50% more soluble than calcite), decreased temperature and increased pressure. In the southwest Pacific Ocean the current aragonite saturation horizon (ASH; the depth at which the ocean becomes undersaturated with respect to the calcium carbonate mineral aragonite) is 1050–1350 m, while the calcite saturation horizon (CSH) is >3000 m. The depth of the Mg calcite saturation horizon will depend on the mol% $MgCO_3$, >12% $MgCO_3$ Mg calcite is more soluble than aragonite.

In accordance with their mineralogy, the aragonitic deep-sea stony corals predominantly inhabit depths above the ASH, while the Mg-calcite galatheid squat lobsters are found down to the CSH. However, although chirostylid squat lobsters are also Mg calcite they are only found down to the depth of the ASH. Chirostylidae are known to be ecologically associated with some deep-sea corals and other host invertebrates, and therefore the mineralogy of the corals may be a key contributor in controlling the depth distribution of the chirostylids rather than their own carbonate mineralogy.

Thursday

12:00–12:15

Room OGGB5 Meteorology

Session Chair: Mike Revell

Influence of the Southern Oscillation on global temperature

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Time series for global tropospheric temperature anomalies (GTTA) and the Southern Oscillation Index (SOI) are compared for the period 1958–2008. GTTA are represented by data from satellite microwave sensing units (MSU) for the period 1980–2008 and from radiosondes (RATPAC) for 1958–2008. After the removal from the dataset of short periods of temperature perturbation that relate to near-equator volcanic eruption, we use derivatives to document the presence of a 5–7 month delayed close relationship between SOI and GTTA. Change in SOI accounts for 72% of the variance in GTTA for the 29-year long MSU record and 68% of the variance in GTTA for the longer 50-year RATPAC record. Because ENSO is known to exercise a particularly strong influence in the tropics, we also compared the SOI with tropical temperature anomalies between 20°S and 20°N. The results showed that SOI accounted for 81% of the variance in tropospheric temperature anomalies in the tropics. The results show that the Southern Oscillation has a consistently governing influence on global temperature, with a maximum effect in the tropics, except for periods when equatorial volcanism causes *ad hoc* cooling. That mean global temperature has for the last 50 years fallen and risen in close accord with the SOI of 5–7 months earlier shows the potential of natural forcing mechanisms to account for most of the temperature variation.

Thursday

12:15–12:30

Room 290-098 Ecology - Fish

Session Chair: Martin Cryer

"Attractive sinks" detract from spawning success: degraded habitats reduce egg production of whitebait in major rivers

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Source-sink dynamics are relevant to a wide range of species that cross habitat boundaries to complete their life histories. Where there are few or no feedbacks between the attractions to sink populations and the causes of life history traps where some life phase cannot be completed, these are termed "attractive sinks". Diadromous fishes such as salmonids and whitebait are particularly prone to the hazards of attractive sinks because to complete their life histories it is necessary for them to cross marine and freshwater ecosystems and, in the case of whitebait such as *Galaxias maculatus*, terrestrial habitats in the riparian zone near river mouths. Here we discuss the latest findings in a long-term, FRST-funded project on degraded habitats affecting riparian-ocean coupling in whitebait. We show that spawning habitat is highly restrictive in this species and that there is a negative correlation between stream/river size and spawning success, as measured by egg production. Experimental manipulations have given us clear pointers in where and how restorative measures should be taken. The alterations to spatially explicit "gateways" in the early life history of whitebait have led to population bottlenecks in many large and heavily fished rivers. This work will feed directly into larger national imperatives to improve and restore habitats of this iconic New Zealand species.

Thursday

12:15–12:30

Room OGGB3 Ecology - Sediments

Session Chair: Conrad Pilditch

Cadmium isotopic composition in oyster and seawater surrounding the South Island of New Zealand

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Cadmium (Cd) in conjunction with phosphate ($PO_{4\#}$) has been used as a paleoproxy for understanding nutrient and $CO_{2\#}$ cycling in historic oceans. However, our limited knowledge of Cd biogeochemical cycling in the oceans has led to many assumptions being used in the application of the $Cd/PO_{4\#}$ proxy. New techniques, double spiking combined with multiple-collector ICP-MS (MC ICP-MS), have increased our ability to measure Cd isotope fractionation. The simultaneous collection of multiple Cd isotopes results in high precision measurements allowing the resolution of small fractionations. Research, using these techniques, has already shown a biological fractionation of Cd in seawater, thought to be caused by phytoplankton uptake. This fractionation of Cd is thought to be very pronounced in dredge oysters (*Ostrea lutaria*) found off the south coast of New Zealand. These oysters have extremely high concentrations of Cd (2 ppm) despite a lack of point source pollution in the surrounding waters. We have proposed these oysters have high levels of Cd due to their food source (phytoplankton) that are actively using Cd and therefore, further increasing the fractionation signal.

These techniques will also be used to further the understanding of Cd fractionation in both seawater and phytoplankton. Phytoplankton growth experiments will help to determine what other metals such as Zn and Fe influence the uptake of Cd by phytoplankton and also if there is a species dependant uptake of Cd and how that influences isotopic signatures. All of this information will help to determine and improve the effectiveness of the current $Cd/PO_{4\#}$ proxy, increasing our understanding of nutrient cycling and $CO_{2\#}$ cycling in our oceans and how they might change with a changing climate.

Thursday

12:15–12:30

Room OGGB5 Meteorology

Session Chair: Mike Revell

Precipitation events during the recent drought on the Canadian Prairies

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The climate system is characterized by extremes in the hydrological cycle. Occurrences of drought and catastrophic precipitation are inherent manifestations of this. Though drought is characterized by a general trend of dryness in a region, the reality is that both extreme precipitation and extreme dryness can occur in close proximity. This work focuses on extreme precipitation events occurring during the recent multi-year catastrophic drought over the Canadian Prairies (1999–2005). Its objective is to better understand the occurrence of heavy precipitation occurring during a multi-year drought. Data from 14 weather station sites throughout the Prairie Provinces were examined from 1960 to 2006 to place this recent drought into perspective. Extreme precipitation events were identified by their accumulated precipitation in comparison to the monthly average precipitation at that site. Only events in which the associated precipitation was greater than the monthly average were considered. The accumulations achieved in some of these events can be 2–3 times the monthly average. It was found that, according to this definition, extreme precipitation events did occur slightly more often during the recent drought than expected from climatology. The characteristics of these extreme precipitation events were examined in detail using a number of different observational and model datasets. Some events were mainly long-lived stratiform events, whereas others were short-lived and mainly convective. The seasonal occurrence of these events was investigated as well as the severity of the drought when the events occurred. These and other results will be presented.

Thursday

12:30–14:00

OGGB - Lunch

Thursday

13:00–14:00

Room 290-098

NZMSS AGM

Chair: Colin McLay

Thursday

14:15–14:30

Room 290-098 Ecology - Fish

Session Chair: Mark Morrison

Seasonal and latitudinal variation in the diet of the New Zealand Butterfish (*Odax pullus*)

Jethro Johnson[1], David Raubenheimer[2], Howard Choat[3], Kendall Clements[1]
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Recent studies have suggested that temperature constrains the digestion of plant material, limiting herbivory in marine ectotherms at high latitudes. The New Zealand butterfish *Odax pullus* provides an example of an ectothermic herbivore that is successful in a cold temperate marine environment. This study examined the diet of *Odax pullus* across a latitudinal gradient of 15° within New Zealand. Its aim was to compare patterns of diet choice and assimilation efficiency with differences in life history and demography in the populations studied.

A total of 540 fish were collected from three locations covering the species' range. In one location, Hauraki Gulf, samples were collected monthly over two consecutive years. Sub-samples of the foregut were analysed to determine diet. The remaining gut was divided into five equal sections to allow study of nutrient uptake from the digesta. Nitrogen was determined via Kjeldahl digestion and total protein determined using high-performance liquid chromatography. For comparison with diet data, stable isotope analyses were carried out, providing $\delta^{15}N$ and $\delta^{13}C$ values for samples of muscle tissue collected at each location.
Adult *Odax pullus* were exclusively herbivorous throughout the distribution studied. They consumed predominantly brown algae at all three locations, with composition of the diet varying across both season and location. Seasonal differences in protein intake were observed in Hauraki Gulf and found to be sex specific, females showing greater protein intake over the spawning months. Preliminary data suggests no clear correlation between latitude and protein consumption. Similarly, nitrogen isotope data showed no clear trend with increasing latitude. We could therefore find no evidence for a temperature constraint on herbivory in this species.

Thursday

14:15–14:30

Room OGGB3 Antarctica

Session Chair: William Henson

A method for the retrieval of top-of-atmosphere albedo over Polar regions using MISR

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The Top-of-Atmosphere (TOA) albedo is a main factor determining a planet's energy budget, yet it is an estimated quantity only; to measure it would require simultaneous satellite measurements of reflected shortwave (SW) radiance over an entire hemisphere. This is where Multiangle Imaging Spectroradiometer (MISR) aboard NASA's Terra satellite has an advantage over other instruments — most of the latter designed to make measurements at one viewing zenith angle (MISR makes precision measurements of outgoing SW radiance at 9 different viewing zenith angles within several minutes). However, current methods used in the retrieval of the TOA albedo from MISR radiance measurements do not account for high anisotropy of reflected SW radiance in polar regions, partly due to low solar elevation angles, often resulting in physically inconsistent albedos. Polar albedos are of relevance to climate change, due to potential ice-albedo feedback amplifying any change. Here a method is developed to improve retrieved albedos. By classifying scenes by cloud fraction, surface type, solar zenith angle and relative azimuth angle, an empirical model of albedo was built with a year's MISR data. Missing relative azimuth angles were calculated by fitting MISR bi-reflectance factors (BRFs) to the SW angular distribution models from the Clouds and Earths Radiant Energy System (CERES) instrument, also aboard the Terra satellite. This empirical model is then used to convert BRF measured at nine different zenith angles to an albedo. The results indicate a reduction in the number of erroneous albedo values across all 4 MISR measurement bands (blue, green, red and near infra-red). The narrow band albedos are converted to a broadband albedo value by using regression coefficients determined from a merged CERES-MISR-MODIS dataset. These broadband albedos are compared with CERES albedo measurements and show agreement to within several percent, allowing for greater accuracy in calculation of global and polar-region albedos, facilitating the study of TOA energy budgets and polar climate change.

Thursday

14:15–14:30

Room OGGB5 Meteorology

Session Chair: Georgina Griffiths

An integrated probabilistic hydrological nowcast scheme

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Accurate forecasts of river flows and flooding, particularly in the short term, are important for a wide range of users, such as hydro-power companies, farmers and the general public.
Hydrological models are usually run from the interpolated input of a sparse array of rain gauges or from the rainfall estimates generated from a regional network of radars where the radar closest to the catchment is often at a considerable distance. Due to beam spreading, the spatial resolution at this range is several kilometres and the radar scanning strategies necessary lead to a rather poor temporal resolution (typically over 5 minutes). For small catchments, especially in convective conditions, this leads to great uncertainty as to the spatial rainfall distribution over the catchment area. This is surely one of the major errors associated with hydrological models.

As the rainfall field is usually found from gauge data or real-time radar data, the lead time of the hydrological forecast is determined solely by how long the fallen rain takes to reach the outlet of the catchment. Additional lead time can be gained using nowcasting. In its fundamental form, nowcasting simply involves extrapolating current radar and satellite data into the future. It has been found that based on this information alone, it is not possible to predict how the precipitation field evolves with time and this leads to great loss of model skill with time. Although one may not be able to accurately forecast the evolution of small-scale rainfall patterns using nowcasting, one may be able to capture the statistics form of this pattern. If a probabilistic rainfall field is generated, one could run an ensemble of hydrological forecasts to find a probabilistic representation of river flow.
It is intended to measure the rainfall field over several catchments in high resolution using the University of Auckland's X-band weather radar to investigate novel techniques in probabilistic nowcasting with application to hydrology.

Thursday

14:30–14:45

Room 290-098 Ecology - Fish

Session Chair: Mark Morrison

Indirect effects of fish on kelp beds

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Predator-prey interactions play an important role in the structure of food webs. A more holistic understanding of these interactions may be possible when they are evaluated within the context of surrounding habitats. In shallow subtidal habitats, beds of brown macroalgae contain diverse communities including several invertebrate grazers, which are potential prey for various fish species. Positive-indirect effects to the macroalgal habitat might arise when fishes remove effective grazers of kelps (*e.g.,* amphipods). Two different ways that predatory fishes might produce such positive effects include: 1) fishes reduce the numerical abundance of herbivore populations, and therefore, overall grazing pressure on plants; and/or 2) presence of fishes induce a behavioural response of herbivores, e.g., causing them to disperse or hide, and thus reducing overall grazing pressure. I use a series of field surveys and manipulative experiments in the laboratory to estimate these direct and indirect effects of reef fishes on mesograzer assemblages (e.g*.,* amphipods) and host kelps. To date, my results indicate that: a) some fish species significantly reduce grazing pressure of amphipods on *Macrocystis pyrifera* by directly reducing amphipod survivorship (i.e., via predation), b) these effects translate to improved performance of kelp (e.g*.,* as measured by growth rates of blades), and c) the presence of some fish species also induce behavioural responses on the mesograzers (independently of direct predation) which may reduce fitness of mesograsers and indirectly benefit host kelps. Overall, the present results highlight the importance of fish predators and their possible contributions to cascading effects in kelp ecosystems.

Thursday

14:30–14:45

Room OGGB3 Antarctica

Session Chair: William Henson

Atmospheric forcing of Antarctic sea ice on weekly to monthly time scales

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The seasonal variation of Antarctic sea ice extent is one of the largest geophysical changes in the Earth's annual cycle, effectively doubling the size of Antarctica in the winter months. Sea ice forms a natural barrier between the atmosphere and the ocean, modulating surface energy exchanges at high latitudes. Understanding the role of Antarctic sea ice in the climate system, and its response to anthropogenic forcing, is a key issue in climate research.

Beyond the seasonal cycle of ice growth and decay, Antarctic sea ice extent is strongly affected by the atmospheric circulation, on times scales from days to seasons. On the monthly to seasonal scale, there is a strong ENSO signal in sea ice extent across the Pacific, associated with atmospheric Rossby wave propagation. On daily to weekly time scales, atmospheric waves also modulate sea ice extent, around the whole of the Antarctic continent.

This presentation will review seasonal and ENSO-related atmospheric forcing of Antarctic sea-ice, and will discuss the nature of shorter-term interactions between the atmospheric circulation and sea ice concentration. The presence or absence of climate change-related trends in sea ice extent will also be touched on.

Thursday

14:30–14:45

Room OGGB5 Meteorology

Session Chair: Georgina Griffiths

Measurement of atmosphere-ocean energy fluxes over a coral reef, southern Great Barrier Reef, Australia

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Coral reefs are thought to face significant threat from global warming due to increased water temperatures and ocean acidity. However, research into the surface energy exchanges over coral reefs and their link to water temperature are rare. More research is also needed into the control of coral reef microclimates by larger scale atmospheric conditions, particularly via cloud cover. Direct *in-situ* measurements of the surface energy balance have been made over Heron Reef, a small platform coral reef in the southern Great Barrier Reef, Australia, in winter, spring and summer. Surface energy exchanges were measured using the eddy covariance method and show that during all seasons more than 70% of net radiation goes into heating of the water column overlying the reef flat and reef substrate, rather than the air. The turbulence fluxes are relatively small in both winter and summer, with latent heat flux (via evaporation) consistently dominating over sensible heat loss to the atmosphere. Overall, sensible heat flux tends to be very small in all seasons. The results suggest that cloud is the dominant control on heating the reef flat environment, especially in summer when maximum heating of the water occurs and a feedback process appears to occur with cloud development occurring over reef areas. Although the pattern of fluxes tends to be consistent over significant periods, case studies undertaken to date suggest that some short periods of exceptional weather conditions can have a major impact on sensible and latent heat fluxes. The current programme of field measurements is ongoing, and will be complemented by atmospheric mesoscale modelling to help understand links to synoptic scale weather patterns and longer term climate variability.

Thursday

14:45–15:00

Room 290-098 Ecology - Fish

Session Chair: Mark Morrison

Latitudinal variation in life history traits of the marine temperate herbivorous fish, *Odax pullus* (Labridae), across New Zealand

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There is a widely expressed view that abundance and diversity of herbivorous fishes decreases with increasing latitude. Temperate Australasia is therefore unusual in having a comparatively high number of herbivorous fish species extending into higher latitudes, and provides an opportunity to investigate how herbivorous fishes function in cold temperate environments. The present work addresses two primary issues: 1) the response of ectotherm life history traits to temperature over a gradient of latitude; and 2) the demographic performance of an herbivorous ectotherm in a temperate marine environment. We examine the effects of temperature on the life history of the ubiquitous New Zealand herbivorous butterfish, *Odax pullus* (Labridae). Sampling six populations from Northland to Stewart Island, we collected sagittal otoliths from over 1000 individuals for estimation of age and gonad samples from over 600 individuals for determination of sexual maturation and ontogeny. Size-at-age estimates were used to establish growth, examine the timing of sexual maturation and sex change, and investigate the relationship between growth, mean maximum body size, sexual maturation, development, and longevity across the species' geographical range. Results show a reduced rate of somatic growth, larger adult body size, delayed development, and extended life span in populations at high latitudes. Results indicate that the demographic and life history performance of *O. pullus* may not impaired by cold temperatures at high latitudes. The response of growth, maximum body size and development coincides with that found across ectotherms, as described by the Temperature-Size Rule (Atkinson 1994). Our results show little evidence for a constraint on life history imposed by reduced digestive capability or nutritional limitation in cold temperate environments.

Thursday

14:45–14:50

Room OGGB3 Antarctica

Session Chair: William Henson

Spatial and temporal variation of summertime surface-layer winds over the Darwin-Hatherton Glacial system, Antarctica

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Three temporary Automatic Weather Stations (AWS) were installed in the Darwin-Hatherton glacial system to study surface-layer wind characteristics in this region to support the Latitudinal Gradient Project (LGP). The Darwin-Hatherton glacial system offers a unique opportunity to investigate the response of the Antarctic Ice Sheet to future climate change.

Logistical difficulties presented unique challenges for the experimental design of the observational network, but one station was placed on the Hatherton Glacier (elev. 800 m), the second was installed over the Darwin Glacier (elev. 900 m), and the third in a region (elev. 600 m) where both glaciers converge and drain into the Ross Ice Shelf (RIS). Aside from measuring meteorological variables, sub-surface temperature, down-welling short-wave radiation and net-all wave radiation were also included. The Hatherton Glacier is composed mostly of blue ice, which has a significantly lower albedo than the snow/ice covered surfaces of the other sites.

Results show that the katabatic wind system is the dominant climatological feature in this region, especially in winter. Yet with the approach of summer, a diurnally reversing pattern is gradually established at lower elevations. There are several theories for the existence of anabatic winds (observed in other Antarctic locations), including a katabatic-opposing pressure gradient resulting from cold air pooling in the coastal areas. Given that the measured net-all wave radiation is higher over blue ice, the anabatic wind system here is most likely a thermally-forced valley wind system.

Thursday

14:45–15:00

Room OGGB5 Meteorology

Session Chair: Georgina Griffiths

Tornado wind induced damages to buildings in Taranaki

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A swarm of tornadoes hit the west coast of New Zealand's North Island on 4 and 5 July 2007, causing widespread damage in the province of Taranaki. These events provided a unique opportunity to collect valuable data concerning the nature of the event and to assess the vulnerability of different types of New Zealand buildings to high wind velocities. In our survey all levels of damage were considered. Undamaged buildings close to extreme damage, large heavy objects that were moved or other elements such as bent road signs also provided useful information about the lower and upper bounds of the strength of wind gusts.

Even though tornadoes varied in intensity, from EF0 to EF2/EF3, analysis of damage data revealed two clear trends: concrete roof tiles performed well, whereas sheet metal and metal tile roofs did not. All severely affected buildings had sheet metal or metal tile roofs. Buildings with weatherboard-type cladding were also most affected, followed by brick veneer and stucco. Another parameter, strongly correlated with damage, was building age; new houses built post 1980 generally performed well, whereas old houses did not. Additionally it was analysed how and where the observed tornado damage to New Zealand's building stock fit onto existing fragility curves, indicating level of damage as a function of wind speed. Since no measured data regarding maximum wind speed were available wind speed calculations were undertaken to derive lower bounds of peak gust wind speeds from posts bent or heavy objects moved during tornado events. A bending test was performed to provide information about moment capacity and yield strength of bent road signs; maximum wind speeds could have been as high as 60–70m/s. In this presentation, aside from presenting the results of the damage survey, we also briefly discuss meteorological aspects of the tornado outbreak.

Thursday

15:00–15:15

Room 290-098 Ecology - Fish

Session Chair: Mark Morrison

The effects of angling stress on key haematological and oxygen equilibrium parameters of snapper (*Pagrus auratus*)

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We sought to identify the strenuous effects of angling on the haematology and oxygen equilibrium of snapper (*Pagrus auratus*), a locally valuable fish species. Using whole blood, we measured indicators of aerobic-anaerobic poise following a period of strenuous exercise (angling capture). Any perturbations to the blood oxygen transport mechanism were quantified by measuring haematological indices, plasma metabolites and the extent, or presence, of fixed acid bohr or root effects.

Haematological data showed an increase in haemoglobin content, blood lactate, and glucose. Conversely, a decrease in venous pH from 7.53 to 7.41 remained within the operational zone of the maximal fixed-acid Bohr effect ($\Phi_{7.4\text{-}7.8}$ = -0.95), but above the critical pH at which the Root effect suppresses oxygen transport capacity. In light of these data, we conclude that stress-induced changes reflect a strategy of optimal O_2 unloading to tissues with the Root effect unlikely to be expressed in the swimming vasculature.

Thursday

15:00–15:15

Room OGGB3 Antarctica

Session Chair: William Henson

Detection and characterisation of siderophores in Sub-Antarctic waters

Imelda Velasquez[1], Sylvia Sander[1], Brook Nunn[2], Enitan Ibisanmi[1], and Keith Hunter[1]

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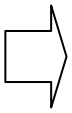
Terrestial and marine organisms excrete organic compounds to facilitate acquisition of iron (III) in the natural environment. These compounds, known as siderophores, have a high iron (III) binding affinity. Iron-siderophore complexes are known to increase iron bioavailability for some organisms. The presence of one known type of marine siderophore has been recently confirmed in natural seawater and evidence suggests that more than one type of siderophore may be present, especially in iron-limited regions of the ocean. Our goal is to chemically and structurally characterize siderophores from the iron-limited region of the Southern Ocean and to better understand local and global iron availability.

In this study, seawater samples from the Southern Ocean were collected and pre-concentrated using XAD-16 resin. Organic compounds that were bound to the resin were extracted back and tested for the presence of siderophores. Competing ligand equilibration-cathodic stripping voltammetry (CLE-CSV) with TAC ((2-(2-thiazolylazo)-p-cresol) as the competing ligand was used to measure the concentration of Fe-binding ligand [L] and stability constant ($\log K_{FeL,Fe3+}$#) of Sub-Antarctic water. Siderophore type chelates were characterized using chromatography and electronspray ionization-mass spectrometry. Chemical assays indicated positive siderophore-activity and presence of hydroxamate type-chelates**.** The iron binding capacities obtained from seawater samples are comparable to published data on natural ligands. Uncomplexed (apo) and iron (III) bound compounds which are potential siderophores were identified based on their observed m/z ratios. The mass spectra of iron complexes appeared to follow a fragmentation mechanism typical of a hydroxamate-type siderophore. This is the first time that siderophore-type chelates have been detected in iron limited waters of the Southern Ocean using mass spectrometry, supported by …



(contd) … results from chemical assays and electrochemistry (CLE-CSV). Detectable amounts of hydroxamate-type chelates were found in surface samples of the Sub-Antarctic water mass, which is consistent with the idea that iron-limitation of this water stimulates bacterial siderophore production. Siderophore compounds detected in this study are possibly just a small portion of a bigger pool of siderophore that are actually present in the Southern Ocean and are likely to affect the bioavailablity of iron.

Thursday

15:00–15:15

Room OGGB5 Meteorology

Session Chair: Georgina Griffiths

Downslope winds — an explanation for roof damage in Cobden, Greymouth in July 2008

Mike Revell, Stephane Popinet, Stefan Reese

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A very deep depression (central pressure ~ 963 hPa) moved over New Zealand late in July 2008. The storm brought extreme winds to some areas. In particular Levin and Greymouth bore the brunt of storm force easterly winds which caused damage to more than 100 houses. In Greymouth the damage was extremely localised. Given the scale of the storm one would have anticipated widespread damage, but the damage was mostly confined to the suburb of Cobden, Blaketown and a few locations in the centre of Greymouth. So what did cause the extreme, localised winds in Greymouth on July 31st 2008?

To answer this question, this event has been re-modelled by scientists at NIWA using a CFD code "Gerris". Initial results indicate that severe downslope winds generated by 50 km/hr southeasterlies over the main divide 30 km upstream combined with funneling through the narrow gap in the local topography at the mouth of the Grey river resulted in a very localised turbulent plume with wind speeds over 150 km/h. The combinations of wind speeds, terrain height and vertical temperature profiles that lead to downslope winds will be discussed. We will also consider the effects of surface friction and 3D as opposed to 2D modelling on the results.

Thursday

15:15–15:30

Room 290-098 Ecology - Fish

Session Chair: Mark Morrison

What controls the distribution of reef fish at the subtropical Kermadec Marine Reserve?

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The Kermadec Marine Reserve is New Zealand's largest and most isolated marine reserve. It is home to many species of reef fish that are not found elsewhere in the country and protects endemic and highly vulnerable species from fishery harvest. We aim to explain variation in assemblages of temperate and tropical species of reef fish at the Kermadec Marine Reserve by investigating factors such as site, spatial scale, depth, trophic structure and season. Underwater visual census (UVC) was undertaken to record species, abundance and size class of reef fish at three sites. Statistical analysis was employed to determine the contribution of each factor to observed variation. We have identified several factors that are responsible for explaining a significant amount of variation in the distribution of reef fish at sites within the Kermadec Marine Reserve.

(contd) … show that the algorithms are effective, with good agreement between derived horizontal wind speeds and those from nearby radiosonde soundings, and with derived vertical wind speeds that are overall consistent with expectations in terms of geometric relationships to the topography. Potential extensions of these techniques to allow use of more limited data will be discussed.

Thursday

15:15–15:30

Room OGGB5 Meteorology

Session Chair: Georgina Griffiths

Estimating 3D wind fields in mountain waves using sailplane flight data

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Computational Imaging Group, Department of Electrical and Computer Engineering, University of Canterbury

Novel methods for determining three-dimensional wind vectors in atmospheric mountain waves using sailplane flight data are described. Results are presented of application to the Sierra Nevada mountain wave.

Mountain lee waves are a form of atmospheric gravity wave that is generated by flow over mountainous terrain. They are of significant importance in meteorology since they can produce drag that affects the general circulation, windstorms, clear-air turbulence and can influence ozone abundance. Wind fields in high-altitude mountain waves, particularly the vertical component, are not particularly easily measured using conventional techniques such as radiosondes and Doppler radar. Research aircraft have been used for this purpose but are expensive. We are exploring the use of routinely collected flight data from sailplane flights to estimate three-dimensional wind fields in high-altitude mountain waves. Sailplanes have the advantage that flights are often conducted in mountain waves over long distances and at high altitudes, basic flight data are routinely logged using inexpensive equipment, and the sailplane aerodynamics are well characterised. In addition to dedicated flights, many sailplane flights are logged worldwide and there is the possibility of using them as "sensors of opportunity."

We will first describe the general problem of determining a 3D wind field from limited aircraft flight data, then two algorithms we have developed: one using logs of GPS position and airspeed to estimate the 3D wind vector along the flight path; the other is based on Bayesian estimation and is a more versatile method that can use a variety of kinds of data. Both methods are based on an assumption of a slowly varying horizontal wind velocity. Results will be presented using data from a sailplane flight in lee waves of the Sierra Nevada Mountains in California that reached an altitude of 14,000 m. The results…

Thursday

15:30–16:00

OGGB - Afternoon tea

Thursday

16:00–16:15

Room 290-098 Ecology - Fish

Session Chair: Ann McCrone

Testing the effect of NZ marine reserve protection on the abundance and size of blue cod and rock lobster

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School of Biological Sciences, Victoria University

We evaluate how size and abundance of two species, blue cod *Parapercis colias* and rock lobster *Jasus edwardsii*, differ within and outside Marine Reserves (MRs). Data were obtained from 13 MRs; and from 21 studies for blue cod, and 24 studies for rock lobster over ~ 30 years. To evaluate the effects of MR area (hectares) and MR age (years) on the biological response, both linear and non-linear functions were fitted to species-specific plots of RR as a function of MR size or age. A Spearman Rank correlation analysis tested the relationship between RR and MR size or age, revealing that in 36 of 49 comparisons (73.5%) MRs supported a greater abundance of blue cod than control areas, and in 14 of 16 comparisons (87.5 %) larger blue cod; for rock lobster, in 41 of 50 comparisons (82%) MRs supported greater abundance and in 45 of 50 comparisons (90%) larger individuals. Focused comparisons of RR for blue cod abundance and size versus MR area were non-linear and statistically significant ($p<0.05$), while RR comparisons of blue cod abundance and size versus MR age were not statistically significant ($p>0.05$); best fit relationships were non-linear and linear respectively. Focused comparisons of RR for rock lobster abundance and MR area and age were not statistically significant ($p>0.05$): best fit relationships were linear and non-linear respectively. Results for rock lobster size and MR area and age were statistically significant ($p<0.05$); best fit relationships were non-linear and linear respectively. Spearman rank correlation analysis revealed a significant linear relationship ($p<0.05$) between rock lobster size and MR age: all other relationships were not statistically significant ($p>0.05$). Our results from MRs across NZ indicate these two species benefit from MR protection; however, our results are less clear about the effect of MR size and age on these biological responses, which differ between the two species.

Thursday

16:00–16:15

Room OGGB3 Antarctica

Session Chair: Steve O'Shea

When sea urchins get sunburnt: impacts of the ozone hole

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University of Otago, Departments: [1]Marine Science, [2]Botany

Increased UV-B exposure, as a consequence of stratospheric ozone depletion over Antarctica, has had a variety of deleterious impacts on marine organisms and communities. One specific concern is oxidative stress, whereby the accumulation of intracellular reactive oxygen species (ROS) overcomes antioxidant defences.

We examined oxidative stress in the embryonic and early larval stages of the Antarctic sea urchin *Sterechinus neumayeri* with respect to (1) sea ice coverage and (2) changes in overhead ozone conditions in McMurdo Sound during the spring of 2008. Oxidative stress was quantified both in terms of damage (protein carbonylation, lipid peroxidation and morphological abnormality) and activity of anti-oxidant enzymes (superoxide dismutase, catalase and glutathione reductase). We observed higher oxidative damage and abnormality in embryos exposed to full ambient UV-B compared to those protected by a layer of sea ice. More importantly, oxidative stress was significantly greater in exposed embryos when overhead ozone concentrations were reduced. Specifically, we measured a 4.4-fold increase in protein carbonyl content, a 2.4-fold increase in the level of lipid hydroperoxides and a 2.5-fold increase in abnormality in embryos exposed to full UV-B during low ozone conditions. Additionally we recorded only slight increases in SOD and CAT activities in embryos exposed to full UV-B. No differences were found across all measures of damage and defence in embryos under the sea ice.

Results indicate that *S. neumayeri* embryos are not well adapted to cope with enhanced UV-B when they are not protected by a layer a sea ice. We discuss the implications of this research in terms of future changes in UV-B exposure and associated impacts on Antarctic marine invertebrate larvae.

Thursday

16:00–16:15

Room OGGB5 Meteorology

Session Chair: Roger Davies

A mesoscale model intercomparison of coastal refractivity

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The vertical structure of the maritime atmospheric boundary layer has a pronounced effect upon radar and communications systems. High-resolution numerical weather prediction (NWP) forecast fields of temperature, pressure, and vapor pressure should be able to be used to diagnose the refractive index of the atmosphere.

To evaluate the current ability of mesoscale models to forecast refractive conditions in a littoral setting, an international collaboration developed: the U.S. Naval Research Laboratory's COAMPS®[1]; Great Britain's Unified Model (UM); New Zealand's MM5, and Canada's GEM. Each model was run over Wallops Island, Virginia, USA and Bay of Plenty, New Zealand during periods of extensive field measurement data collection along radials extending to ~100 km from shore. Field data include helicopter vertical profiles, unmanned aerial vehicle profiles, hourly surface met tower observations and surface buoy time-series, along with a boat-mounted transmitter and shore-based receiver measurement propagation pathloss.

The model evaluation included intercomparison of ducting characteristics such as duct strength, thickness and base height, these parameters provided insight into the spatial evolution of the refractive environments for both of the field sites. An evaluation of standard statistical metrics of the predicted refractivity and ducting quantities suggested potential for model forecast system improvements that would have the greatest impact on refractivity. A detailed investigation of these refractive patterns links them to variations in the vertical distribution of water vapor associated with the myriad mesoscale forcing mechanisms that contribute to structure in the surface, boundary and entrainment layers. The relative importance of several key forcing mechanisms will be considered at the conference.

Thursday

16:15–16:30

Room 290-098 Ecology - Fish

Session Chair: Ann McCrone

Incidental capture of seabirds in recreational fisheries in New Zealand

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Anecdotal and opportunistic reports indicate that the incidental capture of seabirds is a common occurrence in non-commercial fisheries, but little is known about the nature and extent of these captures. Here, we report the first data on recreational seabird bycatch from dedicated boat ramp surveys conducted in the Auckland and Otago regions during summer 2007/08. Information obtained included fishing effort (number of fishers, time fishing), fishing location, method, number and kind of seabirds caught on the day of the interview, and fate of captured seabirds. Fishers were also asked about incidental captures witnessed in the past. On the day of the interview, seabirds were captured in both regions and included albatross, petrels and seagulls, whereas past captures also involved gannets, penguins, shags, and terns. Petrels and seagulls were the most common seabirds caught, accounting for >75% of incidental captures overall. Although the majority (77%) of surveyed fishing trips were close to shore (< 5km) or in estuaries and harbours, a slightly larger proportion of seabirds was caught at offshore locations. Captured seabirds were predominantly entangled in fishing gear, although this form of capture was more prevalent for albatross and petrels than for gannets and shags, which swallowed the hook. The majority of incidental captures were associated with the use of weighted bait. Regarding the fate of captured seabirds, few were released or escaped still entangled or with the hook attached, and most fishers reported that seabirds escaped unharmed. These findings confirm anecdotal and opportunistic data that seabirds are caught in non-commercial fishing activities when their distributions coincide with fishing locations. The scarcity of information makes it difficult to assess the impact of recreational fishing on New Zealand seabird populations and highlights the need for future research of incidental seabird captures in non-commercial fisheries.

Thursday

16:15–16:30

Room OGGB3 Antarctica

Session Chair: Steve O'Shea

The diversity and distribution of holothuroid echinoderms (sea cucumbers) south of the Antarctic convergence — a morphological and molecular story

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The New Zealand IPY-CAML Project 2008 survey of the Ross Sea and Scott and Admiralty seamounts yielded 900 holothuroid (sea cucumber) specimens and associated data. These specimens have been identified using the traditional morphological systematic method. This collection is integral to an analysis of the diversity and distribution of holothuroid species from all depths south of the Antarctic Convergence.

So far, there are 155 known species, of which 38 are undescribed. Species occurrences south of the convergence at Bouvet Island, Heard and Kerguelen Islands, Prydz Bay, Ross Sea, Bellingshausen Sea, Antarctic Peninsula, Weddell Sea, and north of the Convergence in the Magellanic Region are compared. Based on the morphological systematics there is typically a circumpolar distribution south of the convergence. However, most sea cucumber species on the Heard/Kerguelen Plateau do not show a circumpolar distribution. The Convergence is a significant barrier to gene flow north from the Antarctic Ocean.

In collaboration with Gustav Paulay in the University of Florida, DNA phylogenetic data (CO1 gene) are becoming available for tissue samples from all species in this collection. Circumpolar distribution and distribution north and south of the Convergence will be discussed in response to the emerging molecular data. These data are the basis for refinement of traditional morphological systematic conclusions, and are critical to biogeography insights.

Thursday

16:15–16:30

Room OGGB5 Meteorology

Session Chair: Roger Davies

Cloud motion from MISR satellite data using novel stereography approach and comparison with model data

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A fully automated retrieval of cloud motion from a polar orbiting satellite using multiangle imagery is described and the results are compared to model data for validation.

The Multi-angle Imaging SpectroRadiometer (MISR) is part of the payload for the Terra spacecraft launched in December 1999. It has 9 separate pushbroom cameras observing the Earth at nine discrete angles. The approach we have used to find the MISR Cloud Motion Vectors (CMV's) is stereography. With the 9 separate cameras viewing the Earth, a point on the Earth is observed at all 9 angles within a 7-minute interval. Comparing these images provides an independent and wholly geometric means to obtain CMV's and cloud-top heights without any dependence on ancillary information.

National Centres for Environmental Prediction (NCEP) reanalysis data uses geostationary satellite data and active measurements to create an Earth model climate. This means that the information the model is based on is densely measured over regions in the Northern Hemisphere but is sparsely measured over regions of the Southern Hemisphere. MISR satellite observations provide a means for filling the temporal and spatial gaps in the wind network. Using the NCEP data means that comparison of regions of the data-dense North can initially be used to show the accuracy of the MISR stereographic algorithm and comparisons of regions of the data-sparse South can be used to show the accuracy of the NCEP model in the South. Winds at low levels over the Southern Oceans, in particular, show interesting differences, with model appearing to have a fast speed bias when observational data is lacking.

The comparisons suggest that the MISR cloud-track winds are of comparable quality to geostationary cloud drift winds and scatterometer winds routinely used for global forecast models, and MISR winds can provide novel information not available from other data sources to improve reanalysis models in the future.

Thursday

16:30–16:45

Room 290-098 Ecology - Fish

Session Chair: Ann McCrone

Regional scale marine habitat mapping in northern New Zealand

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This presentation details collation of data and habitat mapping in northern New Zealand to support marine protected areas (MPA) planning. In inshore waters of the Hauraki Gulf Marine Park, rocky shores, beaches, mudflats, reef, saltmarsh, mangrove and seagrass were mapped from high resolution aerial photos. In deeper water (10–200 m), depths on paper naval fare sheet soundings were digitised to produce maps indicating areas of high relief and potential differences in habitat such as the presence of rocky reef. Expert knowledge from structured interviews with 26 marine scientists has been mapped. This information has been combined with field surveys, other databases, and literature in a marine geodatabase that documents a wide range of biodiversity values across the region.

These methods are a cost-effective way to provide regional scale maps that indicate locations to target for future, smaller-scale investigations. This marine geodatabase will contribute not only to the MPA process but also help support sound policy and management decisions regarding many aspects of the coastal marine environment.

Thursday

16:30–16:45

Room OGGB3 Antarctica

Session Chair: Steve O'Shea

Responses of coastal Antarctic soft-sediment benthos to pulsed food supply: manipulative experiments involving benthic incubation chambers

Andrew Lohrer[1], Vonda Cummings[2], Peter Marriott[2], Luca Chiaroni[1], Rod Budd[1], Peter Notman[2], Jennifer Beaumont[2]

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In coastal communities of the Western Ross Sea (77°S), food arrives at the seafloor during a brief phytoplankton bloom and when under-ice algae sinks to the bottom. Organic detritus from December–February is assumed to sustain the benthos during winter, with sediment organic content lowest in spring (September–November). We hypothesized that, despite low temperatures that can limit enzymatic activities, benthic feeding and bacterial remineralisation rates would increase substantially in response to pulsed food supply. We investigated a coastal benthic community's response to pulsed food supply by collecting under-ice algae, injecting concentrated doses into benthic incubation chambers covering soft-sediments at Granite Harbour, and measuring effects on fluxes of dissolved oxygen and inorganic nutrients. Fluxes between sediment and water column also provided insights into basic rates and processes (e.g., community respiration and benthic photosynthesis) that are largely unknown for soft-sediment habitats under sea ice. The soft-sediment communities we studied were net heterotrophic in November 2008 (i.e., macrobenthos and microbes consumed more oxygen than was produced by photosynthesis), although rates of oxygen consumption were very low compared to data from temperate latitudes. The density of macrofauna inside the chambers had a significant effect on oxygen flux. However, effects of the food pulse treatment were not significant, suggesting that the main driver of oxygen dynamics in the system was macrofauna rather than the sediment's microbial community. Despite 24-hr sunlight in November, benthic communities at Granite Harbour lacked substantive *in situ* primary production, indicating the near total reliance of macrofauna on advected seasonally-pulsed food.

Thursday

16:30–16:45

Room OGGB5 Meteorology

Session Chair: Roger Davies

Coastal atmospheric research with the Kahu Unmanned Aerial Vehicle (UAV) system: preliminary results from the Bay of Plenty, New Zealand

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Defence Technology Agency, Auckland

The Defence Technology Agency's Unmanned Aerial Vehicle (UAV) system, Kahu, has been successfully employed to gather airborne atmospheric measurements in the coastal environment. Equipped with a suite of meteorological sensors, the UAV flies autonomously using GPS and pre-programmed waypoints collecting atmospheric measurements that are relayed to an operator in real-time. Assessment of the UAV's ability to collect atmospheric data involved a direct comparison with weather station sensors and radiosonde soundings up to an altitude of 500 m. These experiments have shown the airborne collected data to be accurate and precise and that the Kahu UAV may be used to complement and even supplement conventional low-altitude sampling techniques. This paper details the use of the UAV in the Defence Technology Agency's 'Seabreeze 2009' trial, collecting atmospheric measurements during radar propagation experiments in the Bay of Plenty, New Zealand. Vertical and horizontal atmospheric profiles collected by the UAV during sea breeze circulations will be presented to illustrate the systems meteorological sampling capabilities.

Thursday

16:45–17:00

Room 290-098 Ecology - Fish

Session Chair: Mark Morrison

Patterns and processes in the nearshore rocky-reef benthic communities of Wellington's Taputeranga Marine Reserve area

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The development of monitoring programs for protected marine environments requires an understanding of pre-reserve patterns of natural temporal and spatial variation in community structure, as well as physical and environmental processes structuring communities targeted for management. Baseline surveys identify these patterns, which can then be compared with subsequent monitoring surveys to assess the effectiveness of reserve status on recovery of ecologically important and recreationally and commercially impacted species.

The Taputeranga Marine Reserve comprises 854 hectares of temperate rocky reef along the Wellington South Coast (WSC). Our study expands an earlier baseline study in this region, but surveys a broader range of benthic species and incorporates habitat assessment. The goals of our study were to identify: temporal and spatial variability in the WSC's nearshore benthic community; key species for monitoring; and physico-environmental variables that structure the communities. In a BACI design using belt transects and quadrats in the shallow subtidal zone (5–12 m), measures of community structure and condition at nine sites were measured (e.g., abundance, diversity, distribution, species ranges, and size of key species); habitat availability and use were also surveyed. Physico-environmental variables included: quantitative and qualitative sediment measures, habitat category, rugosity, dissolved oxygen, temperature, vertical Secchi depth, slope, and exposure, distance from Wellington Harbour, and urban density. PRIMER analyses, including CAP and LINKTREE, identified patterns in benthic community structure, species distribution, and the relative contribution of environmental and physical variables to these trends. This information will be used to inform the reserve's long-term monitoring plan.

Thursday

16:45–17:00

Room OGGB3 Antarctica

Session Chair: Steve O'Shea

Rocky reef communities of the Bounty and Antipodes Islands

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During March 2009, we completed an expedition to the Bounty and Antipodes Islands, in New Zealand's Subantarctic region. The aim of our research was to describe the islands' nearshore benthic assemblages, the trophic interactions among the terrestrial and nearshore marine environments, and to document some of the marine biodiversity of these World Heritage islands.

Taxonomic collections, photoquadrats, remote video camera and diver observations were used to describe the structure of the subtidal rocky reef communities at sites around both island groups. Although the islands are within the same biogeographic region and are only 100 nautical miles apart, we found significant differences in their species composition, particularly in the relative abundance of various functional groups. The Antipodes Island subtidal rocky reefs were dominated by extensive areas of plating nongeniculate coralline algae, with associated fauna, including a distinctive bryozoan community. In contrast, the Bounty Islands were dominated by filter- and suspension-feeding encrusting invertebrates, primarily sponges, with a significant component of mussels and barnacles. There are several possible explanations for the marked differences, including contrasting geology, oceanography and nutrient input from the adjacent terrestrial environment. The high biomass and important ecological role of coralline algae at Antipodes Island suggests that any decrease in these through ocean acidification may have significant implications for nearshore community structure. Our findings will inform the management of these islands, including proposals for the establishment of marine protected areas in this biogeographic region, provides a baseline for monitoring future change at the islands, and contributes to knowledge of New Zealand's Subantarctic biodiversity.

Thursday

16:45–17:00

Room OGGB5 Meteorology

Session Chair: Roger Davies

Towards variational assimilation of rain radar data in New Zealand

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A contemporary theme in numerical weather prediction is the assimilation of a variety of atmospheric data through variational techniques. In such schemes differences between observations and a model are minimized according to a cost function. The cost function includes an observational operator to convert from model state variables to observations. In the case of rain-radar measurements the transformation from model state space to observations is non-trivial, principally because rain is a diagnosed variable. Further complications arise in specifying physical parameterizations to transformation from model variables to observations which are sufficiently linear to employ in an optimized minimization scheme.

Existing 1D+3D/4D VAR procedures simplify the assimilation problem by first assimilating rain observations at individual grid points. One dimensional minimization problems are solved to generate pseudo observations of model diagnostic variables. These pseudo observations can then be more readily assimilated over the whole model domain.

This paper assesses the suitability of data from local X-Band rain radars for inclusion in a 1D+3D/4D VAR system. The assimilation potential of various radar data products are assessed, in particular the difference between reflectivity aloft and accumulation derived from the Z-R relationship.

Thursday

17:00–17:15

Room 290-098 Ecology - Fish

Session Chair: Ann McCrone

Ecosystem-based management of coastal reefs: understanding diversity and function before trying to manage it

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There is a now a strong impetus for Ecosystem-Based Management (EBM), in recognition that species and communities are inter-connected across ecosystems. Implementing EBM has proved to be difficult, however, because of the detailed knowledge required for it to be effective and also because no one seems to be quite sure what it means in practice. Here I discuss a view of EBM and its application to New Zealand shores, based on long-term studies. Because the underlying drivers of diversity are different on quite fine spatial scales along tidal gradients, and there is a large component of “ephemeral diversity” along New Zealand shores, effective management will need to be multi-dimensional and targeted. Using protected areas as a panacea for multiple impacts is unlikely to be effective in the long run if people-pressure continues to increase. Furthermore, diffuse impacts may well increase, making it imperative that we address broader issues of effective management, societal values and behaviours.

Thursday

17:00–17:15

Room OGGB3 Antarctica

Session Chair: Steve O'Shea

Phylogenetic relationships of Antarctic hyperiidean amphipods using the mtCOI gene

Lisa Bryant[1], Simon Davy[1], Anne-Nina Lörz[2], Els Maas[2], Joe Zuccarello[1], Ken Ryan[1]
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Hyperiidean amphipods are planktonic crustaceans ubiquitous in the Antarctic pelagic environment. Despite their obvious importance to Antarctic ecosystems as a stable food source for higher trophic levels, it is difficult to accurately and confidently identify all but the most common species, leading to much confusion in ecological studies. As well as being one of the most speciose crustacean orders, problems also occur due to the fact cryptic speciation is not uncommon in the Amphipoda, and yet other species exhibit relatively high levels polymorphism. These issues have also left many groups within the Amphipoda in desperate need of systematic revision. The mitochondrial cytochrome oxidase I subunit (mtCOI, or *cox1*) gene is a very to calculate intra- and interspecific distances for many taxa, including Amphipoda. A preliminary phylogeny of antarctic Hyperiidea using the mtCOI gene will be presented showing some discrepancies with traditional morphological phylogenies. The first data showing the population genetic structure of one common species collected in the Ross Sea, *Vibilia antarctica* (Stebbing, 1888), will also be introduced.

Thursday

17:00–17:15

Room OGGB5 Meteorology

Session Chair: Roger Davies

The LUNG: a new approach to greenhouse gas flux measurements

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In order to understand and measure greenhouse gas (GHG) emissions from agricultural sources, soil scientists often use chamber techniques to measure gas fluxes directly from the soil. However, there are limitations with using the chamber technique for quantifying nitrous oxide emission from pastoral agriculture: 1) the emissions are spatially variable due to the patchiness of urine deposition in the paddock and representative spatial integration is hard to achieve with small chambers (usually < $1m^2$ per chamber); 2) the emissions are temporally episodic. Static chamber measurements are labour intensive and rarely provide the continuous measurements required for integrating the flux over time; and 3) chambers are intrusive; i.e. they modify the atmosphere, removing light and wind and altering ground temperature.

We describe an air-sampling system (called the "LUNG") which couples a gas chromatograph with an instrumented mast in order to measure GHG fluxes continuously at the paddock scale. The advantage of the lung system is that simultaneous flux measurements of CH_4, N_2O and CO_2 can be carried out in real time using the same gas chromatography equipment that is currently used for chamber studies.

Our objective is to present the design of the LUNG system, its precision, illustrate its reliability and ease of operation under field experiment conditions. We also present results from an experiment carried out on a dairy farm grazed by a large herd of cows.

Thursday

17:15–17:45

OGGB

Poster Session

Thursday

19:30

Venue Strata Cafe

Graduate Party

Friday

09:00–09:30

Room 569 Plenary

Malcolm Francis, NZMSS Annual Awardee 2008

New insights into shark habitats, migrations and diving behaviour revealed by electronic tagging

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Tags have been used for many decades to detect and quantify the movement of fish around the oceans. Shark tagging began in New Zealand in the late 1970s using simple plastic spaghetti or dart tags. These tags provide limited information (release and recapture locations), and then only if the shark is recaptured. We have come a long way since those early studies, with modern electronic tags now providing locations along a shark's route, enabling estimation of movement tracks, how long the shark remained in each location, and swimming speed. Some tags are equipped with depth and temperature sensors that provide high resolution information on the habitat preferences and diving behaviour of sharks. Satellite tags archive data onboard and transmit them via a satellite, thus removing the need to recapture the animal. Acoustic tags record their presence on data loggers deployed at strategic locations underwater. Results indicate that most shark species travel further and dive deeper than was previously believed. The development of tagging technology, it's application to New Zealand shark populations, and some of the fascinating insights gained into the lives of sharks, will be traced by reference to some important tagging programmes on rig (*Mustelus lenticulatus*), school shark (*Galeorhinus galeus*), mako shark (*Isurus oxyrinchus*), blue shark (*Prionace glauca*), porbeagle (*Lamna nasus*) and great white shark (*Carcharodon carcharias*).

09:30–09:45

Room 569

Heather Murray, NZMSS Student 2008

Effects of UV-B radiation on oxygen consumption of a temperate and tropical sponge

Abstract on page 113

Friday

09:45–10:00

Room 290-098 Conservation

Session Chair: Alison MacDiarmid

Taking stock of the New Zealand southern right whale

Emma Carroll[1], J Jackson[2], N Patenaude[1], T Smith[3] and CS Baker[1,2]
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Around New Zealand, the southern right whale (*Eubalaena australis*) was subject to intensive commercial hunting, with at least 10,000 whales harvested in the 1830–40 period. Today, the species is almost absent from off mainland New Zealand; a remnant population occurs in the sub-Antarctic Islands. Here we present a revised estimate of mitochondrial diversity of New Zealand southern right whale and reconstruct stock-specific population history of decline and recovery. Mitochondrial diversity (h=0.679+/- 0.017, 275 bp) and minimum number of surviving maternal lineages (11) were estimated from control region sequences amplified from skin biopsy samples (from 280 whales from winter surveys conducted from 1995–98). These estimates confirm that New Zealand sub-Antarctic right whale breeding stock has one of the lowest levels of haplotype diversity known for any baleen whale population. The historical trajectory of the population was estimated using a Bayesian logistic population dynamic model integrating demographic uncertainty and genetic data. This was constructed using mark-recapture abundance estimates (n=938, CV=7%) from the 1995–1998 surveys in conjunction with a revised regional catch history, a correction factor for animals struck but lost and population growth rate estimates from con-specific populations. The minimum population size (Nmin) based on the number of surviving mtDNA lineages, was used to constrain these population trajectories. Our results confirm that the population came perilously close to extinction during the late 19th and early 20th centuries. When genetic data are included in the model, growth rate estimates are inconsistent with assumptions about the high rates of population increase used by the IWC to assess the decline and recovery of this species.

Friday

09:45–10:00

Room OGGB3 Dispersal and Connectivity

Session Chair: Shane Lavery

Moving around the oceans: global phylogeography and taxonomy of the giant kelp *Macrocystis*

Erasmo Macaya[1], Filipe Alberto[2], Ester Serrao[2], Sylvain Faugeron[3], Joe Zuccarello[1]
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Buoyant macroalgae may persist at the sea surface for weeks or months after detachment, which may represent an important mechanism of long-distance dispersal. Several studies report high abundance of floating algae in temperate oceans; however, investigations addressing the genetic connectivity between algal populations along this area are lacking.

The brown alga *Macrocystis* represents a good model for dispersal as: it forms kelp rafts that may travel long distances (up to 900 km); and it has been reported that kelp rafts are capable of reproduction after detachment. Currently, four species of *Macrocystis* are recognised based on morphology (i.e. holdfast morphology and blade corrugation). Despite their ecological and economic importance, *Macrocystis* phylogeny and taxonomy remains unresolved.

Herein we examine the phylogeography and taxonomy of *Macrocystis* collected at more than 80 sites around the world. Samples were analyzed using mitochondrial markers and microsatellites. Our results support previous suggestions, and *Macrocystis* should be recognized as a mono-specific genus. Results also reveal shared haplotypes at several sites around the Southern Hemisphere, and very low variability between samples, suggesting that kelp rafts may indeed represent an important mechanism for dispersal and connectivity.

Friday

09:45–10:00

Room OGGB5 Physical oceanography

Session Chair:Scott Nodder

A New Zealand region ocean climatology

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Presented here are some initial results of a new approach to the climatological gridding of NZ region ocean temperature and salinity profiles. Input data incorporate both CTD casts and Argo profiles from the selected gridding domain, either independently or in combination. After preliminary processing, including various data quality control checks, gridding at each of 56 standard depths employs the Variational Inverse Method (VIM) as implemented in software by DIVA. Results compare favourably with other gridding approaches and with published ocean climatologies. Some of the expected advantages of the gridding method are clearly evident. Spatio-temporal sampling bias and sparsity that are major issues for gridding of the CTD casts alone are improved markedly by the inclusion of Argo profiles.

Friday

10:00–10:15

Room 290-098 Conservation

Session Chair: Alison MacDiarmid

Quantitative fatty acid signature analysis of New Zealand sea lions: sensitivity analysis and diet estimates

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The New Zealand sea lion (*Phocarctos hookeri*) is the only pinniped endemic to NZ with 99% of its breeding population restricted to sub-Antarctic islands. Total pup production has declined in the past decade; current hypotheses are that population growth is affected by direct pressure from the southern arrow squid (*Nototodarus*) fishery, and/or by the lack of suitable prey at foraging grounds. We describe the diet of *P. hookeri* using quantitative fatty acid signature analysis (QFASA) on blubber samples from specimens by-caught from 2000 to 2006. Our model was optimised by simulations for which one model parameter (six different sets of calibration coefficients (CCs) from different pinniped species and feeding regime; and the consideration of individuals prey values or mean prey values) varied each time. The "best of fit" parameters were those with the lowest Kullback-Liebler distance values. These parameters were used in a model to estimate the diet of NZ sea lions. QFASA was highly sensitive to the set of CCs applied. Across years, the most important prey estimated were arrow squid *N. sloani* (28.1%mass), rattails Macrouridae (26.9%mass), hoki *Macruronus novaezelandiae* (10.1%mass), and red cod *Pseudophycis bachus* (3.6%mass). Despite the uncertainty on the accuracy of the match between the optimal CCs used and the true FA metabolism of *P. hookeri*, the variation of prey estimated between years was highly consistent with trends of commercial catch. The most important estimated prey were demersal species living mainly at depths >200 m that *P. hookeri* encounter on the slopes of Auckland Islands shelf. Our study emphasised the importance of these areas for *P. hookeri* over the first half of the lactation period. Moreover, the prey species estimated in the diet have a low energy-content which may impact on the reproductive success of females.

Friday

10:00–10:15

Room OGGB3 Dispersal and Connectivity

Session Chair: Shane Lavery

Phylogeography of New Zealand's coastal benthos: them's the breaks

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During the past 30 years, at least 42 molecular studies have been undertaken in New Zealand to examine the phylogeography of coastal benthic invertebrates and plants. Here, we identify generalities and/or patterns that have emerged from this research and consider the processes implicated in generating genetic structure within populations.

Studies have used various molecular markers and examined taxonomic groups with a range of life histories and dispersal strategies. Genetic breaks have been identified at multiple locations with the most frequently observed division occurring between northern and southern populations at the top of South Island. Although upwelling has been implicated as a cause of this disjunction, oceanographic evidence is lacking and alternative hypotheses exist. A significant negative correlation between larval duration and genetic differentiation suggests that larval duration might be used as a proxy for dispersal potential. However, among taxa with short larval durations there was greater variability in genetic differentiation than among taxa with longer pelagic periods. This implies that when larval duration is short, other factors may determine dispersal and connectivity among populations.

Although generally there has been little congruence between the phylogeographic data and recognised biogeographic regions, recent research has resolved population subdivision at finer spatial scales that corresponds more closely with existing biogeographic classifications. The use of fast-evolving and ecologically significant molecular markers could further improve this resolution.

A shift towards hypothesis driven research and collaboration with physical and biological oceanographers will improve our ability to identify population subdivision and the processes structuring marine ecosystems.

Friday

10:00–10:15

Room OGGB5 Physical oceanography

Session Chair: Scott Nodder

Bio-optical classification of New Zealand waters from satellite derived ocean colour

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Satellite-based Earth observation provides a source of synoptic environmental information that is being increasingly exploited for ecological and climate applications. Terrestrial ecological variables measurable by satellite include vegetation type, land cover, phenology, and plant biophysical attributes. Similar variables may be measurable in oceans and coastal waters although with more complex temporal dynamics. In this study we investigated bio-optical water classes from SeaWiFS ocean colour measurements. Pixels in ocean images are areas of ocean for which a single colour measurement represents an aggregate of all the reflected energy and by inference the average biological and chemical properties of the waters within the spatial extent of the pixel. The present study used 4 km resolution as a test of the concept. The nature of the water properties that can be traced is governed by the ability to discriminate their spectral signatures and whether it is meaningful to study them at the available pixel resolution. Permutations of four different clustering algorithms and six data transformations were tested to find combinations that show potential for creating new knowledge of ocean and coastal hydrodynamics and ecology. The initial properties of interest were variations in 1) pigment concentration, and 2) optical properties of waters with changing pigment concentration. The first is of interest for obvious reasons. The latter is the basis on which more information than just chlorophyll concentration might be gained from ocean colour in the future. Classifying waters on the basis of pigment concentration can be done in a somewhat arbitrary fashion by k-means, k-medoids or Wards hierarchical cluster methods. Gaussian mixed model clustering was considered to be superior to other methods in terms of finding variations in the size, shape and orientation of clusters. A method for identifying pigment specific variations in the optical properties of waters was mixed model clustering on anomaly spectra after removal of first order variation using an assumed index of pigment concentration. This exploration of second order variation identified a number of possible bio-optical water classes that now require verification with *in situ* observations.

Friday

10:15–10:30

Room 290-098 Conservation

Session Chair: Ali MacDiarmid

Human-induced changes in behaviour in New Zealand sea lions at Sandfly Bay, Otago, New Zealand

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The NZ sea lion (*Phocarctos hookeri*) is a threatened species with a distribution restricted to the New Zealand region. The purpose of this study was to determine if human encounters elicited responses from sea lions, and to determine what factors were likely to generate a response. Encounters were investigated during two consecutive summers, 2007–2009, at Sandfly Bay, Otago Peninsula; a site with an average of 7 sea lions ashore daily. Sandfly Bay is a popular destination for international and domestic visitors, but their activity here is unregulated and people can come in close contact with sea lions. Focal sampling of sea lion behaviour targeted descriptions of posture before, during and after encounters — their typical response was for a prone animal to lift its head. The variables recorded about people were group size, minimum approach distance to sea lions, type of encounter, and visitor behaviour. Encounters were divided into two types: 'walk-bys' — when people walked past sea lions without stopping, and 'interactions' — when people stopped to observe sea lions. After data analysis, it was found that all except group size were found to be significant in predicting the probability of a response by sea lions. Interactions were significantly more likely to cause a change in behaviour than walk-bys. Boisterous human behaviour — running, shouting, or arm waving — was the most likely to elicit a response for both walk-bys and interactions. Results indicate that visitors exhibiting boisterous behaviour that interact with sea lions from 20 m have a 96% probability of eliciting a response from sea lions. If visitors walk-by sea lions at 20 m exhibiting boisterous behaviour, they have a 71% probability of eliciting a response. This human disturbance could be mitigated by signs or guides on site that emphasize the importance of moving slowly and calmly near sea lions. Visitors to Sandfly Bay are causing changes in sea lion behaviour, but long-term studies are needed to determine if the impacts are detrimental to the species.

Friday

10:15–10:30

Room OGGB3 Dispersal and Connectivity

Session Chair: Shane Lavery

Biogeography of squat lobsters in the southwest Pacific

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The Pacific Ocean has the highest levels of squat lobster species richness and endemism in the world with the majority of the sampling and taxonomic effort over the last three decades focused on the SWP around New Caledonia, eastern Australia and New Zealand. Here we examine the species distributions of squat lobsters (families Galatheidae and Chirostylidae) over the entire southwest Pacific (SWP) region from the longitude of central Australia to French Polynesia (123°E–138°W) and the latitude of the Solomon Islands to sub-Antarctic New Zealand (6–56°S). The analysis incorporates 504 species from nearly 7000 records that represent 60% of the world's known squat lobster species. Biogeographical areas were classified using cluster analysis combined with non-metric multi-dimensional scaling ordination. Subsequently, correlations between observed faunal patterns and a suite of environmental factors were examined.

Our results suggest that a significant portion of the fauna of both the New Zealand region and the combined northern tropical region around New Caledonia has been captured but other regions remain under sampled. The distribution of squat lobster assemblages is discussed in relation to geography, habitat, oceanography and historic records of climate shifts and continental movements. Results are consistent with the current squat lobster fauna being a result of multiple invasions of the SWP regions since the Cretaceous and subsequent vicariance caused by localised oceanic circulations, availability of hard substratum, and depth.

Friday

10:15–10:30

Room OGGB5 Physical oceanography

Session Chair: Scott Nodder

Pitfalls of ship-based measurements

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Measurements from instruments lowered over the side of a vessel are fundamental to physical and biological oceanography. However the vessel is normally subject to downwind drift which creates a wake of disturbed water in the upwind side of the vessel. Unfortunately this is typically exactly where instruments (e.g. CTDs) are lowered. In this presentation we evaluate the nature, severity and extent of this effect through experimentation and modeling. Flow distortion created by the vessel is a well-established concern for airflow measurements around a ship, and detailed modeling has been carried out to account for this airflow distortion. However it has been largely neglected by the oceanographic community until now.

The *Gerris* Computational Fluid Dynamics (CFD) model was used to simulate the effect. Gradients of tracers were included in the model in order to gauge the extent of the effect, both horizontally and with depth. In particular the model predicted strong production of vorticity associated with the sharp bow and keel of the ship. A series of experiments were carried out to compare these predictions with field measurements. In the first of these, rhodamine dye was released along the length of the ship, and the subsequent evolution of the dye as the ship drifted past provided visualization of the turbulent wake. This confirmed the major features of the model and vorticity production. Further experiments utilized ADCP and turbulence profilers, showing enhanced turbulence and distortion of the temperature profile due to the flow distortion. Radar measurements of the wavefield also indicated that the turbulent wake acted to suppress wave breaking upwind of the ship. The wake effects can easily extend to depths of 30 m below the *RV Tangaroa* which will compromise physical or biological sampling made in this range.

Friday

10:30–10:45

Room OGGB5 Physical oceanography

Session Chair: Scott Nodder

Towards more accurate water sample salinity data

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Presented here are the preliminary results of an initiative to improve the accuracy of water-sample salinity instrumentation and data. Traditionally, such data critically underpin the calibrated accuracy of high-vertical-resolution salinity profiles obtained from ocean CTD instrumentation; the target accuracy being that specified for the WOCE Hydrographic Programme: 0.002 [PSS-78] or better. However, the state-of-the-art instrumentation for measuring the salinity of water samples, the Guildline 8400B Salinometer, cannot easily exceed, or even match, the performance (the accuracy or precision) of contemporary CTD conductivity, temperature and pressure sensors.

The present work demonstrates that, without a significant change in basic methodology and without a significant investment in new or radical instrumentation, an ocean CTD facility based on the SBE 911plus CTD can break the reliance on the Guidline 8400B Salinometer while maintaining its target salinity accuracy. Whether this approach leads automatically to a significant improvement in the accuracy and precision of water sample salinity data is an open question at present. However, given the USD30K price tag of the salinometer, the development makes sense on purely budgetary grounds.

Friday

10:30–10:45

Room 290-098 Conservation

Session Chair: Ali MacDiarmid

Marine biosecurity surveillance in New Zealand

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Most non-indigenous marine species are introduced into New Zealand in ballast water or as biofouling on the submerged surfaces of vessels. Because of the close relationship between vectors and non-indigenous species, entry points such as commercial ports and marinas are important foci for early detection surveys. MAF Biosecurity New Zealand currently has a highly effective marine surveillance programme that targets a suite of non-indigenous organisms at a range of locations across New Zealand. This talk will provide an overview of this surveillance programme and some of the findings to date.

(Ed note: this talk could not be accommodated in subsequent biosecurity sessions, given schedule constraints)

Friday

10:30–11:00

OGGB - Morning tea

Friday

11:00–11:15

Room 290-098 Management approaches

Session Chair: Alison MacDiarmid

The interface between western scientific knowledge and Mātauranga Māori in the ecosystem-based management of the Kaipara Harbour

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The Kaipara Harbour is at the centre of a holistic, integrated management project, being led by Nga Kaitiaki Tai Ao o Kaipara, the joint roopu between hapū, marae o Ngāti Whatua. There is an urgent need to protect the ecosystem values of the harbour from further degradation and for Mātauranga Māori to have an explicit role in the future environmental planning and management of the harbour.

Kaipara Harbour is one of the largest harbours in the world, with an estuarine system nearly 94,700 ha, and with 900 km of shoreline. This harbour is an internationally significant place for seabirds, and is also significant for its fisheries, as a nursery ground for commercially and recreationally important species.

Culturally, the Kaipara holds extensive significance for Kaipara hapū as the birthplace of Ngāti Whatua and a paramount scared taonga. Nga Kaitiaki Tai Ao o Kaipara vision is for a healthy and productive Kaipara harbour and the implementation of their vision must be grounded in kaitiakitanga. We present preliminary results on the integration methods used to protect the ecosystem values of the Kaipara harbour. Using a participatory approach with local and central government, non-government organisations and community groups, we built an integrated spatial database that has brought together 67 datasets. Publicly available data on cultural heritage sites was gathered. Using Geographic Information Systems (GIS), culturally significant landscapes and seascapes were digitised and mapped from the information gathered. Decision-support tools such as Marxan and C-Plan were used to integrate cultural features with biodiversity features in the quantitative and spatial conservation prioritisation of the Kaipara harbour.

Friday

11:00–11:15

Room OGGB3 Dispersal and Connectivity

Session Chair: Shane Lavery

Population genetics of the short-tailed stingray, *Dasyatis brevicaudata*

Agnès Le Port[1], Shane Lavery[1,2]
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Many stingray species have wide ranging distributions, and despite the large number of phylogeographic studies published, there have been few investigations into the genetic relatedness of stingray populations. The short-tailed stingray (*Dasyatis brevicaudata*) is a large temperate stingray with a disjunct southern hemisphere distribution, having been recorded from New Zealand, southern Australia and South Africa.

We examine the genetic relationships of short-tailed stingray populations (n = 176) throughout this species' known range using the entire mitochondrial DNA control region (1928 nucleotides). Analyses of the mtDNA control region revealed 14 polymorphisms and 1 indel comprising 18 haplotypes in 176 individuals, with high haplotype (h = 0.78 ± 0.02) and low nucleotide diversities (π = 0.09% ± 0.008). The control region amplified for the short-tailed stingray is the largest fragment known in a marine vertebrate (1928 nucleotides).

Significant regional population differentiation was found (AMOVA, overall $\Phi_{ST} = 0.67$, $P < 0.001$), suggesting limited gene flow, although several haplotypes were shared between New Zealand and Australia. Also, significant population differentiation was found among coastal New Zealand locations (AMOVA, overall $\Phi_{ST} = 0.05$, $P < 0.05$), with indications that dispersal was more limited in females (AMOVA, overall $\Phi_{ST} = 0.08$, $P < 0.05$). However, data did not support the genetic differentiation of individuals from a proposed offshore breeding area from mainland individuals, suggesting fidelity to breeding sites may be low in this species. Population structuring is attributed to species-specific preferences for coastal habitats which may be linked to life history functions (e.g., feeding, pupping) in this species.

Friday

11:00–11:15

Room OGGB5 Air quality

Session Chair: Andy Sturman

Effect of the sea breeze on air pollution in the Auckland Region, New Zealand

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The complex meteorology of coastal regions can adversely affect the transport and dispersion of air pollutants. Local flows such as land/sea breeze circulations limit the ventilation of airsheds by re-circulating air pollutants. The Weather Research and Forecasting (WRF ARW V.3.0) model was employed to investigate and understand the dynamics of sea breezes that may contribute to air pollution in the Auckland region. A novel modelling technique was applied by modifying the WRF model to provide a detailed description of air pollution meteorology during a typical sea-breeze day. The model was run twice for two different cases: model 1 was mainly used for validation purposes, with input data obtained from the 6-hourly National Centers for Environmental Prediction Final Analyses; model 2 was run without synoptic winds; the latter is analysed here.

The WRF model successfully produced sea and land breezes on both coasts of the Auckland region. Model-predicted results agree favourably with observed data. The idealized WRF simulation without synoptic forcing was able to represent some important features of thermally induced mesoscale wind dynamics, allowing their significance for transport and dispersion of air pollutants to be evaluated. During the marine air mass inflow a thermal internal boundary layer of up to 400 m depth formed that may suppress vertical motion of air pollutants emitted into this well-mixed layer. These pollutants may be trapped along the convergence zones that are formed between opposing sea breezes originating from east and west coasts of the Auckland region. Very low wind speeds and higher vertical velocities along the convergence zones on one hand could be responsible for increased pollution levels at the surface, while on the other hand, updrafts along the sea breeze front and convergence lines may transfer pollutants aloft that move seaward with the return flow. These pollutants in the return flow may re-circulate due to downdrafts over the sea.
The results of the WRF simulations suggest that sea breeze circulations and sea breeze convergence zones may locally increase pollution levels …

(contd) … in the Auckland region during hot summer days and under weak synoptic wind conditions.

Friday

11:15–11:30

Room 290-098 Management approaches

Session Chair: Alison MacDiarmid

Bridging the information gap at spaghetti junction. Regional information needs and resources — a management perspective

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While climate change is a huge issue affecting marine ecosystems at a national and global scale, local and regional managers need to make decisions in regard to numerous other issues affecting the marine environment. These may include: pollution, exploitation, sedimentation, invasive species, seawall construction, marine energy structures, sinking of ships to create artificial reefs, seabed mining, tourism, the list goes on. Creating rules in plans to guide use and developing networks of marine protected areas, are proactive ways of minimising environmental damage and reducing our overall impact on marine ecosystems. All of these decisions are made on best available information. Marine scientists have an obvious role in providing information and advice to assist with those decisions. But how often does this happen? Do you want your research to make a difference? How can information transfer be made easier? How can you assist with bridging the information gap? We offer a management perspective on how to ensure scientific information is available for decision making, so that robust conservation outcomes can be achieved.

We will outline DOC's role in marine management and advocacy and more specifically the role of the Marine Technical Support Officer, some regional databases developed by DOC staff, and present new CD information resources developed for the Wellington and Canterbury regions. These resources have searchable bibliographies, and information summaries in the form of text and maps developed from a GIS platform.

Some ideas for speeding up this journey to better integrate science and management are suggested. Together we can navigate our way through the spaghetti junction of marine information.

Friday

11:15–11:30

Room OGGB3 Dispersal and Connectivity

Session Chair: Shane Lavery

How long 'til we get there and how far can we get in that time? Dispersal of macrophyte propagules in rocky intertidal zones

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Many macrophytes thrive in the rocky intertidal — a harsh environment where water dynamics are a turbulent mix of waves and currents. Population structure and replenishment require macrophyte propagules to be fertilised, disperse, reach the substrate, form an initial attachment and then a stronger long-term attachment. Experiments have shown that a minimum settlement density is required for successful population formation; accordingly the numbers and densities of settling propagules are crucial to population dynamics. Achieving these densities, however, is a product of dispersal and complex scale-dependent environmental interactions.

Here, we focus on the dispersal and arrival stages of the reproductive cycle. We consider several different species of fucoids, *Durvillea antartica*, *Durvillea willana*, *Hormosira banksii* and *Cystophora torulosa.* Propagules from these species have a wide range of physical properties (size, density, release height, sinking rate and mucous coating). We consider how these different biological properties interact with the water dynamics to affect the settlement ability and range of the species. Using a local exchange model to look at the distribution of hitting times for different wave/current climates and different biological properties, we then consider the horizontal dispersal potential of the species in the same climates.

We compare our model results with previously measured dispersal data from several sites around Kaikoura. We consider how much the dynamic coastal environment affects the dispersal ranges of the species and how much settlement strategies such as only releasing on calm days may affect this dispersal. We also show that the usual method of using the mean hitting time to calculate dispersal distances may considerably overestimate the dispersal potential of many species, especially those that require a minimum population density for successful settlement.

Friday

11:15–11:30

Room OGGB5 Air quality

Session Chair: Andy Sturman

Background aerosol input to urban air quality

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This paper discusses the influence of the background atmospheric aerosol on urban air quality measures. The National Environmental ambient air quality Standards (NES ambient standards) for New Zealand's fine particulate matter (PM_{10}) sets a concentration limit of 50 $\mu g\ m^{-3}$ as a 24 hour average. This limit is set without reference to the natural background concentration of PM_{10} aerosol, which comprises materials such as wind-blown sea-salt, mineral dusts, natural biomass burning and natural sulfate aerosol.

The major New Zealand urban centres are all coastal cities and there is significant transport of sea-salt salt aerosol inland under windy conditions. In addition, some of the highest PM_{10} measurements ever recorded have been during incursions of material from Australian bush fires. The advection of background aerosol into the urban atmosphere serves to elevate the PM_{10} concentration as well as chemically interact with some urban emissions.

We review available information and data on background aerosol in New Zealand and discuss its impact on PM_{10}. Can the background exceed the NES? Are there more appropriate metrics for aerosol air quality standards and ambient anthropogenic aerosol impact that better account for this background?

Friday

11:30–11:45

Room 290-098 Management approaches

Session Chair: Alison MacDiarmid

Using spatial conservation optimisation tools for ecosystem-based management of the Kaipara Harbour

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The Kaipara Harbour, which at 720 km2 is New Zealand largest estuary, is recognised as a key component in the wider functioning of the West Coast North Island ecosystem. It is also coming under increasing pressure from human activities, both marine and land-based. As a discrete spatial entity, with a wide range of habitats and associated species, and a range of human activities associated with it, it is an ideal place in which to advance and demonstrate the use of ecosystem based management (EBM). This research applies an EBM approach to a real-planning situation, which will provide Māori, community, local and central government with decision-support tools that integrate multiple datasets, knowledge and information. We present preliminary results using GIS and decision-support tools to model various EBM planning scenarios in the Kaipara Harbour.

Friday

11:30–11:45

Room OGGB3 Dispersal and Connectivity

Session Chair: Shane Lavery

Local-recruitment versus far-field dispersal: larval swimming behaviour and substrate choice modify the dispersal kernel of New Zealand sea urchin *Evechinus chloroticus*

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We investigated dispersal of urchin (*Evechinus chloroticus*) larvae which remain in the plankton for several weeks. The ROMS model was used to simulate hydrodynamics around Otago's coastline. The output drove a particle tracking model describing the dispersal of larvae released from each of 175 reefs along the coastline. Each particle represented a small cohort of individual larvae. Numerical experiments examined the influences which larval behaviour has upon probability of successful settlement, and dispersal kernel shape.

Settlement success was estimated in two ways. Firstly, the number of competent-to-settle larvae which came into contact with the seabed within the reef perimeters was determined. There were few such particles. Secondly, we estimated the number of competent-to-settle-larvae which passed over reef habitat – taking account of the fact that particle locations represent the centroid of an expanding cloud of larvae.

By both measures, motile larvae with a preferred-depth of 15 m (pd15-larvae) were more successful than those having a preferred depth of 4 m (pd4-) or non-motile, neutrally buoyant (nb-) larvae. By the first measure, pd4-larvae were more successful than nb-larvae. By the second, the reverse was true. Reefs south of Otago peninsula provide recruits to reefs north of the peninsula, but themselves receive few recruits. Reefs to the north of Otago peninsula were more symmetrically connected with one-another. The magnitude of right-skew in the dispersal kernels for successful larvae increased in the order: pd15<nb<pd4.

Our results demonstrate that, even in systems where there is a strong coastal current, biological details can influence the degree of population connectivity.

Friday

11:30–11:45

Room OGGB5 Air quality

Session Chair: Andy Sturman

Volcanic plumes from Mt Ruapehu: radar, ash trajectories, atmospheric pollutants and health impacts. Part 1: radar and ash trajectories

Geoff Austin[1], Luke Sutherland-Stacey[1], Kim Dirks[1], Rewi Newnham[2]

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The University of Auckland Atmospheric Physics Group's mobile weather radar was deployed to monitor eruptions of Mt Ruapehu in 1996. High resolution (~100 m spatial and 6 second temporal) images were obtained from the plume of ash. Images show that the height of the plume changed rapidly, as did the radar reflectivity, which was as large as 50 dBZ. Individual pulses of ash could be tracked and were seen to rise at speeds up to 15 m s^{-1}. The injection of dust into the atmosphere as well as the trajectory of single bombs could also be observed and rough estimates of the particle sizes could be inferred from the fall times.

The imagery obtained — even in the presence of rain and snow — allow for the measurement of the height in the atmosphere at which ash is being injected into the atmosphere. These data may be combined with upper air wind patterns deduced from a mesoscale model (WRF) to predict the locations and timing of dust hazards from eruptions.

Friday

11:45–12:00

Room 290-098 Management approaches

Session Chair: Alison MacDiarmid

Coastal water quality for ecosystem heath - issues, management, monitoring and the future

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In New Zealand stormwater, industrial and household wastewater and river water, the quality of which is influenced by inputs from the catchment, typically flow into the sea. The contaminants in these flows that have the potential to impact on coastal ecosystem health include nitrogen and phosphorus. It is the input of, the resulting concentrations and the impacts of these nutrients on the coastal water of Canterbury that are the focus of this presentation.

Under the Resource Management Act Regional Councils have responsibility for safeguarding the life-supporting capacity of water and ecosystems. They do this through policies, plans and processes. They also undertake environmental monitoring to both understand the environment they are required to manage and ensure their policies, plans and processes are effective. The coastal water quality monitoring programme undertaken by Environment Canterbury is described in detail.

The Avon-Heathcote Estuary/Ihutai nutrient data and their ecological implications are presented. In this estuary there are high concentrations of ammonia as a result of the discharge of treated wastewater. Open coast nearshore nutrient concentrations are compared to concentrations 3 km from shore. The tools used to translate water quality data to coastal ecosystems effects are discussed. This is an area where there are huge information gaps. These gaps, which include the influence of water quality on phytoplankton and planktonic larvae dynamics, are recommended topics for future research.

Session Chair: Shane Lavery

Southern Connections: population connectivity assessed with molecular and oceanographic tools

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Spatial and temporal scales at which populations are connected by planktonic dispersal are fundamental to the ecology and evolution of sessile marine invertebrates, and molecular tools have revolutionised the way that we assess the level of population connectivity in marine environments. However, our results show that caution is required when inferring ecological or evolutionary processes from genetic patterns alone, as history is often masked by genetic homogeneity.

We examined the genetic structure of the intertidal limpet *Cellana strigilis*, a species complex distributed around southern New Zealand, and the Chatham and SubAntarctic Islands, and compared these genetic patterns to the oceanography described by surface drifters and satellite-derived measurements of ocean currents since 1993. Partial sequences from mitochondrial cytochrome *b*, 12S and 16S genes reveal two genetic lineages that separate the Chatham, Bounty and Antipodes Island populations from the New Zealand mainland, Auckland and Campbell Island populations. The genetic homogeneity observed within the two lineages, in conjunction with larval modelling, suggests that the populations are presently isolated but may have been colonised through long-distance dispersal from the southern island populations.

Session Chair: Andy Sturman

Volcanic plumes from Mt Ruapehu: radar, ash trajectories, atmospheric pollutants and health impacts. Part 2: atmospheric pollutants and health impacts

Kim Dirks[1], Rewi Newnham[2], Geoff Austin[1], Luke Sutherland-Stacey[1]

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During the 1996 and 1997 eruption events of Mt Ruapehu, most of the ash was carried eastward and deposited in the sea. However, for a day or so around June 17 1996 during a major eruption event, the plume veered to the north depositing ash in both Auckland and in the Waikato region. An investigation into the hospital records in Auckland and Hamilton in the month following this event show a significant increase in respiratory mortality compared to what would normally be expected at that time of the year. The aim of this study was to determine whether this increase in mortality could be attributed to the volcanic ash from Mt Ruapehu.

The study involved an investigation into alternative explanations for this increase in respiratory mortality, including air pollution 'events' (independent of the volcanic ash), climatic conditions known to be conducive to high rates of mortality (cold night-time temperatures) and wintertime outbreaks of flu. Records from Auckland and Hamilton were investigated as both were subjected to volcanic ash, and Wellington records were used as the 'control'.

Evidence does not rule out the possibility of a volcanic contribution in Auckland and Hamilton in 1996 but the evidence is not conclusive, largely because of a significant air pollution 'event' (independent of the volcano and simply due to meteorological conditions conducive to high air pollution levels) that occurred in both Auckland and in Hamilton at the time. Also, there is an unexplained peak in respiratory mortality in Auckland in 1997 (when there was no volcanic ash contribution), and a peak (albeit smaller) in Wellington in 1996 (the control). Work is currently underway investigating admissions to hospital for respiratory causes (deemed to be more 'robust' than mortality as a measure) in a quest to solve the mystery.

Friday

12:00–12:15

Room 290-098 Management approaches

Session Chair: Alison MacDiarmid

Regional council monitoring and research — a national network of information?

Megan Stewart-Carbines[1], Jarrod Walker[1], Juliet Milne[2], Lesley Bolton-Ritchie[3], Stephen Park[4], Greg Larkin[5], Paul Sheldon[6], Kate Giles[7], Trevor James[8], Robert Smith[8], Catherine Beard[9], Vernon Pickett[9], Richard Griffiths[10], Jacquie Reed[10], Anna Madarasz-Smith[11]

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From a local government perspective the need to monitor arises from legislative duties, policy and plan requirements and good resource management and business practice. Specifically Section 35 of the RMA (2003 amendment) specifies the duty to gather information, monitor and keep records and take appropriate actions where monitoring indicates that this is necessary. Information gathered is used to report on policy effectiveness, the state of the environment, to feed back into and inform the regional planning process, and to provide information to the public.

As a result of this legislative requirement to monitor and report on the state of the environment, many regional councils around New Zealand have established long term coastal monitoring programmes across a wide resource base. The data collected from these programmes is publicly available for a range of uses and represents a valuable source of environmental information for other studies. The purpose of this presentation is to outline the types of monitoring undertaken by various regional councils. Examples of long term data sets and wide spatial coverage will be given as well as some case studies on how this information has been used in a management context or to provide context for other research initiatives.

As all regional councils are required to carry out monitoring under the same legislation, there is much similarity in the monitoring undertaken and there …

(contd) … is the potential for these programmes to form the basis of a national monitoring network. However there are many challenges which must be tackled, such as information sharing, centralised databases, development of more robust and appropriate guidelines, and standardisation of sampling and reporting methods.

Friday

12:00–12:15

Room OGGB3 Dispersal and Connectivity

Session Chair: Shane Lavery

Nested simulations of the Southland Current

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A series of three nested ocean models has been set up for the southeast coast of New Zealand with the ultimate aim of estimating larval connectivity patterns along the coast. All nesting is one-way and off-line, using the ROMS ocean model. The outer model is a non-assimilating, climatological model for the New Zealand region at 10 km resolution. This model has been shown to generate a realistic Southland Current along the continental shelf edge. The intermediate model is at 2.5 km resolution and covers the continental shelf for a distance of 100 km, in order to represent the effect of fluctuating winds on the flow. Validation at this scale is available from historical current meter data. The inner model is at 0.625 km resolution. The interface between the outer and intermediate models was problematic because the outer model is forced by steady winds, whereas the intermediate model uses fluctuating winds (as does the inner model). No fully satisfactory boundary formulation was found, but a near-boundary nudging zone gives acceptable results.

Results from the model will be presented, concentrating on the first-order effects of fluctuating wind forcing on the variability in the current.

Friday

12:00–12:15

Room OGGB5 Air quality

Session Chair: Kim Dirks

An air pollution climatology for Christchurch, New Zealand

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Department of Geography, University of Canterbury

In order to understand recent trends in air quality and in an attempt to put them into a wider perspective, this study presents a trend analysis of meteorological conditions that are conducive to elevated concentrations of particulate matter and their synoptic forcings in Christchurch, New Zealand. Classification tree analysis using a set of atmospheric predictor variables is carried out to identify meteorological classes to be used as proxies of expected probability of NES guideline exeedence. A key motivation for this work is the assessment of historic trends of air pollution potential and to gain a deeper understanding of atmospheric forcings on climatic scales in both space and time. Furthermore, the ability to separate the effects of weather variability from changes in human behaviour that affect emissions allows assessment of the efficacy of the air pollution reduction strategies used by Environment Canterbury. By seperating out different classes of air pollution potential based on local meteorological conditions, a set of synoptic types is identified which shape local atmospheric set up in Christchurch to be conductive to elevated levels of particulate matter concentrations. Furthermore, strong evidence is found that recent regulatory efforts to reduce particulate matter release into Christchurchs urban atmosphere have indeed been successful and that concentrations are reducing steadily, independent of meteorological variability.

Friday

12:15–12:30

Room 290-098 Management approaches

Session Chair: Alison MacDiarmid

Urban-derived contaminants in Wellington Harbour sediments

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Previous investigations have identified contaminants in urban stormwater discharges as a potential medium to long-term risk to the health of marine organisms living in Wellington Harbour, largely through the accumulation of these contaminants in the sediments. This study was undertaken to assess sediment quality and benthic community health in the sub-tidal depositional zones of the harbour and establish a baseline for future monitoring. Twenty-five sediment cores were collected from each of 17 sub-tidal sites in 2006. Sediments were analysed for particle size, total organic carbon, weak acid-extractable and total recoverable metals, polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides (OCPs) and organotins. A further 8 cores were collected from each site and their benthic fauna identified and counted. Sediment contaminant concentrations were compared against both the ARC Environmental Response Criteria for estuarine environments (ARC 2004) and ANZECC (2000) interim sediment quality guidelines. Univariate and multivariate statistics were used to examine benthic community structure and the relationships between any biotic patterns and physical and chemical variables.

Concentrations of Pb and Hg, and to a lesser extent Cu and Zn, were above guidelines at some sites in the harbour, especially proximal to the city; TBT exceeded guideline levels at the entrance to the Lambton Basin and off Ngauranga, but its less toxic breakdown product, dibutyltin, was widespread. Several PAH compounds exceeded guideline levels at certain sites. Total DDT exceeded guideline levels over much of the harbour. Concentrations of other heavy metals, OCPs and PAHs were below guideline levels. Variation in community structure between sites was not strongly correlated with sediment contaminant concentrations. Despite the presence of elevated sediment contaminant concentrations at some sites, there is no clear evidence that the current levels of contamination are having significant adverse effects on benthic community structure at these sites. However, urban-derived stormwater contaminants …

(contd) … could pose a risk to aquatic ecosystem health if they continue to accumulate in the sediments, suggesting that the permitted activity rules for stormwater discharges in Greater Wellington Regional Council's Regional Freshwater Plan and Regional Coastal Plan may need to be reviewed.

Friday

12:15–12:30

Room OGGB3 Dispersal and Connectivity

Session Chair: Shane Lavery

Spatial variability in dispersal of juvenile bivalves in Whangarei Harbour

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Biophysical models of larval dispersal in Whangarei Harbour suggest that hydrodynamic conditions at different sites will result in differences in relative transport (and thus settlement) of juvenile bivalves. To validate model results, we sampled seven sites using a combination of sediment traps, plankton nets and colonising macrofaunal cores. More exposed sites (Snake Bank, McDonald Bank and One Tree Point) had an order of magnitude higher abundance of larval and early post-settlement invertebrates in traps and plankton nets. This matched both model results and macrofaunal cores, indicating high abundance of bivalves at these sites. Samples collected from two sites at Takahiwai, and two sites in Parua Bay showed smaller abundances in nets and traps, and higher temporal variability based on hydrodynamic conditions relative to wind strength and direction. Generally, experimental observations matched model predictions for both temporal and spatial variations in larval abundance. However, differences in abundance of adult bivalves at each site suggest that both recruitment and post-settlement processes are important in structuring benthic communities.

Friday

12:15–12:30

Room OGGB5 Air quality

Session Chair: Kim Dirks

Condensation nuclei (CN) measurements through the Western Pacific

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Condensation nuclei (CN) are very small (0.001 to 0.1 μm in diameter) hygroscopic particles or aerosols upon which water vapour can condense to a liquid. These nuclei come from both anthropogenic and natural sources. CN are important because the variation in concentration, source and size make a contribution in daily weather and ultimately climate change predictions and effects.

Since 2006, the National Institute of Water and Atmospheric Research Ltd (NIWA) has been monitoring CN on voyages of the vessel "Trans Future 5" between Nelson, New Zealand and Osaka, Japan. Plots of the data show large variations in the concentrations recorded, particularly in the Western South Pacific area. We have analysed the data to locate the areas of high CN concentrations during each voyage and used meteorological trajectories to ascertain the possible source(s). We also investigated whether there were any synoptic meteorological factors influencing these concentrations.

Friday

12:30–13:30

OGGB - Lunch

Friday

13:30–14:00

Room 290-098 Plenary

Global climate phenomena, local-scale environmental variability and biotic interactions influence macrofaunal temporal dynamics at a variety of spatial scales

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Determining the relative importance of environmental forces on population dynamics is a fundamental question for ecologists. Growing concern over the ecological effects of climate change emphasises the importance of defining whether broad-scale environmental forces uniformly act upon local populations (hierarchy theory) or cross-scale interactions influence local responses (multiscale theory). We used a variety of regression models and cross-correlations to analyse 13 years of data on species abundances at 6 sites within a large harbour.

Environmental variables both directly and indirectly related to ENSO were observed to be important predictors of the temporal dynamics of abundance in many species, but the observed effects were not consistent across sites or species. While nearly all species were affected by large temporal and spatial scale variability, smaller temporal scale, location-specific environmental variables (such as wind-generated wave exposure and turbidity) were also generally important, increasing the variability explained by our models by up to 25%.

Further increases in the ability to explain temporal dynamics occurred when metapopulation dynamics and interactions with key species were considered. We suggest that our ability to predict effects of climate change on coastal and estuarine communities will depend on the relative importance of biotic interactions and the degree of interaction between broad-scale climatic factors with smaller-scale environmental variability.

Friday

14:00–14:30

Room 290-098 Long-term studies and monitoring

Session Chair: Megan Stewart-Carbines

A long-term study of a small rocky reef: implications for community dynamics

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A small (5 x 4 m) inter-tidal rocky reef on the northeastern coast of New Zealand has been routinely monitored (~ monthly) for more than 20 years. The aim was to determine the changes in biological community structure and dynamics that occur when there is no special external forcing. The site (Standard Reef) is in the centre of a marine reserve (no direct human interference) and had no history of severe environmental anomalies.

Virtually all significant species (~ 15 out of 50+ recorded at some stage) showed large and frequent variations in abundance over a time period which included 5–25 of their generations. These changes were not predictable (except for very short time frames) but were not random.
Each species had a distinctive pattern of variation and correlations between species were low. Despite the large changes in community structure, the community persisted, and frequently but irregularly reverted to similar structures with the same component species.

None of these results were predicted and they do not match well with existing theory on biological communities. It is generally assumed that community structure is maintained by strong interactions between the more important species (or trophic groups) and that if these are properly measured, they can be used to construct food web (or energy flow) models that are informative and predictive.

The results from Standard Reef suggest that such models are too restrictive to be reliably predictive. The picture that emerges from Standard Reef is that the structures of persistent communities have quite large variations over time, but are constrained by multiple interactions. These interactions are mostly weak, and/or inefficient, and/or sporadic, and include many that are facilitative or mutualistic, as well as ones that involve production, consumption and competition.

While the results from Standard Reef do not match with prevailing ecological views, they do match with the dynamics of 'Complex Systems' which are well-understood in other branches of science. For example, it has been demonstrated that precise weather forecasting is not possible more than a week or so in advance, no matter how much is known about the initial conditions and the physical processes involved. However the climate of a region or locality does have a real level of predictability (so successful farming is possible).

If ecologists considered the component species of a community analogous to the weather at a locality and the entire community analogous to the climate, I believe considerable practical and theoretical advances could be made with existing data.

Friday

14:00–14:15

Room OGGB3 Dispersal and Connectivity

Session Chair: Carolyn Lundquist

Does coral recruitment depend on local or distant sources of larvae?

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There is growing scientific evidence suggesting that a great proportion of coral larvae produced may be retained within the parental habitat. If self recruitment is a common feature in tropical reef systems, it is likely that the abundance of coral of a specific reef will have an influence on the levels of local coral recruitment.

The majority of coral reefs are under severe threat worldwide as a result of human activities that have caused 27% of monitored reefs to be lost and it is predicted that 30–40% will be lost within the next 30 years. It is thus important to understand how hard coral recruitment patterns vary with different degrees of reef degradation in order to develop conservation programmes.

Here we present the first estimates of coral recruitment at four sites with different levels of coral cover on different substrata types in the Wakatobi National Marine Park, Indonesia. We found no difference in the overall coral recruitment rates to different artificial settlement substrates (terracotta or concrete) or between different surface angles. More importantly, we found significant differences between coral recruitment rates in high and low coral cover sites, with higher recruitment levels in high coral cover sites. Our results provide evidence that most coral recruitment occurs locally and that local-scale damage to coral habitats is likely to impact future local recruitment. Our results are important from the perspective of creating Marine Protected Areas to restore degraded coral reef habitats, since our results support the assertion that 'recovery' is likely to take a considerable amount of time as larval sources will be limited once local coral cover has declined.

Friday

14:00–14:15

Room OGGB5 Biosecurity

Session Chair: Sharon Goldstien

Larval competency period and natural dispersal capacity of the invasive colonial ascidian *Didemnum vexillum*

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In New Zealand, biofouling pests have resulted in adverse effects on aquaculture and environmental values. Accordingly, management of spread is imperative. One pest species, the colonial ascidian *Didemnum vexillum*, poses a considerable threat to the NZ aquaculture industry. Initial attempts to manage *Didemnum* in the Marlborough Sounds mussel-farming region failed to eradicate the species, but there is still interest in whether and to what extent its human-mediated spread can be managed at a regional scale. Decisions around managing the human pathways of *Didemnum* spread must consider, among other things, natural dispersal potential; vector management is probably not worthwhile for pathways where natural dispersal also occurs. Here we use a weight-of-evidence approach to evaluate the natural dispersal potential of *Didemnum*. We describe the results of a regional-scale *Didemnum* spread monitoring programme, estimate dispersal distance from the recorded distribution of the species, and measure the distance of larval recruitment from established populations in a field experiment. These estimates are supported by an assessment of the planktonic larval competency period and description of larval behaviour in a laboratory-reared population. Results showed that *Didemnum* larvae can survive up to 24 hours in plankton, retaining the ability to metamorphose and settle successfully. Collectively, our findings indicate that *Didemnum* has the ability to spread further by natural dispersal than assumed for most colonial ascidian species; probably hundreds of metres to kilometres depending on hydrological conditions. This information will assist managers in the implementation of effective eradication and control efforts, as understanding the importance of natural dispersal relative to human mediated dispersal is critical to the management of marine pests.

Friday

14:15–14:30

Room OGGB3 Dispersal and Connectivity

Session Chair: Carolyn Lundquist

The range at which pre-settlement fish can detect ambient reef sound

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University of Auckland: [1]Leigh Marine Laboratory, [2]Department of Physics

Previous research has shown that pre-settlement fishes and crabs are attracted to ambient underwater sound. These results, combined with the excellent transmission of sound in water and presumed auditory thresholds have been used to conclude that coastal reef sound could act as a effective long distance (> 5 km) directional guide for assisting larvae to find suitable settlement habitat. Recently, this conclusion was criticised on the basis of theoretical considerations suggesting the phenomenon may be considerably less important because of a more limited range of effective acoustic transmission (i.e., << 1 km). Using a theoretical model, systematic recordings from an isolated reef, and recordings from an artificial point source we have determined the range dependence of sound propagation from a shallow water reef.

Close to the reef there is a zone where the reef sound level decreases very slowly which we have termed the “reef zone”. Once the reef subtends an angle of approximately 90° from the receiver the reef is effectively a localised source and the sound level decreases more quickly. This is due to the spreading of the sound and attenuation into the seafloor.

Based on our results and the hearing threshold of a pre-settlement fish (111 dB re 1µPa) it was estimated that pre-settlement larvae could detect ambient reef sound from greater than a kilometre. Therefore, we have shown that the assumptions underlying the critical review of the effective range of reef sound are wrong, and that ambient reef sound does have appropriate propagation properties to act as a relatively long-distance guide.

Friday

14:15–14:30

Room OGGB5 Biosecurity

Session Chair: Sharon Goldstien

Reproduction, early life history and substratum selectivity of the invasive tunicate *Styela clava*

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Marine Ecology Research Group, University of Canterbury

A major hypothesis in invasive species ecology relates to "propagule pressure", that is, that increasing numbers of dispersive propagules increase the potential for successful invasion and population growth. The invasive clubbed tunicate *Styela clava* is well established in North America, Canada, Australia and Northern Europe. It may reach densities of 500 – 1000 individuals per square metre, threatening bivalve aquaculture systems and competing with native species. First discovered in New Zealand in 2005, little is known about the specific life history of *Styela c.* in New Zealand. An understanding of the reproductive behaviour of *Styela c.,* and how it responds to a new environment are essential to limiting spread. Here we discuss *Styela c.* gonad development, larval abundance and larval settlement behaviour in an invaded sites near Christchurch (Lyttelton Harbour). Gonad indexes and histological methods show that individuals within the population are capable of reproduction from November and remain active until water temperatures drop below 14°C. Below this, spawning ceases and gonads remain at the developing phase. There are peaks in gonad development throughout this period, during which *Styela c*. continually spawn and redevelop ovaries. Larval abundance in the water column throughout the spawning season was low, as was recruitment. Both appear to be much lower than results found in invaded areas elsewhere. Initial experiments showed that larvae have little preference for different settlement surfaces, although they exhibit a strong preference for the dark-undersides of structures. So far in this study (which has a year to run), reproduction rates in Lyttelton are much lower than those reported overseas, and populations seem to be stable or declining.

Friday

14:30–14:45

Room 290-098 Long-term studies and monitoring

Session Chair: Megan Stewart-Carbines

Archaeological, historical and contemporary evidence for a 700 year long fishery for snapper in the Hauraki Gulf, New Zealand

Ian Smith[1], Foss Leach[2], Divya Varkey[3], Tony Pitcher[3], Bruce Stirling[4], Phillip Cleaver[4], Larry Paul[5], Darren Parsons[5], Malcolm Francis[5], Andy McKenzie[5], Alison MacDiarmid[5]

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Humans first settled in New Zealand around 1280 AD. Archaeological evidence indicates early exploitation of the snapper, *Pagrus auratus*, an abundant demersal fish in warm northern waters. A combination of estimates of the marine component of the human diet, Maori population size, daily human calorific needs and midden composition was used to estimate that the annual human take of snapper from the Hauraki Gulf grew modestly from 105 ± 73 t in 1400 AD to 370 ± 258 t by the close of the 18th century. Historical data indicate Maori fishermen supplied European settlers until the 1860s when commercial fisheries began to develop, initially by hand-lining, set netting, and beach seining, mainly in the sheltered south-western Hauraki Gulf. In 1899, the first small steam-powered beam-trawler began fishing in Hauraki Gulf and over the next 20 years fishing grounds were serially depleted closest to Auckland city until most of the commercial catch was coming from the outer part of the Gulf. Reliable fisheries data are available from 1931 and subsequent landing fluctuations resulted from a complex combination of ground closures, gear developments, economic and social events, and variable recruitment linked to climate. Annual catch from the Hauraki Gulf peaked at 7979 t by 1971 before introduction of the ITQ system in 1986 reduced effort and catch, allowing some stock rebuilding since 1995. Over the 700 years of the fishery about 625,000 t has been fished from Hauraki Gulf, 50% of this in the last 64 years, and the stock is currently ~14% of the prehuman stock size. Use of archaeological and historical information in combination with contemporary data has extended the estimated catch-history for this fishery by over 600 years to the first years of human exploitation.

Friday

14:30–14:45

Room OGGB3 Dispersal and Connectivity

Session Chair: Carolyn Lundquist

Sex, lies and videotape…
The search for sex pheromones in the paddle crab *Ovalipes catharus*

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Pest control using chemicals released by the target organism for signalling has advantages over conventional, toxin-based approaches in that they are often potent, species-specific and environmentally friendly, with little or no effect on non-target species. Our research is aimed at identifying and isolating a crab sex pheromone released by females during their moulting cycle which attracts males for mating. This pheromone can potentially be used to mitigate or prevent the establishment of invasive crab populations.

Here we use the native paddle crab *Ovalipes catharus* for our initial trials to examine behavioural responses of the male crab to female urine, a source of the putative sex pheromone. Behavioural responses of the crabs were tested using still- and moving-water bio assays.

Bio-assays demonstrate that urine collected from pre-moult female crabs induces a sexual response in male crabs. This is the first step in the preliminary purification of a sex pheromone. These results indicate that there is potential for chemical ecology to identify future biological controls of marine invasive species, such as the crab *Charybdis japonica*.

Friday

14:30–14:45

Room OGGB5 Biosecurity

Session Chair: Sharon Goldstien

Demography of the invasive tunicate Styela clava in New Zealand: the numbers game of making it in artificial environments

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Styela clava is a highly invasive tunicate that has a vast non-indigenous range worldwide; it has had considerable economic impacts on mussel aquaculture in north-eastern North America. *Styela*, however, does not appear to be an ideal candidate for an invasive species because it has relatively few, large propagules, limited dispersal, and seemingly specific types of habitat requirements through which it can gain a foothold into new environments. Despite this, *Styela* is known to have established in many ports in both the northern and southern hemisphere, and is considered to be a potential threat to aquaculture in New Zealand.

Since its discovery in New Zealand in 2005, limited work has been carried out on *Styela*. A critical question relating to this species is how it manages to expand populations once it becomes established. In order to answer this question a much greater understanding of its life-history and its interactions with natural and man-made substrata is needed.

Here, we discuss preliminary experimental life history work on this species in Lyttelton Harbour, where it has been established for several years. Surveys, tagging studies and experimental transplants indicate that densities of *Styela* are much lower in Lyttelton port than recorded in other invaded areas around the globe. Growth increments are also very low overall with negative growth recorded in some individuals. Recruitment appears to occur between December and April, which also coincides with high rates of mortality of larger individuals. Subsequent monthly survival rates have increased to around 90%. Best estimates to date are that most established individuals probably do not live much longer than one year. If this is the case, highly variable recruitment may account for the relatively low densities of this species in New Zealand.

Friday

14:45–15:00

Room 290-098 Long-term studies and monitoring

Session Chair: Megan Stewart-Carbines

Tests of point-null hypotheses misrepresent data

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This presentation reviews how the most common mode of data analysis in marine ecology is usually erroneous, and how management decisions based on those analyses can lead to wastage of funds and resources. Despite their widespread usage by marine ecologists, tests of point-null hypotheses frequently — if not usually — mis-represent data. A survey of journals that publish marine ecological studies revealed that most papers presented the results of experiments or surveys in a way that included P-values from point-null hypothesis tests. The problems with the use of P-values as evidence are well-known in the statistics literature, drew attention in the social sciences more than 40 years ago, but appear unappreciated by marine ecologists in the 21st century. We outline the futility of testing an hypothesis that will not be true for any real world situation, the difficulties posed by combining arbitrary alpha levels and sample sizes, and the problems of relating a P-value to a measure of evidence. There are defensible alternatives, such as estimating an effect size, testing interval hypotheses, and comparing alternative models via information-theoretic methods, but they are so seldom used that their merits are yet to be explored. Examples from the study of marine reserve effects are used to illustrate the limitations of interpreting P-values. We suggest that marine ecologists should stop using tests of point-null hypotheses immediately, and focus on biological significance, rather than statistical significance. The credibility of the field of marine ecology will continue to erode, and the management of coastal marine resources will continue to be flawed, unless this occurs.

14:45–15:00

Room OGGB3 Dispersal and Connectivity

Session Chair: Carolyn Lundquist

Induction of settlement in crab megalopa by ambient underwater reef sound

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The larvae of a number of crab species have been found to swim toward ambient underwater sound emanating from coastal settlement habitats. This current study examined whether ambient underwater sound also has the potential to trigger settlement responses in crab larvae. The effect of exposure to reef sound on the settlement behaviour and time to metamorphosis was examined in the megalopae of five common crab species, three from temperate waters and two from tropical waters. The megalopae of all five crab species showed marked changes in swimming behaviour and a significant decrease in time to metamorphosis when exposed to replayed ambient underwater reef sound compared to a silent (control) treatment. Megalopae exposed to sound decreased swimming activity earlier and displayed crawling behaviour that was a precursor to both settlement and metamorphosis. Sound exposure decreased the median time to metamorphosis by 33 h in *Hemigrapsus sexdentatus* and by 75 h in a coastal Grapsidae spp. on the Great Barrier Reef. The consistent results among all species examined indicate that ambient underwater sound is likely to be an important settlement cue for the megalopae of many crab species. The wider ecological significance of acoustic settlement cues in crab larvae, in relation to other settlement cues and processes, now needs to be determined.

15:00–15:30

Room OGGB3 Dispersal and Connectivity

PANEL DISCUSSION

Chair: Carolyn Lundquist

Friday

14:45–15:00

Room OGGB5 Biosecurity

Session Chair: Sharon Goldstien

Contrasts in the recent introductions of two tunicates to northern New Zealand

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The recent introduction to northern New Zealand of two tunicates, the club sea-squirt (*Styela clava*) and cunjevoi (*Pyura praeputialis*), exhibit contrasting patterns of arrival, spread and potential impacts. Both were likely introduced via fouling on international boats, both attach to hard substrata at low tidal and shallow subtidal depths, and when first identified both were well established, probably having been present for 3–10 years. The similarities end there however.

The club sea-squirt colonises relatively sheltered environments. After arrival, this species spread rapidly around the inner Hauraki Gulf over a three year period (2002–2005). It has since been transported to several ports around NZ, and has caused fouling problems in northern Europe. When first identified from NZ in 2005 its arrival caused major concern and rapid surveys were undertaken to establish the viability of eradication. It is causing biofouling problems for aquaculture in Hauraki Gulf, although in most natural rocky shore environments its numbers are generally too low to have a major impact on the native biota. Conversely, cunjevoi colonises exposed, rocky environments and since its arrival ~ 5 years ago it has not spread far (9 km) around the rocky shores of Cape Maria van Dieman. This species was probably introduced from Australia, also the inferred source for the cunjevoi that has taken over the low tidal rocks in Chile in the last 100 years. When first reported from NZ in 2007 its arrival caused no major concern or response, as it was not seen to be an economic threat to aquaculture. Where cunjevoi has colonised, it forms a dense mat, 5–10 cm thick, on low tidal rocks. It completely overgrows and kills existing native biota, including green-lipped mussels, forming a new distinctive low-tidal zone, just as it does in Australia and Chile. Whether it will have any impact on the nearby Ninety Mile Beach mussel spat fishery is unknown; it may take decades to spread south down the exposed coasts of Northland and Auckland because of wide habitat gaps.

Friday

15:00–15:15

Room 290-098 Long-term studies and monitoring

Session Chair: Megan Stewart-Carbines

Changes in underwater life at the Poor Knights Islands over the past 50 years, based on recollections of long-term divers

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The Poor Knights Islands are a small archipelago located 20 km off the mainland of temperate northeastern New Zealand, and are considered one of the country's best recreational dive sites due to their spectacular geology, clear warm water, and abundant marine life. In a recent survey, tourist divers rated the underwater environment at the Poor Knights as near pristine, perhaps influenced by the knowledge that the islands have been protected within a no-take marine reserve since 1998. However, none of the divers surveyed had dived at the Poor Knights before 2002, so they lacked the experience required to recognise any long-term environmental degradation. I will describe major changes in abundances of several key marine species at the Poor Knights since the 1950s, based on the recollections of long-term divers. These recollections were quantified via a questionnaire-based survey and validated against quantitative monitoring data.

Friday

15:00–15:15

Room OGGB5 Biosecurity

Session Chair: Sharon Goldstien

Temperature and salinity tolerances of zoea I larvae of an invasive portunid crab, *Charybdis japonica*, in northeastern New Zealand: implications for further invasions

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The successful invasion of a non-native species depends on several factors, including initial colonization and establishment of a self-sustaining population. Populations of the non-native crab *Charybdis japonica* were first recognized in Waitemata Harbour, Auckland, in 2000, most likely arriving in ballast waters of an Asian merchant vessel. A survey completed in 2003 found *C. japonica* throughout Waitemata Harbour, and further sampling in 2008 has revealed several well-established populations in estuaries up to 120 km from the putative invasion point.

As the potential for further establishment of *C. japonica* beyond this area may depend on the temperature and salinity tolerances of their free-swimming larvae, we quantified the survival of first day *C. japonica* zoea I subjected to temperatures ranging from 5–45°C or salinities from 5–45 ppt in the laboratory. Upon hatching, replicate *C. japonica* larvae were directly transferred from 21°C and 34.6 ppt seawater to either pre-heated filtered seawater at the experimental temperature or one of the salinity values prepared using artificial seawater or filtered rainwater. Behaviour and death rates of the larvae were monitored over a 24 hour period in the absence of food. The results show that *C. japonica* zoea I tolerate a broad range of temperatures and salinities and can survive natural conditions in northeastern New Zealand. The potential for *C. japonica* to invade other New Zealand and South Pacific estuaries and harbours is discussed.

Friday

15:15–15:30

Room 290-098 Long-term studies and monitoring

Session Chair: Megan Stewart-Carbines

Decadal trends in temperate marine reserves

Nick Shears[1], Tim Haggitt[2], David Kushner[3], Russ Babcock[4]
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Monitoring of coastal ecosystems is becoming increasingly important in a changing environment and long-term data from marine reserve and fished sites is necessary to separate out the effects of fishing from other anthropogenic factors including climate change. We compared long-term data from two of the most well-studied marine reserves in temperate reef ecosystems to investigate decadal variation in the response of kelp forests to protection. The Leigh Marine Reserve (established 1976) in northern New Zealand and the Anacapa Island State Marine Reserve (established 1978) in Southern California are broadly analogous kelp forests ecosystems, with a few dominant predators (lobster and large predatory fish) and abundant sea urchins. In both systems, comparisons between reserve and fished sites are consistent with a trophic cascade, with greater biomass of predators and kelp in reserves, and greater urchin abundance outside. However, the trajectory of change between reserve and fished sites varied greatly between the two systems. At Leigh, predators increased rapidly in the reserve (< 5 yrs), while sea urchins declined and kelp recovered over a period of ~15 yrs. In contrast, kelp, urchins and predators remained relatively stable in the reserve at Anacapa over 25 yrs, whereas at fished sites predators declined, urchins increased and kelp declined. At reserve sites in both systems kelp forests have been more stable (following initial recovery at Leigh), whereas large fluctuations in urchins and kelp have occurred at fished sites due to other disturbances (e.g., ENSO and disease). This suggests that the direction, magnitude and timing of change at reserve vs. fished sites will depend on the initial state of habitats within reserves and that communities within reserves will exhibit greater resiliency to anthropogenic change.

Friday

15:15–15:30

Room OGGB5 Biosecurity

Session Chair: Sharon Goldstien

Mediterranean fanworm (*Sabella spallanzanii*) elimination programme — Lyttelton Port

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In 2008 MAF Biosecurity New Zealand (MAFBNZ) initiated a local elimination programme in response to a finding of *Sabella spallanzanii* (the Mediterranean fanworm) in the Port of Lyttelton. *Sabella spallanzanii* appears to have been found in the early stages of establishment through the MAFBNZ targeted surveillance programme. MAFBNZ subsequently launched its first elimination project on this scale in the marine environment.

The *S. spallanzanii* local elimination programme is multi faceted with specific treatment, surveillance, monitoring and communications programmes all operating in parallel. An adaptive approach to the *S. spallanzanii* elimination programme has been developed with the surveillance component designed to identify areas of *S. spallanzanii* infestation and to focus treatment effort. The treatment component currently uses SCUBA to search and remove all *S. spallanzanii* within the elimination areas identified through surveillance. While this is a labour intensive operation, the low numbers and densities of *S. spallanzanii* found to date suggest that SCUBA based search and removal options appear to be the most effective surveillance/treatment methods available at present. A series of settlement plate arrays have also been deployed as part of a suite of monitoring tools used to determine if undetected *S. spallanzanii* population's are still present within the port area.

The *S. spallanzanii* local elimination programme in the Port of Lyttelton is currently planned to extend over a five year period with regular reviews as to the efficacy of the programme. A summary of the response progress and the findings to date will be presented.

Friday

15:30–16:00

OGGB - Afternoon tea

Friday

16:00–16:15

Room 290-098 Long-term studies and monitoring

Session Chair: Mary Livingston

Long term trends in marine water quality in the Auckland region

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Auckland Regional Council

Understanding the marine environment and detecting anthropogenic impacts requires long-term data to describe both natural and induced variability over a range of scales. As part of the Auckland Regional Council's State of the Environment monitoring, 16 water quality parameters at 27 sites are routinely measured on a monthly basis. Sites range from upper harbour estuarine to open coastal sites. Monitoring was initiated in 1986 at six Manukau harbour sites with the remaining sites having data records starting during 1991 and 1993. Inner-harbour sites tended to have poor water quality, whereas water quality in coastal or outer harbour sites was relatively good. Water quality in Manukau Harbour has shown dramatic improvements in suspended sediments and some nutrients since decommissioning of the Mangere oxidation ponds in 2002. Across the region as a whole there were significant improvements in levels of suspended sediments, phosphorus and nitrate. These findings are consistent with patterns described for water quality measured in stream and rivers in the Auckland region.

These data have enabled tracking significant changes in resource management and water quality in the Auckland region along with allowing the identification of emerging water quality issues facing the marine environment.

Friday

16:00–16:15

Room OGGB3 Aquaculture

Session Chair: Mark Fitzpatrick

Implications of bacterial films that promote mussel settlement for aquaculture

Annapoorna Ganesan, Andrea Alfaro, John Brooks, Tim Young, Colleen Higgins, John Robertson, Noemi Gutierrez-Maddox.

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School of Applied Sciences, Auckland University of Technology

The New Zealand native green-lipped mussel, *Perna canaliculus,* is of significant commercial importance to the aquaculture industry, with exports exceeding NZ $200 million per annum. This shellfish industry depends almost entirely on the wild-caught spat attached to seaweed to meet 80% of its seed requirements. In the wild, the mussel larvae (220–300 µm) remain planktonic for about six weeks, before settling onto suitable substrata. A range of filamentous macroalgae and hydroids are the primary settlement sites for mussels, prior to their transfer to the rocky shore (secondary settlement). The strong affinity to specific macroalgae has been attributed to morphological and chemical settlement cues. However, the role of bacterial biofilms, routinely observed on the surfaces of the seaweeds, has not been addressed thus far. The effect of marine bacterial biofilms on larval settlement of *P. canaliculus* larvae were analysed in the laboratory. Marine bacterial species from seaweeds, seawater, and mussels, were isolated and screened for their ability to induce mussel larval settlement. Two unique mono-specific Gram-positive bacterial biofilms have been demonstrated to significantly induce larval settlement (80%), when compared to controls. Moreover, cell-free extracts of the biofilm (biofilm exudates) provided similar results, highlighting that the settlement cue was associated with the quorum sensing pathway of bacterial biofilms. Further experiments have shown that the planktonic bacterial cells (prior to forming a biofilm) did not produce a settlement cue. Also, the biofilm of a Gram-positive rod isolated from one macroalga had no significant inductive effect, and dramatically increased larval mortality. These results reflect the strong specificity of these bacterial species as larval attractants or repellents. Currently, these bacteria are being indentified to species level, and the chemistry of biofilm exudates is being characterised. The results of this research have direct implications for the …

Friday

16:00–16:15

Room OGGB5 Biosecurity

Session Chair: Mike Hickford

The successful establishment and spread of an introduced fish

Jeremy Barker**,** Lindsey White, Barbara Breen

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The Australian oyster blenny (*Omobranchus anolius*), was discovered in Auckland in 2003. A subsequent survey of inner Hauraki Gulf revealed 24 specimens, the majority (20) occurring in Tamaki River. Not all non-indigenous species that arrive are able to establish a self-sustaining population; of those that do, many do not extend their range beyond the immediate vicinity of their arrival site. Predictions of whether *O. annolius* would establish and spread were difficult because this species had previously never been found outside of its native range and little was known of its ecology.

Recent surveys throughout Hauraki Gulf confirm this blenny has successfully established itself and bred in New Zealand waters. The recognised distribution of this species has increased, and it is now known from as far north as Whangateau Harbour, as far east as the Coromandel Peninsula, and is widespread throughout Waitemata Harbour. The successful establishment of the oyster blenny may have been facilitated by the invasive habitat-forming Pacific oyster (*Crassostrea gigas*), with 92% of individuals found within their shells, although it has also been recorded from native oysters (*Saccostrea glomerata*) and tube worms (*Pomatoceros caeruleus*). The known range of inter-tidal habitats this fish occupies has increased and now includes: mud and sand-flats, mangroves, reef platforms and artificial structures. Importantly this fish has been discovered on hull fouling and in at least five oyster farms. These habitats provide a possible vector for inter-regional transport via coastal shipping, or through oyster transfers between farms. Implications for the management of this potentially invasive species are discussed.

(contd) … development of pre-conditioned biofilm ropes that improve settlement and retention of mussels in farm settings.

Friday

16:15–16:30

Room 290-098 Long-term studies and monitoring

Session Chair: Mary Livingston

Towards a national marine environment monitoring programme in New Zealand

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MFish, Wellington

New Zealand has responsibility to manage natural resources in one of the largest and most varied ocean territories in the world, in an area 15 times the size of our landmass. We make wide use of our ocean resources, with an economic value alone of billions of dollars. Governance, policy and management of our oceans are, however, fragmented. This provides challenges for us, particularly when it comes to assessing national-scale issues; e.g., analysis of the state of the marine environment within the context of environmental change, or the effects of increasing pressure on marine resources. The fragmented nature of ocean governance also means that information and research data are held across a variety of organisations that can be difficult to access or discover. The lack of ready access to data on a national scale not only affects our ability to report on trends in our oceans and ecosystems, but also our capacity to report on the state of NZs marine environment in the international arena. Scientists within NZ also struggle to locate datasets that provide context for their research or allow them to address large-scale questions.

In 2009, the MFish Biodiversity Research Advisory Group held a workshop to investigate the possibility of developing a co-ordinated marine environment monitoring programme. The goal is to identify and protect existing long-term data-collection programmes that could contribute to regular nation-wide assessments of NZs biotic and abiotic marine environment, while facilitating ready access for scientists to the wide range of marine data sources in New Zealand.

Three key steps towards developing a coherent, collaborative and cost-effective national Marine Environment Monitoring Programme (MEMP) have been identified. 1. Develop an online meta- database of marine datasets that exist in New Zealand. 2. Identify core datasets in terms of their 'fit to purpose' for long-term monitoring of the marine environment in New Zealand and conduct a gap analysis (contd) … 3. Ensure that the Programme facilitates strong links between science and policy, and improved collaboration with the marine science community.

Friday

16:15–16:30

Room OGGB3 Aquaculture

Session Chair: Mark Fitzpatrick

Farm to fork: how a stress-free harvest can influence the quality of frozen Chinook salmon

Denham Cook[1,3], Jan Holland[2], Malcolm Forster[3]
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[1]Leigh Marine Laboratory, University of Auckland; [2]Seafoods and Marine Extracts Unit, New Zealand Institute of Plant and Food Research; [3]School of Biological Sciences, University of Canterbury

Attaining an optimal product necessitates an approach that begins with mindful animal handling throughout the grow-out period and harvesting continuing through processing, retail presentation and consumption — a 'farm to fork' approach. We investigate whether harvest method effects deteriorative processes occurring during the frozen storage of Chinook salmon white muscle tissue. Comparison of two harvest methods, 'rested,' involving sedation with the aquatic anesthetic AQUI-S™, and 'exercised', a simulated conventional harvest not involving sedation, contrasted levels of activity of the animal prior to and upon slaughter. Analysis of tissue metabolites identified that rested and exercised harvesting protocols produced tissue in significantly different post-mortem physiological states prior to freezing. Rested, post-harvest tissue maintained high metabolic energy stores of ATP and glycogen, with low concentrations of tissue lactate; exercised tissue exhibited near-depleted concentrations of ATP and glycogen and a marked lactate accumulation. For both no significant change in metabolite levels was seen over a 6-month storage period at -19°C when tissue was frozen immediately post harvest. Analysis of lipid oxidation (rancidity) products, via TBA-RS assay, during frozen storage (-19°C) identified an increase in secondary lipid oxidation products over time, although harvest treatment had no effect on their pattern of increase. Upon transfer of frozen tissue (-80°C and -19°C), to refrigerated temperatures (-1°C and +4°C respectively) tissues underwent rapid glycolysis, depleting tissue ATP and glycogen stores and increasing tissue lactate concentrations. Metabolic activity was more significant in rested tissue owing to the larger concentrations of metabolic energy stores and occurred at temperatures between -3°C and -1.5°C. After thawing, tissue then was stored at refrigerated (+4°C and -1°C) temperatures. Rested tissue had a significant ability to retard development of secondary lipid oxidation products compared to conventionally harvested tissue. Therefore, once removed from frozen storage, tissues harvested by 'best practice' 'rested' methods possess an ability to retard the onset of rancidity, thus increasing the deemed 'quality' of the product.

Friday

16:15–16:30

Room OGGB5 Biosecurity

Session Chair: Mike Hickford

Primary production rates in subtidal macroalgal beds: does the presence of *Undaria pinnatifida* make a difference?

[1,2]Derek Richards, [1]Chris Hepburn, [1]Stephen Wing, [2]Catriona Hurd

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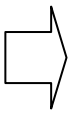
University of Otago, Departments: [1]Marine Science, [2]Botany

Subtidal macroalgal communities are highly productive and increase habitat complexity and food sources for a variety of marine animals, particularly juvenile reef fish and grazing invertebrates. The objective of this study was to measure the productivity and succession of seaweed communities in habitats with and without the invasive laminarian kelp, *Undaria pinnatifida*. Six shallow subtidal reef areas (three with and three without *U. pinnatifida*) on the Otago Coast were selected. Species density, richness, and diversity were quantified for macroalgae and invertebrate communities. Within each reef area a wave-exposed and wave-sheltered site was chosen, and five depth strata (0–6 m depth from low tide) were sampled along a 30-meter transect line using 10 randomly positioned 1 m^2 quadrats. Another two sites in this area, one without (Karitane) and one with *U. pinnatifida* (Purakaunui Inlet), were selected for a community productivity experiment. At each site, six spore-settling frames were placed haphazardly at 2–4 m below the low tide mark. Light sensors were attached to one cage per site to obtain *in situ* records of light conditions. Net photosynthesis at a range of irradiances was measured for the communities that developed on the plates after six months in the field, using a 30 litre incubation chamber with re-circulating water in-line oxygen electrode at 12ºC.

Sub-tidal surveys revealed that average macroalgal species richness at Karitane (14.5) was greater than that at Purakaunui Inlet (6). In addition average species richness of the three spore-settling plates was higher at Karitane (6 species per plate) compared to Purakaunui Inlet (4 per plate). Although not significant (F=1.47; P= 0.231) net productivity and light use efficiency (alpha) values obtained from the Karitane communities were higher (three-fold and ten-fold increase respectively) than the values from the Purakaunui Inlet plates…..



(contd) … We relate differences in the photosynthetic characteristics of early successional and mature macroalgal communities between habitats with and without *U. pinnatifida*.

Friday

16:30–17:00

Room 290-098 PANEL DISCUSSION

Long-term data needs

Chair: Mary Livingston

Friday

16:30–16:45

Room OGGB3 Aquaculture

Session Chair: Mark Fitzpatrick

The effect of microalgal and formulated diets on the performance of green-lipped mussel spat *Perna canaliculus*

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The green-lipped mussel, *Perna canaliculus*, is extensively cultured in New Zealand (~90,000 tonnes per year), accounting for nearly 5% of global mussel production. However, the collection of wild mussel spat is extremely variable in its quality, quantity and timing of arrival, which can hamper the continuity of supply of mussels to international markets. The hatchery rearing of *P. canaliculus* spat is aiming to overcome the unstable supply of wild mussel spat and underpin the rapid growth of the New Zealand mussel industry. The purpose of current study is to evaluate the efficiency of a formulated artificial diet, MySpat, for use with green-lipped mussel spat as a less-costly substitute for live microalgal feeds. This formulated diet has gained commercial recognition in the nursery rearing of spat of the blue mussel *Mytilus galloprovincialis*. Different combinations of live microalgae and MySpat were fed to mussel spat of a range of sizes and growth and survival were measured.

Our experimental results showed that this artificial diet could replace up to two thirds of the algae requirement while supporting excellent mussel growth, indicating the product could be effective as a potential low-cost algae alternative for the nursery culture of green-lipped mussel spat. The ontogenetic changes in the structures and surface morphology of gill filaments in this species were also examined and related to changes in particle selection and the utilization of artificial food particles by the spat of this mussel species.

Friday

16:30–16:45

Room OGGB5 Biosecurity

Session Chair:Mike Hickford

Cogitations from a marine biosecurity perspective

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MAF, Wellington

Vessel biofouling has been recognised as a vector in many historical introductions of marine species into New Zealand, such as Pacific oysters (*Crassostrea gigas*), and continues to contribute to both the international and domestic spread of marine species. Biosecurity New Zealand (BNZ) is the lead agency charged with the protection of New Zealand's indigenous fauna and flora from invasive species. In the marine environment, shipping movements provide a vector for both international and domestic translocations of species that would otherwise be impossible. Ballast water has received the most attention with several high-profile introductions, such as the zebra mussel (*Dreisenna polymorpha*) in North America's Laurentian Great Lakes, proving the catalyst for international action. However, ships also translocate organisms as biofouling of sea chests, cooling and ballast plumbing, and hull surfaces. BNZ has been pursuing a research program into the potential risk posed by marine biofouling, surveying five categories of vessels arriving in NZ ports. International recreational, fishing, passenger, commercial vessels, and slow moving barges and oil platforms have all been surveyed over a 2-year period to correlate ship type, geographical movement, fouling level and fouling organisms. This presentation will discuss the general outcomes of the initial analysis, in particular thinking about biofouling risk management in terms of taxonomic groups. I will also touch on what other countries are doing, where NZ stands in relation to this, recent international developments in biofouling, and the way forward.

Friday

16:45–17:00

Room OGGB3 Aquaculture

Session Chair: Mark Fitzpatrick

Mussel waste as a food source for juvenile sea cucumber *Australostichopus mollis*, growth and polyculture / aquaculture implications

Matthew Slater, Andrew Jeffs
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Leigh Marine Laboratory, University of Auckland

Improved knowledge of juvenile feeding behaviour in the sea cucumber *Australostichopus mollis* is essential to assist in raising hatchery-reared juveniles, however, the feeding, nutrition and early growth of juvenile *A. mollis* remains undocumented. The survival and growth of juvenile sea cucumbers on artificial feeds was assessed over three months. Growth and survival of tank-held juveniles was compared for a natural sediment diet, fresh mussel farm waste and dried *Sargassum polycystum*. Juvenile sea cucumbers fed the highest rate of mussel waste diet exhibited the greatest ($P < 0.01$) overall specific growth rate (SGR), increasing in weight by an average of 30% (± 7.7 SD) over three months. Natural sediment diets resulted in negative SGR, while the *Sargassum polycystum* diet and lower feeding rates of mussel waste produced intermediate SGRs. The growth performance of the different diets was also reflected in morphometric parameters (mean gutted weight, body wall and muscle band thickness) in the experimentally raised juvenile sea cucumbers. Growth results are compared to 1 year growth of juveniles caged in their natural environment. Stocking rates for culture, time to harvest and potential life history implications are discussed.

Results show that fresh mussel waste is a suitable artificial diet for juvenile sea cucumbers if provided in sufficient quantities. The results also indicate that rapid growth can be expected among juvenile sea cucumbers cultured beneath mussel farms provided sea cucumber stocking rates are managed appropriately to ensure an adequate supply of mussel waste.

Friday

16:45–17:00

Room OGGB5 Biosecurity

Session Chair: Mike Hickford

MITS: Marine Invasives Taxonomic Service

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NIWA, Wellington

Increasing awareness of the potential impacts of invasive marine species and the need for accurate identification of specimens led to the creation of the Marine Invasives Taxonomic Service (MITS). MITS was established in late 2005, funded by MAFBNZ and delivered by NIWA. MITS provides a centralised identification, curation and data storage service for specimens collected under MAFBNZ marine programmes and miscellaneous other sources. These programmes include port surveys, surveys of vessel hull fouling and targeted surveillance. Since its establishment MITS has identified over 40,000 specimens. From these, approximately 1200 species have been identified through MITS, of about one-sixth are alien to New Zealand.

Friday

17:00–17:15

Room 290-098

Chairperson: Mary Livingston

Rachel Butler

NMZZ – a means of gathering scientific maritime information

Friday

17:00–17:15

Room OGGB5 Biosecurity

Session Chair: Mike Hickford

From the ocean to the lab – new organisms and you

Donna Campbell[1], Angela Kidd[2]
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[1]ERMA New Zealand; [2]MAF Biosecurity, Wellington

The Hazardous Substances and New Organisms (HSNO) Act 1996 established the Environmental Risk Management Authority (ERMA New Zealand) to assess and decide on applications to introduce hazardous substances or new organisms into New Zealand. Any new organisms that are brought into New Zealand for the purpose of development or propagation are regulated by the HSNO Act. New organisms are those organisms that were not present in New Zealand prior to 29 July 1998, are genetically modified, or are regulated under a HSNO Act approval. For the purposes of the HSNO Act the boundary for New Zealand is the territorial sea, or 12 nautical miles from the low water mark of coastal New Zealand. Any viable new organisms intentionally brought into New Zealand from outside the territorial sea require a HSNO Act approval.

MAF Biosecurity New Zealand is the division of the Ministry of Agriculture and Forestry charged with leadership of the New Zealand biosecurity system. It encompasses facilitating international travel and trade, protecting the health of New Zealanders and ensuring the welfare of our environment, flora and fauna, marine life and Maori resources. MAF Biosecurity New Zealand is the enforcement and compliance agency for new organisms under the HSNO Act, and is also responsible for regulation of organisms that are unintentionally imported into New Zealand under the Biosecurity Act 1993.

This seminar will focus on the regulatory processes in place for collecting samples from beyond the 12 mile limit, from the documentation required from both MAF and ERMA to the transport requirements and physical management of the samples within a MAF approved facility.

POSTERS

Phylogeography of the endemic New Zealand alga *Carpophyllum maschalocarpum* (Fucales, Sargassaceae) shows the influence of contemporary processes and historical events

Joe Buchanan, G. C. Zuccarello

School of Biological Sciences, Victoria University

We analysed spatial patterns of mitochondrial DNA variation to investigate contemporary dispersal and historical range expansion in the New Zealand endemic fucalean brown alga *Carpophyllum maschalocarpum* (Turner) Greville. Populations bounded by habitat discontinuities were strongly differentiated from adjoining populations. High diversity was found in one region of north-east New Zealand (the Bay of Plenty), with a general decline in diversity with distance from this region, but with four notable exceptions: (1) High haplotypic diversity in the far north of New Zealand arising from introgression from the congeneric *C. angustifolium*; (2) connectivity between the northern and eastern regions of New Zealand's North Island that is congruent with ocean current patterns; (3) low southern diversity, consistent with spatial expansion following range restriction during the Last Glacial Maximum; and (4) high diversity in the Chatham Islands, 650 km from mainland New Zealand, which we suggest arises from dispersal driven by prevailing westerly winds, and by possible survival of Chatham Island populations during LGM cooling. These patterns are consistent with the life history of *C. maschalocarpum*, with limited dispersal at the gamete/zygote stage, but potential for dispersal by detached, drifting adult thalli.

Developing accurate and effective marine ecosystem monitoring tools

Timothy Jones[1], Jonathan Gardner[1], Estate Khmaladze[2], James Bell[1]

Victoria University: [1]Centre for Marine Environmental and Economic Research, School of Biological Sciences; [2]School of Mathematics, Statistics and Operations Research

In light of the increasing number of marine reserves and marine protected areas, marine ecosystem monitoring is critical, however, if poorly designed, monitoring can lead to false conclusions about the state of an ecosystem or population. Our research aims to address this problem for coastal marine ecosystem monitoring by examining different subtidal and intertidal monitoring designs and identifying optimum methods that minimise the probability of making false conclusions, or so called 'type II' errors. The analysis is based on existing data from a wide variety of subtidal monitoring schemes, incorporating a range of focal species and sampling methods. Furthermore, data collected from intertidal ecosystems in New Zealand, using a range of sampling techniques, will be analysed to assess the effectiveness of different sampling methodologies. Adopting a statistical power analysis approach, the data will be analysed to assess the statistical power each method is capable of achieving for detecting long-term trends over time or other significant effects. Thus comparing between methods, optimum methods of monitoring, i.e. those that give the greatest likelihood of detecting an effect when one is occurring (greater statistical power), can be identified for schemes focussing on single species and for monitoring schemes that aim to monitor multiple species simultaneously. These methods are discussed and presented along with the achievable statistical power for detecting given effect sizes and the minimum effect sizes detectable for a given level of statistical power. These are presented both for intertidal and subtidal ecosystems; describing an accurate and effective coastal monitoring scheme that will be informative in the future design of monitoring schemes in New Zealand and globally.

Stomach contents of beaked whales stranded on the New Zealand coast

Emma Beatson

Earth & Oceanic Sciences Research Institute, School of Applied Sciences, Auckland University of Technology

One of the most poorly known of the marine mammal groups is the family Ziphiidae, the beaked whales. The taxonomy of the beaked whales is largely uncertain, however, there are at present twenty recognised species in six genera. Although New Zealand has recorded the highest diversity of beaked whale species worldwide (at least 12 species in five genera), including several species that strand frequently, this is the first description of the diet of any beaked whale species from New Zealand waters. Stomach contents are reported for ten individuals from four species of beaked whale (*Mesoplodon bowdoini, Mesoplodon grayi, Mesoplodon layardi,* and *Tasmacetus shepherdi*) stranded on the coast of New Zealand between 1987 and 2009. Prey items recovered from two Andrew's beaked whales (*Mesoplodon bowdoini*) included both cephalopod and fish remains, dominated by the oceanic cephalopod *Teuthowenia pellucida*. Five Gray's beaked whales (*Mesoplodon grayi*) had consumed a combined total of two species of cephalopod from two families (Cranchiidae and Histioteuthidae), and six fish taxa. The most numerous prey remains belonged to lanternfish (Myctophidae) and slender cod (Moridae: *Halargreus johnstoni*). A further five

Gray's beaked whale stomachs were examined and found to be empty. Two specimens of strap-toothed whale (*Mesoplodon layardi*) had eaten a combination of cephalopods from the families Cranchiidae and Chiroteuthidae; salps and a plastic bag were recovered from the stomach of a single specimen of Shepherd's beaked whale (*Tasmacetus shepherdi*). These results are consistent with the limited published data on diet of these species, with beaked whales appearing to have a relatively higher proportion of fish in the diet than other deep-diving odontocetes such as sperm, pygmy sperm and pilot whales.

Marine protected areas in New Zealand: 40+ years of progress?

Stacey Byers, Ann McCrone

Department of Conservation, Wellington

Marine reserve networks are a necessary and effective tool for conserving marine biodiversity. They also have an important role in oceans governance and sustainable management of marine resources. International agreements and conventions have called for the establishment of a network of marine protected areas that protects 20-30% of each habitat type by the year 2012. National and international progress on implementation continues to be slow.

New Zealand has had a long history (over 37 years) of no-take marine reserve establishment since the Marine Reserves Act was introduced in 1971. Approximately 7.1% of New Zealand's territorial sea is protected in 33 marine reserves. However, only 0.2% (32,775 hectares) of the territorial sea around the mainland is protected in 31 marine reserves (consisting of 37 individual sites).

Although progress towards establishing designated legal protection for marine biodiversity has been relatively slow in New Zealand there has been considerable public interest in marine protection. Our literature review of previously nominated marine protected sites reveals the practical expression of the peoples' interest. This poster illustrates the number and distribution of past marine protected area proposals, the percentage of nominations that became gazetted marine reserves, the length of time from proposal to gazettal, and how much closer New Zealand might have been towards it's marine protection target of 10% by 2010.

Archival tagging of *Coscinasterias muricata*: is the low salinity layer limiting to sea stars in Doubtful Sound, New Zealand?

Tracey Channon[1], Miles Lamare[1], Chris Cornelisen[2]

[1]University of Otago, [2]Cawthron Research Institute

Predation and grazing by echinoderms has a strong influence on benthic community structure in New Zealand Fjords. Activities of these species are often influenced by a low salinity surface layer (LSSL). The purpose of this study was to develop a method of tagging the predatory sea star (*Coscinasterias muricata*) to understand their vertical movements in relation to changes in salinity, while a laboratory study aimed to determine whether the sea stars are being limited by the LSSL in Doubtful Sound, which acts as a predator refuge for mussels.
Sea stars were tagged three times, collecting movement data over periods of up to two weeks. In laboratory experiments sea stars were fed on four different treatments that varied in the amount of food offered. For one of these treatments, the time available for the sea stars to feed was based on the amount of time the salinity in Doubtful Sound, at 2m was greater than 30PSU. At the end of the experiment the growth, pyloric caeca and gonad indices were calculated, along with measurements of spermatogenic column widths and oocyte diameters.

The sea stars were successfully tagged without behavioural effects over three separate occasions. The sea stars were occasionally found in less than 2m of water in the low salinity layer, however this was infrequent and only for short periods. There were no effects of the feeding regime on weight, length or pyloric caeca. There was a reduced gonad index for sea stars from the field compared to the sea stars fed once every five days. Sea stars fed once every ten days had thinner spermatogenic columns and female sea stars fed on the *ad libitum* diet had the smallest oocyte diameters. Interestingly the sea stars fed based on the salinity, did not seem to be limited in their growth or exhibit changes in their pyloric caeca, gonads, spermatogenic columns or oocytes.

In conclusion we found that the sea stars do spend some time in the LSSL. It is likely that during these times they are feeding on blue mussels (*Mytilus eduli galloprovinciallis*). The long-term feeding study shows that even if the sea stars have limited access to their food source by the low salinity waters, there is unlikely to be an effect on their growth or reproductive capability. Even when provided with only one mussel every ten days, there was little reduction in reproductive indicators and this was only observed in relation to the spermatogenic columns.

Spatial scaling on an intertidal flat, Aberdeen, Scotland

Luca D. Chiaroni[1], Mark Bulling[2], Martin Solan[2], Leigh Murray[2]

[1]NIWA, Hamilton; [2]Oceanlab, Aberdeen, Scotland

Benthic soft-sediment habitats are extremely heterogeneous, with the heterogeneity occurring across a range of space and time scales. Heterogeneity in soft-sediment systems is generated by the interaction of a range of biotic and abiotic processes, with organisms themselves being particularly important in defining and creating spatial patterns. Patterns apparent at one scale can collapse to noise when viewed from other scales, indicating that patterns, processes and our perceptions vary in a scale-dependent manner. Spatial patterns and habitat variation can play an important role in affecting the strength and even direction of processes that influence ecosystem function. To understand the scale-dependence of variables important to functioning on intertidal flats, we peformed an experiment on a tidal flat in the Ythan Estuary (Aberdeen, Scotland). We aimed to quantify how patterns of macrofaunal abundance, bioturbation rate, nutrient fluxes and sediment chlorophyll content changed with scale. This involved measurements of the parameters at randomly placed replicates nested within a 4 x 4 m grid. Spatial statistics and mathematical modelling were employed to assess the scalability of each variable and the bounds of confidence from we are able to safely extrapolate data.

Recent trends in frost for New Zealand

Anthony Clark[1], James Sturman[1], Trecia Smith[2], Andrew Tait[1] and Michelle Hollis[1]

[1]NIWA, Wellington; [2]Ministry of Agriculture and Forestry, Wellington

This study aimed to detect trends in frost across New Zealand for the period 1972–2008 using all the suitable minimum screen temperature observations from NIWA's climate monitoring network. Two analysis strategies were implemented. First, minimum temperature observations from 112 climate stations were homogenised and annual screen frost frequency determined using the assumption that a frost occurs when temperature falls below 0^{o}C. Trends were detected using linear regression, including calculation of the F ratio and p value to characterise the strength of the linear fit. Station trends were then interpolated using a two dimensional laplacian thin plate spline to provide a frost trend surface. Second, station level minimum temperature observations were interpolated using a three dimensional laplacian thin plate smoothing spline with elevation as a covariate and linear trends fitted to each grid cell on a 0.05^{o} grid across New Zealand. Consistent with previous findings, the study found strong evidence of a national warming trend with a significant decrease in frosts detected when the data were aggregated nationally. However when regions within New Zealand were examined with the spatial models both warming and cooling were detected as significant negative and positive trends in frost occurrence. The general spatial trend pattern was consistent across both analysis strategies, although the second approach yielded more geographic detail but with a known warming bias in higher altitude zones. The study highlights the role of New Zealand's maritime climate, topography and decadal variability on the formation of frost and the interaction of these processes with larger scale global forcing.

Land-sea interactions at New Zealand's Subantarctic Islands.

Sean Cooper[1,2], James Bell[1]

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High concentrations of seabirds and marine mammals can provide marine material that is an important energy source forming the basis of food webs on islands and coastal areas. The New Zealand Subantarctic islands provide the only available habitat within the New Zealand sector of the southern ocean for resting, breeding and moulting seabirds and also support large concentrations of land breeding marine mammals. Currently, the trophic interactions at the New Zealand Subantarctic islands are poorly understood. Our research will assess the trophic interactions between the marine and terrestrial environments at the Subantarctic Bounty and Antipodes Islands, primarily through stable isotope analysis of both terrestrial and marine species, and through analysis of nutrients in nearshore and oceanic waters surrounding the islands. We aim is to develop methods for describing the trophic interactions between the marine and terrestrial environments and to determine the scales at which these interactions occur. The outcomes of our research will not only provide a better understanding of New Zealand Subantarctic biodiversity, but also provide conservation managers with a framework for considering the size and scale of marine protected areas surrounding significant island and coastal conservation sites. The study will also provide a baseline for assessing long-term changes in the species interactions, foraging strategies of top predators and marine flora and fauna of the islands.

Marine Protected Areas for New Zealand's Subantarctic Islands

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In 2004 the Department of Conservation initiated a process to consider developing marine protected areas around the Subantarctic island groups of Antipodes, Bounty and Campbell/Motu Ihupuku Islands. As an initial step in that process, the Department published a background resource document and commissioned a scientific report from NIWA on the Subantarctic region to be used as an information base for future planning.

The process for establishing marine protected areas (MPAs) is set out in the Marine Protected Areas Policy and Implementation Plan (MPA Policy) that was released in 2006. The Subantarctic Biogeographic Region is one of 14 coastal regions within which MPAs are to be implemented.

In 2008 a stakeholder forum was convened to propose marine protected areas around the Subantarctic Islands. The forum consisted of representatives from key stakeholder groups including Maori, commercial fishing, environmental and science interests. The Department of Conservation and Ministry of Fisheries provided policy guidance, planning and technical advice and participated *ex officio* in support of the Forum.

The Forum worked through the steps set out in the MPA Policy which included gathering information from both external sources as well as from Forum members' own areas of expertise to ensure planning was based on the best available information. In developing options for protection the Forum also took into account the international importance of these islands and their surrounding territorial seas which all have World Heritage status.

In June 2009 the Forum released a consultation document seeking comment on two sets of options for marine protected areas around each of the island groups. One set of options proposes marine reserves around each island group extending to the 12 nautical mile limits of the territorial seas. The other set of options proposes marine reserves covering between 33% and 44% of the territorial seas with the remainder as candidate MPAs subject to a prohibition on Danish seining in addition to prohibitions on trawling and dredging that exist under the benthic protection area regulations.

At the end of the consultation period, feedback received on these options will be taken into account as the Forum develops final recommendations which it will then present to Ministers. Final recommendations are expected to be made by the end of this year and will mark the first such recommendations to be made by joint stakeholders under the MPA Policy.

The role of non-indigenous species on the diet of snapper

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Non-indigenous or invasive species are often thought of in a negative context. However, in degraded marine environments such as Rangitoto Channel, Hauraki Gulf, invasive species may play an important role as trophic surrogates, given the loss of native biodiversity. Snapper are a commercially and recreationally important species in New Zealand waters. They are considered to be opportunistic feeders feeding on a diverse array of readily available prey.

To investigate the role of invasive species in the diet of snapper, the distribution, abundance and biomass of invasive species throughout Rangitoto Channel was determined. Stomach content analysis was conducted and coupled with benthic monitoring at four sites within the channel. Results indicate that the diet of snapper in Rangitoto channel comprises a significant proportion of non-indigenous species. Snapper were also found to actively select some of these species, contradicting the perception that they are solely opportunistic feeders. The implications these findings have for management are that in degraded areas invasive species could be acting as trophic surrogates and therefore benefiting some commercially or recreationally important species.

The macrofaunal succession rate of stranded *Durvillaea antarctica* on an Otago exposed sandy beach.

Céline Dufour, Keith Probert, Candida Savage

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Diversity and abundance of sandy beach macrofauna was found to be influenced by the presence of washed up wrack: macroalgae or seagrass that is washed on beaches from surrounding kelp beds. Wrack accumulates on beaches all around the world forming a strand line of detritus on the upper shore. Macrofauna associated with wrack on New Zealand beaches include the common sandhopper *Talorchestia quoyana*, dipteran larvae, nematodes, enchytraeids and coleoptera. Little research has been conducted on New Zealand exposed sandy beaches.

This research investigated the ecology of Otago's exposed sandy beaches by analysing the macrofaunal succession rate of washed up bull kelp (*Durvillaea*

antarctica) on Victory Beach, off the Otago Peninsula.

In late summer (April-May) 24 mesh bags (37cm x 38cm) containing 1kg ± 0.100kg of *Durvillaea antarctica* were placed along four sites of the upper shore at Victory Beach. A mesh bag was collected from each of the sites after 1, 3, 6, 10, 20 and 30 days. Three core samples (10cm diameter x 10cm) were additionally collected at each site beneath the kelp, and at 0.5m and 1.0m distance from the kelp. Kelp samples and associated sand were washed and sieved in the laboratory to extract kelp associated macrofauna which were taxonomically grouped.

Trends have shown a difference in species abundance and diversity over a 30 day period, where the *T. quoyana* appeared to be more abundant during days 1 to days 6 while coleoptera and diptera species were the most abundant after 30 days of exposure. Macrofauna abundance also appeared to decrease with increasing distance from washed up *D. Antarctica*. These findings may suggest that macrofaunal species use *D.antarctica* as a source of food and shelter at different stages of kelp decomposition.

Reproductive seasonality of the invasive ascidian *Didemnum vexillum*: mitigating impacts through pest-inoculation windows

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The introduction of a number of high profile invasive fouling species to commercially important aquaculture regions globally poses a significant practical and economic barrier to the development of competitive shellfish aquaculture. New Zealand, even though geographically isolated from other problem areas, is not immune to these difficulties. Currently several introduced ascidians threaten New Zealand's highly valued shellfish aquaculture industry, and as such efforts to control and manage these species are ongoing. This has led to an increased demand for tools to mitigate the effects of biofouling pests, including knowledge of the biological characteristics of fouling species that underpin management. Avoidance of crop and equipment infection through knowledge of pest inoculation windows is an example of one such management tool. Most pest species have a fixed reproductive season, often regulated by water temperature, during which eggs or larvae are released and dispersed. Industry can therefore manage their activities to avoid deploying vulnerable life-stages (such as mussel or oyster spat) during high risk periods. We recently assessed the reproductive seasonality of the colonial ascidian *Didemnum vexillum*, in order to determine the duration of the reproductive season of this species and the occurrence and timing of avoidance windows. Weekly recruitment levels were measured and correlated with environmental parameters (water temperature and salinity) over an 18 month period at two locations. Results indicate that although recruitment levels vary considerably between locations they follow a similar seasonal pattern. *Didemnum* recruits were detected between late November 2007 and early July 2008, a period of 7 months, with a recruitment peak in late January to early February 2008. This shows a 5 month period during the colder months (water temperature < 13°C) when *Didemnum* populations are not producing larvae. Later we will analyse tissue samples that have been simultaneously collected, to evaluate the utility of determining *Didemnum*'s reproductive seasonality from assessment of larval development. This information can be applied to the management of this species through industry avoidance of spat seeding at high risk periods, to maximise the growth of these vulnerable small size classes before *Didemnum* populations spawn and larvae are present in the water column.

Seabreeze 2009: a multidisciplinary experiment investigating radar propagation and ocean and atmospheric processes, Bay of Plenty, New Zealand

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Defence Technology Agency (DTA) scientists and collaborators from Australia, the USA and the UK have successfully completed a two week field experiment, SEABREEZE 2009, in the Bay of Plenty, New Zealand. The aim of this experiment was to observe radar performance during sea breeze/land breeze coastal mesoscale circulations in a maritime environment. This experiment used a range of permanent, stationary observatories in the region to gather atmospheric and hydrological observations. These data were supplemented by diurnal onshore and offshore soundings, a high-density of offshore vertical profiles from kite-mounted sondes, floating SST sensors, weather buoys and an array of meteorological observations collected using DTA's Unmanned Aerial Vehicle (UAV) system. One way radar propagation measurements were provided by three X-band pulsed radars mounted on a ship transiting between 1 and 30 nm from a suite of shore-based receivers. Experimental design was guided by real time high resolution mesoscale numerical weather prediction model products enabling daily sampling regimes to focus on capturing

measurements of radio frequency duct boundaries. Strong sea breeze signatures were measured and modelled on 5 days during the measurement period. Seabreeze 2009 forms one of the most detailed investigations of radar performance during coastal mesoscale circulations ever undertaken, and is the only dataset of its kind from the Southern Hemisphere. This research, therefore, aims to improve our understanding of the affects of sea breeze circulations on low level radar propagation, and expand the geographical and temporal range of data currently available to researchers and modelers.

An overview of recent work on New Zealand climate extremes

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This poster overviews recent research on New Zealand daily climate extremes, outlining key results and identifying areas of future work. The regional nature of extremes, particularly rainfall, is notable, and relates to both changes in circulation, and mean temperature to a lesser degree, in the New Zealand region. In addition, ENSO is a significant source of seasonal and year-to-year climate variability in New Zealand and Australia, and is known to affect temperature extremes in the Asia-Pacific region (Nicholls et al, 2005). Analyses of Australasian MSLP circulation patterns, SST indices, and the detrended NINO3.4 index are correlated to Australasian extreme temperature indices. The results indicate that some measures of ENSO, such as NINO3.4 or MSLP2, have the potential to be better predictors of many of the temperature extremes over large areas of the Australian (particularly eastern Australia) and New Zealand region, than other broadscale indices, such as SSTs.

Benthic invertebrate assemblages and sediment quality in Northland estuaries

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Estuaries are important ecological, economic and social assets. Vegetation clearance for agriculture, forestry, urban and infrastructure development has increased sediment, nutrient and contaminant inputs to Northland's estuaries. To determine how healthy Northland's estuaries are, benthic invertebrate assemblages, sediment grain size and sediment metal and nutrient concentrations in Whangarei Harbour, Kerikeri Inlet and Ruakaka Estuary were measured in 2008 and 2009. Results from 2008 are presented in this paper. Sediment concentrations of metals and nutrients in Whangarei Harbour, Kerikeri Inlet and to a lesser extent Ruakaka Estuary were high in comparison to concentrations reported in similar studies in New Zealand. In 2008, benthic invertebrate assemblages at different sites within each of the estuaries sampled were significantly different from each other ($p < 0.001$). Differences between the benthic invertebrate assemblages at different sites suggested that concentrations of metals and nutrients are likely to have influenced benthic communities. Lower abundances of taxa sensitive to anthropogenic disturbance were recorded at sites in the upper sections of Whangarei Harbour and Kerikeri Inlet, where concentrations of metals and nutrients were highest. Also, higher abundances of taxa tolerant of disturbance were recorded at these sites. The Bioenv procedure performed on the benthic invertebrate and sediment data showed that the benthic invertebrate assemblages at different sites were strongly correlated to sediment properties at the different sites in Whangarei Harbour (0.809) and Ruakaka Estuary (0.878). The benthic invertebrate assemblages at different sites in Kerikeri Inlet was only weakly correlated to sediment properties (0.483), indicating that other environmental parameters not measured in this study are influencing benthic invertebrate assemblages. Future monitoring will be undertaken to determine if concentrations of nutrients and metals are increasing or decreasing and to further understand the relationship between sediment properties and benthic invertebrate assemblages.

Investigating bivalve post-settlement transport in Whangarei Harbour, New Zealand

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Many juvenile bivalves exhibit post-settlement dispersal, potentially allowing for redistribution after initial settlement from planktonic larval stages to more suitable sites for growth and reproduction. Laboratory experiments have demonstrated variability in dispersal potential with respect to current flow and species-specific behavioural characteristics. We designed experiments to explore differences in the *in situ* post-settlement dispersal of three bivalve species, *Austrovenus stutchburyi*, *Macomona liliana*, and *Paphies australis*. We dyed sediment and macrofauna using Fluorescein on the intertidal estuary in Whangarei Harbour, and measured dispersal of juvenile bivalves outward from experimental plots. Three experimental sites, Takahiwai, Parua Bay and Snake Bank, exhibited differences in post-settlement dispersal rates based primarily on pre-chosen hydrodynamic differences

between each site that were expected to drive differences in post-settlement dispersal. Dispersal was also correlated with abundance of early post-settlement bivalves, abundance of adult and juvenile bivalves and abundance of other common macrofaunal species (e.g. polydorid polychaetes). In conjunction with a number of other experiments including the utilisation of bedload traps, plankton nets and colonising macrofaunal cores, experiments are designed to elucidate larval and post-settlement juvenile bivalve dispersal.

Scale dependent information loss in a bivalve survey: a GIS comparison

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Estuaries are among the world's most productive ecosystems and are important ecological assets. They are complex systems that provide a transition zone between marine and terrestrial environments. Estuaries provide essential ecosystem services, and the species living therein contribute to critical ecological processes. Consequently, monitoring environmental flux in estuaries is crucial if we are to understand and manage the processes driving these systems. Monitoring entire estuaries at fine scales provides information at high resolution but requires substantial resource input and can be logistically difficult. One solution is to sample at coarser scales, but this approach generates less information. In this study I compare scale dependent information loss in a cockle survey undertaken in Kawhia Harbour on the west coast of the North Island.

Sampling sites were systematically located every 100 m in a grid across the intertidal area. Distribution and abundance maps were produced by converting data into raster models in ArcGIS. By randomly re-sampling the original data and creating new raster models, distribution and abundance maps were also produced on 200 m and 500 m grids to compare the loss of ecological information at these lower sampling resolutions.

As expected, a reduction in sampling resolution resulted in loss of ecological information, as indicated by the raster modelling. The smaller, less dense cockle beds were not represented on the re-sampled 200 m grid, whereas the large dense beds remained. However, on the 500 m grid most of the information was lost, resulting in an inaccurate picture of the cockle density and distribution in Kawhia Harbour. These results demonstrate that sampling at coarse scales may grossly underestimate the number of bivalves in an estuary, and that this method of mapping may not be suitable for coarse scale sampling.

Sheep Hill port development: a nearshore ecological survey and effects assessment in Spencer Gulf, South Australia

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Golder Associates (NZ) Ltd., Auckland

Centrex Mining has mineral rights to several significant iron ore deposits in the Eyre Peninsula of South Australia. Shipment of ore through existing ports on the peninsula was not considered feasible for a variety of economic, social and environmental reasons. Construction of a new port facility in Spencer Gulf at Sheep Hill (located approximately 200 km west of Adelaide) could, however, potentially meet social and environmental obligations while still being economically viable. The proposed port would require wharf structures extending up to 400 m from the shoreline and to 20 m depth. A full environmental and social impact assessment (ESIA) was conducted to determine the viability of such a port in this relatively unstudied area. The shoreline in the area is bordered by an extensive system of coastal dunes and boulder fields, while the intertidal zone is comprised of sandy beach areas and rocky platforms. The range of organisms present is typical of these areas (burrowing crustaceans and bivalves in sandy areas, barnacles and molluscs on hard substrates) and turfing algae were found low on the rocky shore with a variety of red and brown seaweeds closest to the low tide mark. Subtidal areas were dominated by seagrass habitat which was mapped using a remotely operated vehicle (ROV). *Zostera/Heterozostera* species dominated close inshore, to be replaced at depths of 3-5 m by a mosaic of *Amphibolis* and *Posidonia* species to about 12-13 m depth. Habitats greater than 13 m depth were largely comprised of sandy substrates and inhabited by a variety of taxa, notably bivalves and infaunal polychaetes. Over 240 different taxa were recovered from the nearshore area, with high diversity of algal, annelid, arthropod and mollusc taxa. Survey results were used to guide the final design and placement of the wharf and mooring structures at the proposed port prior to submission for regulatory approval.

Comparison of zonation and Marxan for prioritising biodiversity of demersal and reef fish in New Zealand's Northeast bioregion

Kathryn Julian, Carolyn Lundquist, John Leathwick

NIWA, Hamilton

Prioritisation of sites for biodiversity conservation, such as the designation of suitable locations for marine protected networks, can be a challenging process. Many software tools can assist in incorporating a comprehensive, adequate and replicated set of representative habitats and

biodiversity into conservation planning. We illustrate similarities in biodiversity prioritisation between two conservation tools, Zonation and Marxan, for New Zealand's Northeast Bioregion. Three datasets were compared: 1) 56 demersal fish species from research trawl data for the entire bioregion; 2) 72 reef fish species from subtidal diver surveys for 'reef' habitat only; and 3) demersal fish species analysed over reef habitat only. We also illustrate: differences in results with respect to scale of analysis (1 km, 5 km and 10 km grids); differential weighting of endemic species; and use of aggregation algorithms to increase minimum size and connectivity of priority areas identified for biodiversity conservation. Both tools identified similar regions as having high biodiversity values, and showed similar responses to different scales, endemic species weighting, and aggregation. However, we note that the purpose of these analyses was to compare conservation tools and identify optimal strategies for using these tools with available biodiversity data. As such, these analyses considered only biodiversity benefits, and were not weighted by costs to stakeholders of reserving areas from fishing or other resource uses. Additional analyses incorporating both biodiversity values and socioeconomic costs can identify a suite of options that maximises both stakeholder and biodiversity values. The ability of software tools such as Zonation and Marxan to present graphical solutions that balance costs and benefits of biodiversity protection makes them a valuable addition to assist in informing the decision-making process.

The *Aiptasia* sp./*Symbiodinium* sp. symbiosis — infection dynamics and cell proliferation

Daniel Logan, Anne LaFlamme, Virginia Weis, Simon Davy

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The regulation of both host and symbiont cell growth and division is essential to the initiation and maintenance of a stable symbiotic relationship. We describe the spatial and temporal patterns of symbiosis establishment in the symbiotic sea anemone *Aiptasia* sp., as determined by confocal microscopy, when infected with cultured clade B *Symbiodinium* sp. dinoflagellates (type FlAp2). Furthermore, once the symbiosis reaches a stable state at 4 weeks post-reinfection, we describe: 1) the asynchronous nature of host and symbiont cell division; 2) the relationship of host and symbiont cell division rates to host body zones, as determined by BrdU (Bromodeoxyuridine) labelling, and 3) the relationship of symbiont cell division to light/dark cycles.

The *Aiptasia*/*Symbiodinium* symbiosis is widely used as a model system for the study of cnidarian / dinoflagellate symbiosis, and data gained from the study of this system will provide insight into the processes that govern the stability of other such symbioses, for example in coral bleaching events. We present the significance and wider implications of our model-system data in this presentation.

Climate regime changes in New Zealand during the last 1000 years

Andrew Lorrey[1], James Goff[2], Bruce McFadgen[3], James Renwick[4], Anthony Fowler[5] Catherine Chagué-Goff[2], Paul Williams[5], Darren King[1], Helen Neil[4]

NIWA, [1]Auckland, [4]Wellington; [2]University of New South Wales, Sydney; [3]ArchResearch, Wellington; [5]University of Auckland

We used a diverse array of terrestrial archives covering all or part of the last 1000 years to reconstruct climate changes for New Zealand. We assimilated these records using regional climate regime classification, which exploits unique inter-regional precipitation patterns that result from orographic effects to reconstruct past regional-scale atmospheric circulation. This method helps identify times when circulation regimes and synoptic types were more frequent in the past. For the last millennium, all of the available terrestrial proxy archives in New Zealand are susceptible to 'distortion' by geophysical, analytical, and/or anthropogenic impacts on the landscape. We therefore provided an objective weighting toward the palaeoclimate archives with the least susceptibility to distortion for this climate reconstruction. Examples of Zonal, Blocking, and Trough climate regimes, as well as hybrid types, were observed. Periods when sub-tropical influences were more prevalent occurred during 1050–1250AD & 1350–1450AD, while periods characterised by more frequent zonal flow were more common during 1250–1350AD, and post 1650AD to the late 1800's. A key circulation shift during the last 1000 years occurred some time between 1450–1600AD, and was characterised by disturbed flow and more frequent Trough synoptic types. The onset of the Trough regime demarcates the transition between the first and second half of the last millennium. High resolution tree ring data suggests this change may have been abrupt. Additional high resolution data needs to be developed in order to improve on the resolution and timing of past climate regimes changes during the last millennium.

Differential palatability of blades and pneumatocysts from floating algae: implications for long-distance dispersal.

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A large number of brown algae in New Zealand possess floating structures (pneumatocysts), which provide buoyancy and let entire plants float to the sea surface after becoming detached from benthic substrata. These algae might persist afloat for weeks or months, which has important implications for dispersal of the algae themselves as well as of their associated biota. Peracarid crustaceans are among the most abundant rafting organisms on floating algae, and many of them consume algal tissues. Previous studies have reported palatability among different algal parts (blades, holdfast, stipes), but pneumatocysts have largely been ignored in these studies. Since these structures are crucial for long-distance dispersal, herein we studied palatability of blade and pneumatocysts in two species of *Carpophyllum*, two species of *Cystophora* and *Macrocystis pyrifera*. To examine algal palatability and feeding preferences of two common grazers (isopods), choice feeding assays were carried out using fresh algal tissues and artificial algal-derived food. Our results indicate a clear preference for blades tissue in fresh feeding assays, which was consistent with consumption results from artificial food for some of the algal species. Our experiments demonstrate that pneumatocysts are less preferred and maintain buoyancy after grazing. The avoidance of pneumatocysts by common grazers improves persistence of floating macroalgae at the sea surface, thereby enhancing the possibility of long distance dispersal and population connectivity via algal rafting.

The effect of UV-radiation on sea urchin larval respiration

Alaric McCarthy, Miles Lamare

University of Otago

Larvae are particularly vulnerable to enhanced UV-radiation exposure as they are small, highly transparent, undergo rapid cell division and occupy the upper regions of the water column. UV-radiation has the potential to induce a range of deleterious effects on planktonic larvae including increased metabolic costs, DNA damage and mortality. Respiration efficiency is a good measure of metabolic costs. Larvae may mitigate UV induced damage via a number of strategies including the dietary uptake of sunscreen compounds such as mycosporine-like amino acids (MAA's).

This study looked at the relative sensitivity of larvae to UV-radiation from different environments. The link between UV-radiation exposure, MAA protection and respiration was investigated in sea urchin larvae from a range of latitudes, including a tropical (*Tripneustes gratilla*), two temperate (*Evechinus chloroticus* and *Pseudechinus huttoni*) and an Antarctic (*Sterechinus neumayeri*) species. Larvae were exposed to varying levels of UV-radiation both in the lab and field using in situ techniques that were standardised to allow direct comparisons between species. Larvae samples were poured into 125 ml UV transparent bags (5 larvae per ml) under two light filters (UV transparent filter, UV opaque filter) and moored at two depths (0.5 m and 2.5 m from water surface). Samples were also fed a range of algae feeds to induce varying MAA levels and left in the field for up to one day. Larval respiration was measured and quantified using a micro-respirometer and MAA levels were measured using high performance liquid chromatography (HPLC).
Respiration was found to change when exposed to UV-radiation, but species and wavelength specific. MAA's provided greatest protection for tropical larvae but had comparatively little effect on Antarctic larvae which suffered highest mortality rates under controlled UV-radiation exposure. The results suggest that Antarctic larvae are most susceptible to UV induced damage. The annual formation of the ozone hole over Antarctica may therefore impede larval development and subsequently affect higher trophic levels.

Comparison of satellite remote-sensed and ship-based measurements of aerosols over the Pacific Ocean

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Atmospheric aerosols are a topic of considerable current interest to climate and solar radiation researchers, both directly, due to their scattering and absorption of solar and infrared radiation, and indirectly due to their role as cloud condensation nuclei and consequent influence on cloud microphysics and radiative transfer properties. Inadequate knowledge of aerosols and clouds has been recognised as a significant constraint on the understanding of climate change. The Aerosol Robotic Network (AERONET), a global network of land-based aerosol measurement stations, and the Maritime Aerosol Network (MAN), its extension to the oceans using instruments onboard commercial and research vessels, were established primarily to address this issue. Both systems provide high quality aerosol information, with traceable calibrations, from several hundred individual points distributed over the Earth's surface. Satellite remote sensing has considerable potential to compliment these networks by providing fill-in coverage between surface

measurement sites and, in the case of MAN, extended temporal coverage over the ocean. Satellite aerosol retrieval algorithms, however, face more severe constraints than their ground-based counterparts, with some preliminary results suggesting difficulties with satellite aerosol products at high latitudes over the ocean. Validation of satellite aerosol retrievals is thus an additional objective of the AERONET and MAN systems. This work describes one such intercomparison between aerosol information obtained from the MODIS instrument onboard the Terra and Aqua spacecraft, and MAN aerosol measurements obtained onboard the vessel Transfuture 5 during 3 transits between Nelson, New Zealand, and Osaka, Japan, in 2007 and 2008. Future work will extend this validation to the NOAA AVHRR instrument, and pave the way for a larger study in which satellite remote sensing will be used to investigate the interactions between phytoplankton growth, aerosols, and cloud properties over the maritime regions surrounding New Zealand.

Latitudinal gradients of atmospheric radiocarbon: a new window onto dynamical controls of the Southern Ocean?

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We present an analysis that suggests a first-order importance of physical processes over the Southern Ocean in contributing to the global atmospheric radiocarbon signal. Measurements of radiocarbon in tree rings over the last 1000 years indicate that there was a pre-industrial latitudinal gradient of atmospheric radiocarbon of 3.9- 4.5‰ and that this gradient has temporal variability on the order of 6‰. Previous efforts to explain the variability in the latitudinal gradient have suggested that it is caused by changes in the frequency of ENSO in the tropics. We test the alternative hypothesis that the natural latitudinal gradient of radiocarbon is primarily controlled by ventilation of the Southern Ocean using fluxes from a suite of models based on the Modular Ocean Model version 3 (MOM3), which are used to force the atmospheric transport model Tracer Model version 3 (TM3).

The results from this suite of simulations suggest that the atmospheric latitudinal gradient of radiocarbon is sensitive to wind stress in the Southern Ocean. Increased wind stress in this region leads to greater upwelling of strongly radiocarbon depleted Circumpolar Deep Waters to the surface, leading to a strong decoupling of the air-sea fluxes of $^{12}CO_2$ and $^{14}CO_2$ in this region. This results in the ocean having a pronounced net uptake of $^{14}CO_2$ relative to $^{12}CO_2$ in this region. These dynamical perturbations to the Southern Ocean are much more efficient that dynamical perturbations in the tropics or the North Atlantic in changing in atmospheric radiocarbon signal. Perturbations of amplitudes similar to those of observed decadal trends in Southern Ocean winds for the NCEP reanalysis (~25%) are sufficient to account for changes in the latitudinal gradients in atmospheric radiocarbon from the tree-ring proxy records over the last 1000 years.

Biogeomorphology of a Maldivian reef island

Kyle Morgan

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Carbonate sand generation in contemporary coral reef systems is the result of the interaction between bioconstruction and bioerosion processes. The magnitude and rate of sediment production derived from reef communities has been explicitly linked to the survivorship of reef islands in a changing global climate. This research 1) examines the linkages between living reef ecology and the formation and maintenance of a small Maldivian reef island, 2) determines and quantifies sediment mobilisation pathways from the outer reef to the island shoreline, 3) examines biogenic sediment characteristics suitable for island construction, and 4) assesses whether modern reef communities are producing sediment of a suitable magnitude and grade for island construction. This project offers new tools and methodological developments for conducting sediment budget studies of reef islands within a biogeomorphological framework. The results generated from this study are of direct significance to a number of low-lying mid-oceanic nations where reef islands provide the only source of habitable land. Outcomes of this research have the potential to influence the future management of coral resources by illustrating a direct link between reefal sediment production and island persistence.

Filtration rates in the New Zealand clam *Paphies australis*

Nawwar Mamat, Andrea Alfaro

School of Applied Sciences, Auckland University of Technology

Pipi, *Paphies australi*s, are burrowing bivalves endemic to New Zealand. Currently, all pipi supplied to local markets are harvested from wild populations.

However, the fishery of this species is threatened by over-harvesting. Evidence of over-harvesting is indicated by the fact that the total allowable catch was reduced from 657 to 200 tonnes between 1986 and 2003. Therefore, there is a high potential for the production of hatchery-reared seed to re-stock wild populations and/or form the foundation for a future clam aquaculture industry in New Zealand. To this end, knowledge of hatchery-culture requirements for this species is currently needed, especially regarding feeding aspects. In this study, the filtration rates of *P.australis* fed five microalgal species were determined. The clam samples between 30.0 and 40.0 mm in shell length were collected from Waiwera Beach, Northeast Auckland. Initial cell concentrations of *Isochrysis galbana* (T-ISO strain), *Chaetoceros gracilis*, *Pavlova lutheri*, *Tetraselmis suecica*, and *Thalassiosira pseudonana* were determined. The decreasing numbers of cells as a function of time were monitored by taking water samples every 30, 60, 180, and 360-minute intervals, and recording cell concentrations using a haemocytometer. Results showed that the filtration rates for all experimental microalgae were similar throughout the experimental period. However, *Pavlova lutheri* differed significantly in the first 30-minute interval. These findings indicate that *P. australis* clams are capable of filtering a variety of microalgal species, regardless of particle size. Feeding trials with enriched microalgae and artificial feeds are ongoing to optimize feeding of hatchery-reared *P. australis*.

The effects of ultraviolet -B radiation on the oxygen consumption of a model temperate and tropical sponge

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The predicted rise in harmful ultraviolet-B radiation and deeper penetration depths of these wavelengths in the marine environment are concerning, as the effects on important marine benthic taxa, such as sponges, are not well known. The aim of this study was to investigate the influence of ultraviolet-B radiation on the physiological functioning of model temperate and tropical sponges, *Tethya bergquistae* and *Aaptos* sp., respectively. Oxygen consumption, a measure of the energy needed for all physiological processes, was determined for sponges exposed to ultraviolet-B radiation over 7 hours. It was expected that sponge oxygen consumption rates would increase with the exposure to radiation, due to the energy cost for repair processes caused by direct DNA damage. It was found, however, that ultraviolet-B radiation, at 60 μW cm^{-2}, had no effect on the oxygen consumption rate of either sponge species over the experimental period. The results indicate that long-term survival and distribution patterns in *Tethya bergquistae* and *Aaptos* sp., and perhaps other sponges, may not be affected by exposure to ultraviolet-B radiation levels up to 60 μW cm^{-2}.

Captured in time: A long-term perspective on the seasonality of foraminifera from sediment traps

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A ten-year study using time-incremental sediment traps deployed at 1500 m water depth, north and south of Chatham Rise, New Zealand has revealed marked regional and seasonal differences in foraminiferal flux, both between and within sites. The southern trap is located beneath cooler, less saline, iron- and light-limited, but nitrate-rich, subantarctic waters, whereas the northern trap is placed beneath warm, saline, nitrate-limited subtropical waters.

These marked differences reveal that faunal boundaries are not static but instead reflect highly variable oceanographic conditions. Sediment trap samples represent a snap-shot in time as opposed to the time-averaged data observed in sediment cores. In contrast, however, trap samples allow the actual variability of foraminiferal fluxes in terms of magnitude, timing and speciation, to be elucidated in a time-series sense, over timescales of weeks to years. This information is paramount to our interpretation of climate and oceanographic history derived from proxies preserved in sediment records.

Egg-straw-dinary habitat: artificial spawning substrata for a diadromous fish species.

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New Zealand's diadromous galaxiid fish ("whitebait") cross between major ecosystems to complete their life cycle. The most abundant species, *Galaxias maculatus,* has an oceanic larval phase before migrating into freshwater to develop and breed. Spawning occurs almost exclusively in tidally influenced areas of coastal streams. Within these, we have shown that spawning adults show strong preferences for very specific qualities of habitat and vegetation. Eggs are laid supratidally in riparian vegetation and develop in the terrestrial environment for 2–3 weeks until they hatch after being flooded again by spring tides. Surveys of many streams and rivers around the South Island showed that the same spawning areas in rivers are used by successive spawning cohorts within and between years.

Anthropogenic impacts, especially sedimentation, impoundment, stock grazing, and modifications to riparian contours and vegetation, have severely impinged on this species' ability to complete its life cycle by limiting the availability of quality spawning areas. In an initial step towards mitigation, leading to rehabilitation and restoration, we experimentally placed artificial substrata along degraded stream banks. Egg production was dramatically improved, in one case going from near-zero to hundreds of thousands. By using these cheap, biodegradable substrata we may be able to "kick start" the rehabilitation process that leads to longer term fixes involving restored habitats. These devices can also be used as temporary bridging-habitat for pristine streams affected by natural disturbances (e.g., flooding and sedimentation), and can serve as a standardised measure of potential egg production when prioritising streams for restoration or protection.

The effect of temperature on life cycles, growth and mortality of two estuarine mysid species in the Auckland region

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The effects of seasonal temperature changes on growth, mortality and the life cycles of two species of mysid, *Tenagomysis novaezealandiae* and *T. chiltoni*, in the Auckland region are reported. Abundance, length frequency and sex ratio data are presented for 23 monthly field surveys for mysids within Kakamatua stream, Waitakere Ranges. These data are compared and contrasted with those from laboratory studies evaluating the effects of temperature on growth, life cycle duration and mortality for these two species. Laboratory studies involved replicated stocks containing 15 newly hatched (< 24-h old) juvenile mysids held at three temperatures: 13 ± 1°C (comparable to winter); 18 ± 1°C (spring and autumn) and 23 ± 1°C (summer), each monitored for four weeks, during which time mysid total body length was measured every four days. Replicated experiments similarly were conducted at each of these temperatures using gravid females of each species to determine embryonic developmental period.

Higher temperatures accelerated embryonic development and larval growth. Generation time at the lowest temperature treatment, winter (13 ± 1°C) for *T. chiltoni* and *T. novaezealandiae* was 4.5 and 3.25 months respectively, 3.5 and 2.5 months for spring and autumn, and 3 and 1.75 months for summer. Mortality was greatest for *T. chiltoni* at 23 ± 1°C, moderate at 18 ± 1°C and least at 13 ± 1°C, while juvenile survival of *T. novaezealandiae* at each temperature was not significantly different.

These results have important implications for conservation of mysid habitat in estuarine environment, particularly with respect to loss of riparian vegetation, hence shade, as a consequence of coastal development.

Local perceptions of and satisfaction levels for the Taputeranga marine reserve, Wellington, New Zealand

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Marine Reserves (MRs) and Marine Protected Areas (MPAs) are amongst the most common tools used for marine conservation around the world. Their main purpose is to conserve biodiversity for biological, social and economic benefits. However, in NZ the main objective of MRs is different; the purpose of MRs is to allow scientific research to be conducted in the absence of human disturbance. As a result, social factors have received less attention by researchers and government agencies during the establishment and maintenance of MRs, compared with the numerous projects and studies on biological topics. Despite the fact that the MR establishment process must include a public consultation by the Department of Conservation, this process can be limited in scope. Far more studies are required to improve our limited understanding of the socio-economic impacts of MRs in NZ. For this reason, the goal of our research is to investigate the perceptions and satisfaction levels of local populations (people who live in the vicinity of MRs), fishermen (commercial and recreational) and local businesses in the vicinity of the Taputeranga MR which was gazetted in August 2008. According to the Department of Conservation, establishment of the Taputeranga MR was supported by the majority of people in the vicinity. The MR is located mostly in Island Bay, but our study includes a wider area from Red Rocks to Breaker Bay along the south Wellington coast, and we have identified this area as the "impact area". We used a mixture of social methodologies to investigate perceptions of MRs. These methods included literature reviews, two type of observations (participative and non-participative), questionnaires, and interviews with local community leaders. Our results show there are significant differences in public perceptions before and after the MR establishment. Moreover, there are also considerable differences between perceptions of groups of respondents, particularly between

recreational and commercial fishermen. This kind of study is useful to determine the impact of a MR, to evaluate public projects and the processes with respect to MR establishment in NZ. In addition, this type of methodology enables us to obtain powerful results which can be used to improve communication between decision-makers and stakeholders and to build better relationships between researchers and non-extractive users of MRs.

Are extreme wind patterns over New Zealand changing?

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Wind simulations are available for the New Zealand region from an ensemble of global circulation models forced by IPCC SRES emission scenarios. However, attempts to quantify changes in wind distributions, particularly for the extremes, are hampered by the low resolution of the climate models. This is an obvious shortcoming for the global climate models, but is also an issue for the NIWA regional model run at 30 km resolution.

This study describes approaches to estimating changes in wind extremes in the absence of very high resolution modeling. Mean sea-level pressure (SLP) data related to extreme winds have been extracted from the ECMWF ERA-40 reanalysis data set. A new technique for "trend empirical orthogonal function" analysis has been applied to both the extracted SLP data and the high percentile wind speed data. This methodology is designed to extract dominant trends in the data, which are described for the New Zealand region.

Preliminary results of future extreme wind changes will be presented, where trends in SLP patterns from the IPCC Fourth Assessment models are used as a proxy for high resolution wind speed data. These projections are complemented by analysis of wind percentile changes at the model grid-scale, and by analysis of changes in extra-tropical cyclone tracks and their intensities.

The histology and etiology of *Porites* tissue loss

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Coral reefs are one of the most spectacular and diverse marine ecosystems on earth. Scleractinian corals make up the framework for the existence of this ecosystem but recent increase in coral disease prevalence represents a serious threat to their functioning and resilience. Reports of new coral diseases have increased considerably in recent years and it is thought that the effects of global warming (especially the rise of sea surface temperatures) and anthropogenic impacts largely contribute to this increase. A new lesion, *Porites* Tissue Loss, has recently been observed at Coconut Island Marine Reserve, Oahu, Hawaii. It manifests in *Porites* corals as tissue thinning with eventual tissue loss and subsequent algal colonisation. Observations suggest that this infection progresses rapidly but almost nothing is known about its etiology. *Porites* are the main framework-building corals in Hawaii; a severe decline of this important genus could result in an ecological shift in the reef system resulting in a decline in biodiversity. The aim of this study will be to investigate and characterise *Porites* Tissue Loss. This research is important from a management perspective because only once we understand the etiology of *Porites* Tissue Loss can we mitigate against its spread. Histological examinations will be carried out to provide a systematic morphological description of this lesion followed by a characterisation of associated micobial communities in healthy and diseased tissue using fluorescence in situ hybridisation and molecular sequencing. The study will also involve measuring the photo-physiological impacts of *Porites* Tissue Loss on the coral holobiont using Imaging PAM and determining the effects of environmental factors (especially temperature and sedimentation) on the virulence of *Porites* Tissue Loss through manipulative laboratory experiments Finally, the influence of season on the behaviour of *Porites* Tissue Loss will be measured by the permanent tagging of infected colonies. The outcome of this research will provide a better understanding of the nature of *Porites* Tissue Loss and its potential effects on the environment. The investigation of the relationship between environmental factors and disease progression, as well as potential causative agent(s), will contribute to the effective conservation management of coral reefs.

Assessing community structure for conservation in temperate nearshore benthic rocky reef environments: What can diversity indices tell us?

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Monitoring programs for marine protected areas require descriptions of pre-reserve community structure that can include measures such as species similarity and distribution patterns among survey sites. Such descriptive measures, in addition to abundance and population structure, contribute to a baseline description useful in evaluating the success of reserve status on the recovery of ecologically important species. Descriptive measures used to assess community structure include patterns of species abundance, distribution, and diversity.

Diversity evaluates species richness, species evenness, and taxonomic distinctness and diversity across sites and communities, and can be calculated from baseline survey data. Although the interpretation and analyses of such indices must be undertaken with caution and an understanding of their strengths, they can be useful tools for the identification of changes in community and functional group composition due to decreased anthropogenic stressors. The Taputeranga Marine Reserve (gazetted in spring 2008) comprises 854 hectares of temperate rocky reef communities along the Wellington South Coast (WSC), NZ. The goals of our baseline study were to identify and characterise: 1) similarity in species composition across the monitoring sites; 2) patterns of species richness and evenness, 3) distribution patterns, and 4) taxonomic distinctness of the sites. In a BACI design using belt transects and quadrats in the shallow subtidal zone (5-12m), abundance measures at nine sites along the WSC were collected for three functional groups: Macro-algae (48 species), mobile macro-invertebrates (42 species), and sessile macro-invertebrates (46 species). Using PRIMER, diversity indices calculated for these three groups included Shannon species diversity (*H'),* species richness (Margalef's *D)*, evenness (Pielou's *J)*, taxonomic diversity index Δ and taxonomic distinctness index Δ*. Abundance and distribution patterns identified will be used to inform the reserve's monitoring plan and evaluate long-term changes in community structure.

Interactions between heavy metal contamination and the movement of *Austrovenus stutchburyi*

Michael Townsend, Judi Hewitt, Ngaire Phillips, Giovanni Coco

NIWA, Hamilton

The little neck clam, or common cockle (*Austrovenus stutchburyi*), is an ecologically important suspension-feeder inhabiting many of New Zealand's harbours and estuaries. Its high abundance and activities in the sediment make it a key species for influencing biodiversity, driving bioturbation and sediment reworking and regulating ecosystem processes. Cockles can often be seen moving around at the sediment surface when the tide is inundated and are capable of travelling considerable distances; in excess of 1.5m over a tidal cycle. *Austrovenus stutchburyi* is common throughout many intertidal sand flats including those around the Auckland region. Urbanisation in areas such as this, have resulted in heavy metal contaminants associated with storm-water runoff and sedimentation, to enter intertidal ecosystems. As contaminants have the potential to alter the abundance, distribution and behaviour of cockles, they may simultaneously impact ecosystem processes and goods and services. Here we present one component of our investigation into the interactions between *Austrovenus stutchburyi* and storm-water contaminants. Our laboratory based studies investigated the relationship between the levels of movement in *Austrovenus* and the concentration of sediment-bound heavy metal contamination (Copper, Zinc and Lead). We found that under laboratory conditions, size and density of cockles proved to be key factors in cockle movement, but this was unaffected by the level of sediment contamination. The presence of *Austrovenus* altered suspended sediment concentrations in the overlying water, with significantly higher concentrations in the cockles' absence. This signified the important role that this species plays in the dynamics of both sediments and contamination in estuarine pelagic and benthic environments. We compare our results with some contrasting finding from field studies and describe the potential feedback loops that exist between this species and its environment.

Ontogenetic shifts in diet for snapper (*Pagrus auratus*) within an estuary

Natalie Usmar

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Snapper (*Pagrus auratus*) is New Zealand's most important coastal finfish species, supporting large commercial and recreational fisheries around the east and west coasts of northern New Zealand. The diet of snapper was quantified within an estuary, the Mahurangi Harbour and compared to previous studies. Four *a priori* habitat types were sampled across the harbour for juvenile snapper (10–100 mm) using a 4 m beam trawl with 9 mm mesh. As snapper larger than this were assumed to be more mobile, sampling for fish from 100 mm to 600 mm was undertaken using longline and rod and reel. Benthic sampling within the *a priori* habitats was conducted on one occasion using a Smith-McIntyre grab to compare what was in the environment with the stomach contents of juvenile snapper.

Four methodologies were used to examine the stomach contents. These were percent composition, percent numerical frequency, percent frequency of occurrence and the index of relative importance. Ontogenetic shifts occurred in diet with growth. Juveniles < 20 mm consumed planktonic copepods, with > 20 mm consuming benthic copepods, mysid and caridean shrimps and polychaetes. Snapper > 100 mm consumed brachyuran crabs, caridean shrimps, bivalves, polychaetes and hermit crabs, with > 300 mm fish able to consume harder shelled molluscs and bivalves. The *a priori* habitats were equally productive in terms of prey as determined from the stomach contents and this may be advantageous for juveniles who can then select a habitat for other qualities, i.e. protection from predation.

Preferred macroalgae habitat identification for coastal reef fish recruitment and adult populations on the Otago coast

Robert Win, Chris Hepburn, Steve Wing

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New Zealand's coastal reef communities are areas of high productivity, providing habitat complexity and abundant food sources for a wide range of important customary, commercial and recreational species such as Blue Cod (*Parapercis colias)* and Greenbone (*Odax pullas)*. Macroalgae are important structuring components of these systems and play a key role in the life cycle of many temperate fish species. The East Otago Taiāpure is a small (25 km^2) locally managed fisheries area that was established in 1998. Kaitiaki/tangata Tiaki (Māori guardians) and the Taiāpure management committee have raised concerns that knowledge concerning reef fish populations and recruitment was lacking. The objective of this study was to identify critical habitat types for recruitment and adult populations of rocky reef fish species for use in management of fisheries within the taiāpure. Several methods were employed including standard monitoring units for the recruitment of temperate reef fishes (SMURF's), which were deployed within the taiāpure over three macroalgal communities (shallow *Carpophyllum / Cystophora* beds*, Macrocystis* kelp forest and deep *Ecklonia radiata* beds). Fish population surveys using stationary visual counts to quantify adult and juvenile habitat preferences and numbers present seasonally were conducted. Species composition of macroalgal communities and cryptic fish species were quantified using a 4 x 1 metre quadrat. By identifying critical macroalgal habitat for recruitment and adult fish populations the taiāpure committee will be able to advocate protection of these areas to help maintain and enhance local fisheries.

Benthic communities off eastern Waiheke Island, Hauraki Gulf

Clara Wong, Steve O'Shea

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Spatial variation in the composition of benthic-invertebrate assemblages within and proximal to an existing mussel farm off eastern Waiheke Island, is reported. Substratum type, whether muds, gravels or an admixture of the two, mud/gravels, is shown to influence species composition; the bivalve *Theora lubrica*, ostracods, amphipods and polychaetes characterise muddy substrata; polychaetes, particularly spionids and syllids, ostracods, amphipods, bivalves and ophiuroids characterise mud/gravel substrata; and diverse assemblages of polychaetes, bivalves, pagurid crabs, gastropods, ostracods, ophiuroids and nemertean worms characterise gravel substrata. Two 'formations' (*Purpurocardia* and *Echinocardium*) reported by Powell to be widely distributed throughout the region are not, as assemblages vary according to substratum, which was variable throughout the region. Gravel-based substrata throughout this region are amongst the most species rich and densely populated thus-far recognised in Waitemata Harbour. Muddy substrata in this region also host more individuals and species than any other thus-far recognised muddy substratum in Waitemata Harbour.

The effects of green-shelled mussel mariculture on benthic-invertebrate communities off eastern Waiheke Island, Hauraki Gulf

Clara Wong, Steve O'Shea

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Temporal variation in benthic-invertebrate assemblages beneath and proximal to an existing mussel farm is reported off eastern Waiheke Island for February, May and August of 2008. The existing mussel farm is reported to significantly effect sea-bed communities, but in a manner not previously reported for New Zealand in that species richness and abundance are elevated beneath it.

Beneath the farm, species richness (d), abundance (N), Shannon index (H') and Simpson index (1-λ') were higher during May and August than during February; diversity values outside the farm were similar to those beneath the farm during February and May, but species richness (d), evenness (J'), Shannon index (H') and Simpson index (1-λ') were all greater outside the farm during August.

Beneath the northern side of the farm sediments were characterised by greater abundances of polychaetes and crustaceans (Malacostraca), whereas outside the farm they were characterised by greater abundances of bivalves and ostracods. During February, sediments both inside and outside the northeastern border of the farm were characterised by similar abundances of polychaetes, bivalves and ostracods; sediments inside and outside the farm along its southern border were characterised by similar abundances of polychaetes, bivalves, crustaceans (Malacostraca) and gastropods.

No obvious difference in sediment grain size was apparent along a transect extending from 20 m inside the farm to at least 110 m outside it. The biological footprint of the farm was limited, extending no

further than 20 metres from the northern physical boundary of the farm.

Marine invertebrate larval settlement: review on chemical cues research

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Marine invertebrates have complex life histories and diverse behaviours, mediated by environmental and biological stimuli. Approximately 80% of marine invertebrates produce microscopic larvae that develop in the plankton. These larvae, which have morphologies completely unlike those of their parents, may remain in their larval phases for minutes to months, depending on the species. During this time, larvae may drift great distances in the water column, being swept along by ocean currents, before settling on a suitable substratum and metamorphosing into their adult forms. Over the past forty years or so, considerable interest has been mounting into the processes which govern larval settlement behaviour. Gaining an understanding of these processes is important to enhance our knowledge of marine invertebrate ecology, and also may assist in the development of technologies with applications in aquaculture and marine biofouling. The transition of larvae from a pelagic environment to a benthic one is, at least partially, modulated by the presence of various chemicals in the environment. These chemical stimuli often are species-specific, and may be associated only with particular substrata. Unfortunately, the identities of natural compounds which have the ability to induce larval settlement are currently unknown for the majority of marine invertebrate species. There are many challenges facing researchers who undertake such tasks. Because of these difficulties, a common technique employed to investigate settlement behaviour is the application of pharmacological compounds in the laboratory, which have the ability to induce larval settlement. Although insight into the biochemical mechanisms controlling settlement behaviour can be gained through such methods, the lack of consistency and standardisation of the techniques employed often lead to ambiguous claims in the literature. Furthermore, results of such studies often are misinterpreted, and the progression of the field restricted. These problems are compounded by the often limited collaboration among larval biologists, natural product chemists, and biochemists. Because of these issues, comparing and contrasting results from the literature are fallible. This presentation aims to review the literature on marine invertebrate larval settlement, and identifies common sources for error. This review was motivated, in part, by the results gained from our own research on larval settlement behaviour, using the New Zealand green-lipped mussel, *Perna canaliculus*, as a model species. Our results are briefly explored in this presentation, with an emphasis on those which suggest a cautionary approach should be taken by researchers when reviewing the literature, and designing future larval settlement experiments in the laboratory.

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